Meeting of the Tropical Tuna Resource Assessment Group (TTRAG)

FINAL RECORD

TTRAG 37

14-16 MARCH 2023

TROPICAL TUNA RESOURCE ASSESSMENT GROUP (TTRAG)

Chair: Dr Cathy Dichmont
Date: 14-16 March 2023
Meeting: 37
Venue: Maroochydore (Maroochy RSL Boardroom 2, 105 Memorial Avenue) and video conference
ATTANDANCE:
All members attended the meeting venue, except those identified. Chair, Dr Cathy Dichmont.

Members	Invited Participants	Observers
Dr Ian Knuckey, Science Member	David Ellis, Industry[1]	Laura Tremblay - Boyer, CSIRO
Dr James Larcombe, Science Member[2]	Terry Romero, Industry	Jessica Bolin, University of Sunshine Coast[3]
Dr Rich Hillary, Science Member (online)[4]	Paul Williams, Industry[5]	Dr Karen Evans, CSIRO[6]
Dr Ashley Williams, Science Member		Dr Jason Hartog, CSIRO[7]
Gary Heilmann, Industry Member		Selina Stoute, AFMA
Dr Julian Pepperell, Science/Recreational Fisheries Member		Dr Don Bromhead, ABARES (online)[8]
Robert Curtotti, Economic Member[9]		Dr Tim Emery, ABARES (online)[10]
Kate Martin, AFMA Member		Alice McDonald, AFMA (online)[11]
Lachlan Farquhar, Executive Officer, AFMA[12]		

[1] Present Day 1 and 3, left meeting Day 2; 3:45pm
[2] Left meeting Day 2; 4:31pm
[3] Present Agenda Item 4.2 and 4.3
[4] Left meeting Day 1 3pm; Day 2 11:20am and Day 3 11:50am.
[5] Present Day 2 9:13am and left Day 2 10:29am
[6] Present Agenda Item 4.2 and 4.3
[7] Present Day 1 and 2
[8] Present Agenda Item 4.4 only
[9] Present Day 1 11am and left Day 2 3pm
[10] Present Agenda Item 4.4 only
[11] Present Agenda Item 6 only
[12] Present Day 2 and 3

Agenda item 1 - Preliminaries

1.1 Welcome and Apologies

The thirty seventh meeting of the Tropical Tuna Resource Assessment Group (TTRAG 37) was opened at 11:00am on 14 March 2023 by the Chair, Dr Cathy Dichmont. The Chair welcomed members and observers to the meeting and:

a) made an acknowledgement of country;

b) noted the only apology for the meeting from Mr Pavo Walker, Industry Member; and

c) advised members the meeting would be recorded to assist with the preparation of the meeting record. The recording will be deleted once the record is finalised.

1.3 Declarations of interest

The standing declaration of interests was reviewed by RAG members and RAG members provided updates as necessary following last TTRAG meeting (meeting 36). The updated declarations of interest are at **Attachment 1a**.

The RAG agreed that industry members with fishing concession holdings, the industry invited participant, and CSIRO employees (science members and observers) held potential conflicts with *Agenda 5 - AFMA Research Committee – tropical tuna research funding application*. These members were asked to leave the room while the RAG considered the nature of the conflict and what action should be taken when the agenda item is discussed. The RAG members agreed on an inclusive approach to manage the perceived conflicts to make use of the expertise of members. The RAG members agreed that industry members would be involved in the discussion and recommendation making, whereas employees of CSIRO would be involved in the discussion but would be excluded from formalising any recommendations.

1.4 Adoption of agenda

The RAG adopted the agenda with the addition of a presentation on COVID-19 operational covariates under Agenda Item 3. A further amendment was made on day two of the meeting to remove the *Agenda Item 9 Resource Assessment Group and Management Advisory Committee Consultative Framework Review* due to timing constraints and acknowledging that the item was for noting only. Further the RAG noted that information on the review is available to members and members will be engaged separately by the consultants undertaking the review.

Throughout the meeting the order of agenda items was revisited to ensure presenters had sufficient time for breaks and to meet the availability of invited presenters.

The agreed agenda is at **Attachment 1b**.

1.5 Actions arising from previous meetings

The RAG noted the status of actions items and considered whether certain actions items, highlighted by AFMA, remain relevant. The status of actions arising together with RAG advice on the ongoing relevance of certain items, can be found at **Attachment 1c.**

1.6 Out of session correspondence

The RAG noted the out of session correspondence between TTRAG 36 and TTRAG 37 as detailed in the table below.

Date	Description
21 October 2022	Notification of the extension of Exemption Period Under the Import Provisions of the Marine Mammal Protection Act.
01 November 2022	Invitation to complete WTBF and ETBF National Compliance Risk Assessment 2023-25.
14 November 2022	A request from FRDC's seeking feedback on the Research Priority - Recreational data collection in the Tropical Tuna fisheries.
24 November 2022	Request for RAG advice on the ARC Research Proposal - Scientific advice for management of Tropical Tuna and Billfish Fisheries.

Agenda item 2 Member updates

2.1 Industry, recreational fishing and scientific member update

The RAG noted the following update from the recreational fishing member:

- Reports from recreational fishing tournaments held since July 2022:
    - The Mako shark tournament in August caught very few mako's and the number of boats targeting this species were down.
    - Tournament season in NSW has commenced, however ongoing high fuel price is preventing some boats from participating.
    - Heavy tackle season for adult black marlin charter bookings have increased after the impacts of COVID-19. Very few juvenile black marlins were seen off the coast of Townsville, however large numbers have been caught in Harvey Bay with larger 5kg to 15kg fish seen in January off the Sunshine coast.
- The NSW Game Fish Association (GFA) has introduced new minimum weights on blue and tiger sharks. Tiger sharks: 120kg to 250kg; blue sharks: 100kg to 150kg. The recommended weight limit changes are reviewed periodically and are important for understanding Catch Per Unit Effort (CPUE).
- 2023 marks the 50th anniversary of the start of the NSW GFA program. The program has tagged a total of 500,000 fish, including 160,000 billfish, 77,000 black marlin, 38,000 yellowfin tuna, 33,000 south bluefin tuna, 22,000 albacore and 13,000 blue marlin, along with small numbers of swordfish and bigeye tuna.

The RAG noted the following updates from the industry members:

- Reasonable catches have been experienced in the Western Tuna and Billfish Fishery (WTBF) and the Eastern Tuna and Billfish Fishery (ETBF). Striped marlin and black marlin were prominent species being caught in late 2022. Skipjack tuna have been caught by longline vessels and there has been an increase of yellowfin tuna catches early 2023 off the Sunshine coast.
- A new concession holder will begin fishing off the Albany coast, primarily targeting southern bluefin tuna and bigeye tuna.

- Tuna Australia advised that the spatial squeeze on the fishery footprint from various exploration companies such as windfarms, seismic surveys and energy exploration was a major challenge for industry and industry associations. Energy companies are continually seeking advice and impact statements from fishing companies, and industry associations on proposed exploration areas within the Australia Fishing Zone.
- The Marine Stewardship Council (MSC) have released a new 3.0 standard for certified fisheries to be assessed against. The invited industry participant noted there are potential implications on the certified ETBF swordfish fishery. Tuna Australia are continuing to work with MSC.
- Jellymeat in a swordfish has been identified in a processing distribution centre this week.
- Crew recruitment and retention remains a key challenge for all fleets, particularly around availability of international crew. The industry invited participant raised concerns with trained and experienced crew having to return home prior to reapplying for work visas.
- The fishery is slowly returning to pre-COVID 19 conditions, as freight accessibility has increased to international markets with a gradual decline in freight costs: $2.80/kg for Japan; $4.50/kg for USA. Bait prices have continued to remain high for quality squid bait ($6/kg). Fuel price continues to be high and has constrained some fishing operations.
- The predicted climatic change from La Nina to El Nino could see an abundance in yellowfin tuna with warmer water moving into key fishing locations.

2.2 AFMA Management and international meetings update

The RAG noted the:

- AFMA Management update as detailed in the agenda paper outlining outcomes from TTMAC 28 (held on 11 October 2022), and TAC decisions made by the AFMA Commission for the current season of the ETBF and WTBF. The AFMA member noted that the AFMA Commission agreed to the modified harvest strategy for Swordfish noting that the modification has been designed and tested assuming the level of recent under-catch ceases from 2025 onwards. The Commission noted that the new decision rules are intended to remain in place until the scheduled 2023 review of the HS is complete and, assuming the extreme under-catch continues, these rules are likely to guide TACC setting for the 2023 and 2024 seasons; and
- presentation by Dr James Larcombe, ABARES, on relevant outcomes from recent IOTC and WCPFC meetings. Dr Larcombe's presentation is provided at **Attachment 2.2.**

Agenda item 3 - ETBF Catch Per Unit Effort (CPUE) standardisation

3.1 CPUE 101

The RAG noted the presentation by Laura Tremblay-Boyer explaining how standardised CPUE is used to create a relative index of stock abundance. Laura Tremblay-Boyer's presentation is provided as **Attachment 3.1**.

RAG members made the following observations:

- it is important for the RAG to ensure that the impacts on CPUE standardisation are considered when designing management changes. Abrupt changes in the fishery that impact catchability cannot be readily captured by the standardisation model. This is because the model cannot discern the difference between the year effect and the abrupt change in the covariate. Potential examples for the ETBF include the rapid transition to circle hooks, the removal of wire trace and the periodic use

of lead weighting at the hook (note industry did advise that for some changes, it may take an operator 4-5 trips to get a modification 'through their gear'. This approach ensures fishing is not interrupted whilst the modification is made). Members noted that if a change occurs over three to four seasons, it can provide sufficient contrast in the data and in turn give the model the power to separate changes in catchability from the year effect (it was also noted that another way to account for an abrupt change is to add experimental data to the model).

- CPUE standardisation can only be informed by the data available. It is important therefore to have good communication between scientists, industry and managers on changes that might be occurring in the fishery that could be influential in the standardisation model, especially if the change is not described by existing fields in the logbooks (e.g., if a change in bait quality is impacting catch rates); and
- CPUE standardisation can be improved if the intended target species was reliably reported for each shot. Members noted that this field is available in the eLog. However, fishers tend not to complete it accurately.

A question was raised on the value of calculating a CPUE-based index of abundance for the ETBF tuna species noting that for those species, Australia is not a major harvester and does not have harvest strategies in place for them. Scientific members advised that the index provides a means to monitor the fishery (i.e. fishery indicators) and standardised CPUE data from the ETBF are used as an index of abundance in the broader WCPFC assessments. The AFMA member further noted that one of the objectives of the research funding proposal to be considered under Agenda Item 5 is to review the processes for recommending TACCs (i.e. harvest strategies and indicators) for the five key target species. This will enable the RAG to revisit monitoring needs for the Fishery.

3.2 A proposed approach to identify changing fishing strategies through time in the ETBF

The RAG noted the presentation by Laura Tremblay-Boyer on a new analysis undertaken to identify discrete fishing strategies through time in the ETBF. The analysis is based on an adaptive modelling approach to identifying fishing strategy metrics. Laura Tremblay-Boyer advised the RAG that it was important to have the RAG review and agree on the appropriateness of fishing strategies generated by the model prior to them being included in the CPUE standardisation model as a covariate.

One RAG member recalled that the targeting field in the electronic logbooks has historically been completed inconsistently between fishers reducing the data reliability. As a result, a proxy has been used to identify targeting strategies, with catch composition used as the proxy to date. Other possible indicators of a fishing strategy have yet to be formally considered.

The RAG noted that there can be limitations with only using species composition to determine fishing strategies as it is not always representative of targeting. Different targeting strategies are used for the same species, fishers use different gear configurations (e.g. Coral Sea), fishers may report target species as the dominant species in the catch, and strategies can change over time (e.g. Swordfish). However, it was noted that species composition on its own can be reliable for some species such as southern bluefin tuna (SBT).

The RAG noted that an alternative approach by *Parsa et al. 2020* to determine fishing strategies had been previously presented to the RAG. The method categorises fishing strategies using operational covariates, species proportion and gear covariates. Laura Tremblay-Boyer's new analysis expands on the *Parsa et al. 2020* method by using a two-step classification process. The covariates included species composition, latitude/longitude, hooks, hooks-per-float, mainline length, moon illumination and percentage of light sticks used. However, distance from the shelf/sea mount is yet to be added. Laura Tremblay-Boyer advised that

based on these covariates, a machine learning algorithm identifies fishing strategies (the model was set to identify no more than six strategies). This setting can be modified for each year of data (for this analysis annual catch data spans 1998 to 2021).

The RAG agreed that six persistent fishing strategies could be identified through the fishing strategy categorisation (also referred to as 'clusters' in the meeting). A further two possible clusters, mahi mahi and swordfish, were identified but will likely require additional gear covariates and the metric of distance to shelf or port to clearly distinguish between the strategies.

The RAG supported continued work on the new approach presented by Laura Tremblay-Boyer and **RECOMMENDED**:

- further refinement of the gear covariates to try to better define 'swordfish' fishing strategies;
- assess distance to port or distance to seamount;
- bait status: live vs dead; and
- fishing shots be grouped by set.

The RAG considered the merits of removing SBT catches from the CPUE standardisation analysis for the ETBF given the targeting strategy is clearly defined. The RAG agreed. However, a precautionary approach should be taken and further work is required to quantify the impact of removing data from the analysis noting the effort is drawn from the fishery which includes byproduct catches of swordfish and other tuna species. The RAG agreed to keep SBT catch as part of the CPUE standardisation until such time that effects of removing the data were examined.

ACTION ITEM: TTRAG to meet inter-sessionally to consider and agree on the final settings for the fishing strategies co-variate to be used by CSIRO in the CPUE standardisation model.

3.3 Impact of effort metric on standardised CPUE for broadbill swordfish in the ETBF

The RAG noted the presentation by Laura Tremblay-Boyer explaining the impact of the longline effort metric used on standardised CPUE for broadbill swordfish in the ETBF. Laura Tremblay-Boyer's presentation is included as **Attachment 3.3**. The objectives of the analysis were to determine whether hooks is an appropriate metric to be used for CPUE, especially in relation to swordfish. Industry has previously raised concern that hook numbers were not suitable measures of effort for swordfish catches due to the non-aggregating behaviour of the species.

RAG members recalled that the CPUE standardisation model for the ETBF uses catch per hook which is a traditional metric used across longline fisheries. However, industry have advised that in relation to swordfish, an increase in hooks per longline does not necessary result in an increase in swordfish catches. Fishers may increase the number of hooks on a longline to improve catches of other species, knowing that the extra hooks will not significantly lift catches for swordfish. Industry enquired about the most effective ratio of hooks/km that should be set when targeting SWO.

The RAG noted the following analysis undertaken by Laura Tremblay-Boyer and results derived:

- The nominal CPUE was compared using the number of swordfish caught per set and swordfish caught per hook. The nominal CPUE per hook showed a clear declining trend whereas the nominal CPUE per set showed fluctuation but little trend. However after standardising the indices using the gear

covariates, the two standardised indices aligned very closely. Therefore, using either hooks or set as a measure of effort results in very similar CPUE indices, as long as the gear covariates are included in the models.

- The CPUE model predicted that swordfish catch rates declined as hooks/km of line increased, confirming the effect noted by industry members is captured by the logbook data. Prior to 2006, the hook density covariate had a positive influence on the standardisation as hook density per km of mainline was lower on average prior to 2006. The hook density covariate included in the CPUE standardisation (hooks per km of mainline) shows a general increase since 1998. An industry member noted that fishers targeting SBT use fewer hooks than the northern fleet who target marlin, setting approximately 40 hooks per km of line. Clarification was provided that this is mitigated by comparing set for set, rather than aggregating data for the whole fishery.

Having considered the results presented the RAG agreed:

- the relative effect of increased hook density not having a linear relationship with SWO catches had been accounted for in the standardisation model, and that that using catch per hook or catch per set does not influence the trend of the resulting index; and
- to continue using hooks as a measure of effort in the CPUE standardisation model.

ACTION ITEM: CSIRO to provide a graph detailing the approximate catch rate of SWO in relation to mean hook density per kilometre of mainline in the ETBF.

3.4 Preliminary analysis of the effects of eddies on catch rates for tuna and billfish in the ETBF

The RAG noted the presentation by Laura Tremblay-Boyer explaining a new preliminary analysis of the effects of eddies on catch rates in the ETBF**.**

The RAG recalled that in the previous CPUE standardisation model, eddy effect was accounted for by including an eddy kinetic energy (EKE) variable. However EKE does not account for eddy type[13] or persistence. The EKE variable was removed from the standardisation model in 2022 as it was found to have no effect on the index of abundance and its inclusion resulted in the removal of a significant number of logbook records due to missing data. Noting ongoing industry advice on the importance of eddies in guiding fishing strategies in the fishery, CSIRO undertook further analysis to explore the effects of eddies on the catch rate data but using a different approach to describe the effect of eddies. The RAG noted the results presented by Laura Tremblay-Boyer were preliminary and further work is required to determine if and how such information should be incorporated into the CPUE standardisation model.

The RAG noted that the additional work undertaken by Laura Tremblay-Boyer considered the results from a recent study[14] which explored eddy effects on nominal catch rates of key target and bycatch species for deep-set longline fisheries in Hawaii. In that study the probability of catch and catch rates tended to be higher in anti-cyclonic eddies. Industry members advised that similar trends occurred in the ETBF with high catch rates in warm eddies, and minimal effort in cold eddies (with the exception of deep-setting for albacore).

[13] There are two types of eddies. In the southern hemisphere they are classified as a) warm=anti-cyclonic=high=anti-clockwise; b) cold=cyclonic=low=clockwise

[14] Arostegui, M.C., Gaube, P., Woodworth-Jefcoats, P.A. *et al.* Anticyclonic eddies aggregate pelagic predators in a subtropical gyre. *Nature* **609**, 535–540 (2022). https://doi.org/10.1038/s41586-022-05162-6

Of particular interest, the recent study used a new oceanography product developed by AVISO+ to access an open-source database of eddy trajectories including the size, location and movement of eddies (cyclonic and non-cyclonic) overtime (see www.aviso.altimetry.fr/). The model has a global scope and includes predictions of eddy trajectories for the Australian EEZ. Laura Tremblay-Boyer used the model outputs to explore potential correlations between ETBF catch rates and eddies (including eddy types). While the model is useful as an exploratory tool Laura Tremblay-Boyer advised that CSIRO could not confirm the longevity of the oceanography product as it is managed by a foreign organisation.

The RAG noted the following from Laura Tremblay-Boyer's analysis that overlayed ETBF effort data on the forecasted pattern of anti-cyclonic eddies:

- there was strong correlation between the presence of eddies and the location of fishing sets;
- fishing effort not associated with eddies, generally aligned with fishing on the shelf. Members noted that the shelf environment provides similar habitat to eddies in terms of currents and upwellings; and
- that including the East Australian Current (EAC) in the analysis may provide further insight into the relationship between currents and fishing strategy.

As a matter of interest, the Science/Recreational Member advised that while commercial fishers generally targeted eddies that were present for greater than a week, the recreational fishing sector also targets ephemeral eddies. Industry members advised the start and end of a shot and haul may not be representative of the actual curve in the line or where the longline drifted.

The RAG noted that several variables could be used to characterise the eddy effect (the effect of eddy type and proximity on fishing strategy and catch rates) including: polarity, persistence, location of set (start and end) compared to core or periphery of the eddy and direction of set. Given the range of possible variables, the RAG agreed that a stepwise approach to exploring correlations between catch rates and the outputs of the eddy model would be appropriate. As a priority the RAG **RECOMMENDED** that CSIRO explore the covariates polarity, persistence, location of set (start and end) compared to core or periphery of the eddy and direction of set. Further, the RAG **RECOMMENED** that a metric describing the EAC is incorporated in the modelling.

ACTION ITEM: AFMA to disseminate eddy journal articles to RAG members.

3.5 Characterisation of changes to the distribution of key CPUE covariates during the COVID period

The RAG noted a presentation by Laura Tremblay-Boyer showing results of further analysis investigating potential changes to key CPUE covariates during the COVID 19 period including if, and when, they changed, with the aim of understanding whether declines in swordfish catch rates during the COVID period could be explained by the variables available in the logbook data. The analysis was focused on swordfish and was undertaken in response to ongoing industry advice that fishing strategies significantly changed during COVID 19, and that the changes have not been properly accounted for in the CPUE standardisation model. Most notably, industry advised that there was significant decline in targeted fishing for swordfish.

The RAG noted the method applied by Laura Tremblay-Boyer was to examine each set and hook gear covariate separately by month and spatially between 2015 to 2022. The results showed:

- there was generally less effort (number of hooks in set) in 2020-21 compared to the years prior (2015-2019);

- As previously advised by industry, in response to the COVID 19 impacts, effort shifted to waters adjacent to north Queensland (QLD) to target albacore.
- a clear movement effect pre and post COVID 19 period with more fishing occurring closer to the QLD shelf. Industry members advised that operators fished closer in order to:

    a) adapt to the limited freight opportunities;

    b) save on fuel costs; and

    c) take tuna species that were available in the area and could be sold on the domestic market.
- During March to April and November to December 2020 the gear covariates (hooks per basket and hook density) increased due to a change in fishing strategy (shift to deep set albacore).
- Mainline length remained consistent throughout the COVID 19 period however the light stick covariate showed a significant decline during this time. Industry advised that during the COVID 19 period operators reduced their use of light sticks to reduce cost and that light sticks are generally not required when deep setting for albacore.

The RAG **RECOMMENDED** CSIRO expand the analysis to include distance to either landing port or processing site.

Agenda item 4 Research project updates

4.1 Tuna Australia Research Projects Update

The RAG noted the update on Tuna Australia research projects as presented by David Ellis, CEO of Tuna Australia and detailed in **Attachment 4.1.**

4.2 Forecasting Kudoa sp. in broadbill swordfish within the ETBF (CSIRO/University of the Sunshine Coast)

The RAG noted the outcomes to date of the project: Identifying environmental drivers associated with Kudoa sp. in swordfish within the ETBF as presented by Jessica Bolin. Ms Bolin's presentation is at **Attachment 4.2**.

The RAG noted the following general information about Kudoa spp:

- Kudoa spp. are parasitic cnidarians related to jellyfish and are about the size of a blood cell.
- there are 100 species globally infecting freshwater and marine fish. Only a small subset of Kudoa cause jellymeat and the infection is known to occur in high-value fish like swordfish, tuna, salmon, mackerel and snoek.
- there is little known about their life cycle, however what is known is that Kudoa spp secrete an enzyme into the tissue after fish death. Over the course of ~24-72 hours, the muscle can liquefy into jellymeat. It is understood that the enzyme secretion is likely triggered when the pH of the tissue drops (something that naturally occurs after death).
- Infection is assumed to arise by spores which float through water column encountering a fish and entering the tissue. The spores remain in the tissues within an oval-shaped sac called a plasmodia. Whilst it hasn't been directly observed in swordfish, in other fish, it's only when these sacs break open, that the spores and enzyme can then penetrate into the tissue.
- the species infecting swordfish within the ETBF is called *Kudoa musculoliquefaciens*
- importantly not all swordfish infected with Kudoa sp. progress to jellymeat.

The RAG noted the following key results of the project:

- the project was not designed to predict jellymeat, but rather the risk of harvesting a swordfish that is infected with Kudoa sp. and therefore might progress to jellymeat based on the presence and intensity of occurrence of the parasite in the fish. The project represents the first attempt to understand the links between the environment and the prevalence and intensity of Kudoa sp. infection in swordfish in the ETBF.
- of the total number of samples (n = ~1600) collected, just under 80% were infected with the parasite, regardless of where or when the fish were caught, with up to 50% of fish captured within a fishing trip observed to be infected. A model of the observed data against likely explanatory covariates predicted a higher prevalence of infection (i.e., more fish infected) with warm sea surface temperatures (SSTs), and in association with the southern flow of the East Australian Current. However, where the average monthly temperatures are stable and there is less variability in those temperatures between years, there is a slightly reduced risk of Kudoa infection. Of note, the model explained a low proportion of the variability in the observed data and was not deemed suitable to generate usable forecasts of Kudoa spp. infection.
- to assist fishers in assessing and potentially mitigating the risk of jellymeat, more information is needed to understand the link between infection and progression to jellymeat. Information is needed on when jellymeat is occurring throughout the supply chain and what might be contributing factors to its progression (handling, storage etc). The project team welcomes further collaboration from industry to resolve some of these information gaps. Further, more research on understanding the parasite's life history and infection process would be very useful. This includes better understanding how the parasite infects swordfish, how many spores it takes before the meat goes to jelly, and whether the swordfish can fend off infections and under what conditions.

The RAG noted advice from an industry member that jellymeat was not common. The industry member recalled experiencing around 6-7 occurrences of jellymeat. Despite this, the RAG welcomed the study as a first step and highlighted that it would be beneficial to examine whether infection rates and prevalence was correlated to certain vessel effects such as the length of trip, time on hook, whether the fish was alive or dead when hauled, and age of fish. Noting the high infection rates found in the study however, the RAG agreed the most useful next step would be to monitor the supply chain to determine when and where jellymeat is occurring and explore what factors may have caused the infection to progress to jellymeat.

The industry participant emphasised the need to review any publications to ensure they are written in the right context as to not alarm the market.

4.3 Update on FRDC Oceanography Project (CSIRO)

The RAG noted the outcomes of the completed FRDC project: *Investigate oceanographic and environmental factors impacting on the Eastern Tuna and Billfish Fishery* as presented by Dr Jason Hartog (CSIRO)**.**
Dr Hartog's presentation is at **Attachment 4.3.** The specific project objectives were to:

a) enhance AFMA and industry understanding of influence of climate-ocean system drivers upon the spatial and temporal variability of key ETBF species;

b) develop and deliver predictive models at seasonal and decadal time scales to assist management and industry planning;

c) provide operational forecasts of habitat distribution for Australia and the regional partners within the life of the project; and

d) inform harvest and allocation discussions at national and international scales.

The RAG noted:

- the outputs of the modelling work show that primary (e.g. temperature at 500m) and derived (e.g., depth of the 20°C isotherm, heat content in the upper 300m, and mixed layer depth) sub-surface oceanographic variables are likely important in influencing the spatial and temporal variability of ETBF species. However, these variables are limited in their ability to be explain catch rates. Further many of these variables are yet to be fully assessed for forecast skill (a measure of accuracy); and
- that the project has created analysis-ready datasets which will improve the accessibility of large environmental data sets that can be used in standardising CPUE and providing updates on the current ocean state.

The RAG further noted the following recommendations from the project:

- ongoing development of operational systems and engagement with the Bureau of Meteorology to include the sub-surface variables of interest should be pursued.
- a substantial limitation in assessing the environmental influence on tuna and billfish availability in the ETBF and surrounding regions is the limited fishery independent data such as that obtained from electronic tags.
- there is a need for targeted studies of species of interest in the Australian region to explore the influence of environmental variables in more detail; and
- catch data are clearly influenced by decisions made by fishers and managers, primarily to do with economics (e.g., distance from port, market price or demand), or harvest controls, which confound the ocean influences on fish distribution.

The RAG reflected that the fundamental purpose of the project was to develop a forecast tool to assist industry when making business decisions to optimise their fishing strategies. A next step would be for industry to use the tool and report back to the RAG and CSIRO on what, if anything, they found useful or would ideally like added (for example eddy age). The industry invited participants recommended that CSIRO convene an information session with industry to explain how to use the tool and volunteered to coordinate with industry on a suitable time. Dr Hartog supported this suggestion.

4.4 Comparative analysis between electronic monitoring and logbook data (ABARES)

The RAG noted the presentation by Dr Tim Emery on ABARES' comparative analysis of electronic monitoring (EM) and logbook data in the ETBF.

The RAG noted the study compared EM and logbook reporting of catch numbers per fishing activity (e.g., set or shot) for both key retained and discarded species, as well as interactions with TEP species in the ETBF between 2015-16 and 2019-20 financial years.

At a high level, the analyses presented in this report indicate that the overall level of congruence (similarity between EM and logbook data) for the ETBF was:

- superior for key commercial species compared to byproduct/bycatch species,
- higher for retained than discarded catch; and
- higher for TEP groups (i.e., seabirds, marine turtles, and marine mammals) than at a species taxonomic level.

Importantly, fleet-wide estimates across the period analysed, concealed significant inter-annual and inter-vessel variation in congruence for some species. Consequently, whether ETBF logbook data can be utilised for scientific analysis and management decision making processes, for any given species (or group of species) will depend on:

- the findings from the comparative analysis at both fleet and individual vessel levels;
- the type of analysis being undertaken and/or management process to be informed; and
- whether the EM data itself can be used directly in the analyses as a replacement for logbook data, or as a source of information to help correct for logbook biases or identify and screen out biased or non-representative logbook data.

The ABARES study provided several recommendations aimed at assisting AFMA to identify and prioritise actions to further improve their EM Program, which will maximise the significant current and future benefits of the EM and logbook data collection programs for science and management processes. At a high level these included:

- periodically review and seek to improve individual vessel EM system configurations where required;
- improve/maintain the capability of EM analysts and fishers to identify species;
- strengthen feedback and education mechanisms between AFMA and fishers where logbook reporting requires improvement; and
- prescribe clear tolerance levels for logbook reporting through the development of quantitative evaluation standards.

In discussing the results, the RAG noted:

- where congruence between EM and logbook data is high at both the fleet and individual vessel level, scientists and managers can have increased confidence that the data is representative of the actual catch/discards in that sector, and in using the logbook data directly for analysis/assessment and management purposes.
- the ability of ABARES to update the congruence analysis in the future should be expedited once the cleaning of the data is complete, as the R scripts are finalised and available.
- blue and black marlin (and shark species) can be challenging to distinguish as the line is often cut-off at the side of the boat. The dorsal fin is a key diagnostic indicator which may not be examined in this process. Scientific Member Dr Julian Pepperell offered to review EM footage to determine limitations in identifying marlin species while on busy decks or alongside the vessel.
- the original intention of EM was to improve the accuracy of logbook reporting which the congruence analysis has clearly demonstrated. Investing more resources to further refine congruence needs to be cost benefit assessed.

Agenda item 5 AFMA Research Committee – tropical tuna research funding application

The RAG was asked to consider comments from two industry invited participants on the research funding proposal received for the ETBF and WTBF from CSIRO titled: *Scientific advice for management of Tropical Tuna and Billfish Fisheries.* The RAG noted these comments were provided during AFMA's initial out-of-session consultation with the MAC and RAG however due to an administrative oversight, they were not

tabled with the AFMA Research Committee (ARC). The industry invited participant explained that it was their preference for the RAG to do more than simply roll-over past approaches to assessing and setting TACs in the fishery. The invited participant advised that in their view, a more innovative approach to research was required to explore key information needs for the fishery. Key areas for both clarification and research identified by the invited participant included:

- Revisiting the need to undertake CPUE standardisation and the current indicator monitoring process for the WTBF and ETBF tuna species. Noting that Australia is not a major harvester of those species the invited participated queried whether the current approach for the fishery is inconsistent with the Commonwealth harvest strategy.

- Pursuing research that can resolve uncertainties in the stock structure of swordfish i.e. migration as this gap determines whether swordfish is assessed under MSY principles.
- The invited participant advised that FRDC has unspent Commonwealth funds which the ETBF could apply to leverage to support an initial tagging study. Note at this time the Chair advised the RAG that as COMRAC Chair, she has a potential conflict of interest with any further discussions on pursuing FRDC funding.

- Identifying research that should be undertaken in the WCPFC to ensure the sustainability of stocks within its area of competence. The invited participant noted that such information could then inform Australia's engagement with WCPFC.

In response RAG members noted the following:

- the proposed research funding proposal will provide the scientific support for the RAG to not only provide annual advice necessary to support the current TAC setting framework for the ETBF and WTBF, but it will also provide support for the RAG to review the swordfish harvest strategy and indicators approach for tuna species. In doing so the RAG will be able to consider in appropriate detail the type of concerns being raised by the industry invited participant. Any departure from current practice will require evidence-based RAG advice and agreement by the AFMA Commission. Members agreed that it is the RAG's role to effectively establish the term of reference for these reviews and for the project, within the constraints of the project budget, to provide the necessary advice and analysis;

- whilst the ETBF may have less impact on the regional status of the tuna species, TACs can also play an important role in managing the economic performance of fishery. More explicit use of economic metrics could be considered in a future review of the current indicators approach for the tuna species;

- the project analyses (e.g., CPUE standardisation for some species) of ETBF data also inform broader WCPFC assessments;

- pursuing new research projects was in principle supported by members. However, members agreed that more comprehensive planning is required to ensure research investments properly address key information needs in the fishery. The information needs (the question) must be clearly identified and prioritised. Members agreed that it was timely for the RAG to revisit the strategic research priorities for the fishery. Members agreed that the RAG should commence a review of priorities at its July meeting. In addition, several streams of work over the next 12-18 months will assist the RAG to evaluate and re-evaluate the strategic research priorities for the fishery. These include work to be undertaken under the proposed research project, the RAG data needs review planned for March 2024 and the RAG's development of a Climate and Ecosystem Status Report for the ETBF.

- in the context of the WCPFC, it is routine for future research needs and key uncertainties to be identified alongside each stock assessment. Additionally, the SPC maintains a report card on the performance of each contracting party in meeting data collection expectations of WCPFC.

CSIRO employees (Ashley Williams, Laura Tremblay-Boyer and Rich Hillary) were asked to leave the meeting whilst remaining RAG members finalised its recommendation on the CSIRO funding proposal.

Having considered the issues raised by the industry invited participant together with what is expected under the proposal and RAG priorities over the next 12-18 months, the remaining RAG members **RECOMMENDED** that the funding proposal be supported in its current form. However, the principal investigator is to be provided written direction from AFMA and to take guidance from the RAG on priority analysis needed to ensure an innovative approach is taken to all aspects of the project. This includes review of processes for recommending total allowable commercial catches (i.e harvest strategies and indicators) for the five key target species.

Agenda Item 6 AFMA's Climate Adaptation Program

The RAG noted the presentation by Alice McDonald on AFMA's Climate Adaptation Program. Ms McDonald's presentation is at **Attachment 6.**

The RAG noted that:

- AFMA has been working with CSIRO and Fisheries Research Development Corporation (FRDC) over several years to improve understanding of climate impacts on Commonwealth fisheries. In 2021 the FRDC "Guidance on Adaptation of Commonwealth Fisheries management to climate change project" was completed, providing key adaptation resources including climate sensitivity analyses for all Commonwealth fisheries and species, and the "Adaptation of fisheries management to climate change handbook"; and

- AFMA is now undertaking a program of work to ensure that climate impacts are routinely and explicitly incorporated into the management of Commonwealth fisheries. As a foundational element of this program, in July 2022 the AFMA Commission endorsed a suite of actions to build explicit and structured consideration of available information and research on climate change impacts into RAG, MAC and Commission decision-making processes.

To progress AFMA's climate change adaptation program, RAG advice was sought on the following:

a) Would a domestic Climate and Ecosystem Status Report be beneficial for both the ETBF and WTBF?
    - The RAG agreed the Status Report would be useful initially for the ETBF and then consider those learnings and apply to the WTBF.
    - The RAG noted advice from AFMA that the development of a draft Status Report will be funded from AFMA's Climate Adaptation Program and would not be cost recovered.
    - The Recreational member noted that the Status Report should consider impacts on protected or recreational species that the fishery interacts with i.e. blue and black marlin, mako shark etc.

b) What changes are operators seeing on the water that might be linked to climate change?
    - The Chair noted there were limited operators in the meeting and it would be advisable for RAG members or AFMA's Climate Adaptation Program to meet with operators out of session.

c) Would a climate adaptation stakeholder workshop, that looks at current science on climate impacts and potential management and industry adaptation options, be beneficial?
    - The RAG agreed a workshop would be beneficial and noted Tuna Australia's offer to work with AFMA's Climate Adaptation Program to organise a workshop either via Teams or alongside Tuna Australia's research meeting scheduled for November 2023.

In summary the RAG **recommended** that priority be given to developing a Climate and Ecosystem Status Report for the ETBF and for AFMA to work with Tuna Australia to convene a climate adaptation stakeholder workshop.

Agenda Item 7 Coral Sea Zone Hook Trial

The RAG noted an update by the AFMA member on the Coral Sea Zone (CSZ) Hook Trial including:

- a summary of trial results to date, together with outcomes of the Small Working Group meeting held on 15 February 2022 **(Attachment 7)**.

- AFMA's decision to extend the CSZ Hook Trial for the 2023 and 2024 fishing seasons in its current form (retain working group and arrangements) alongside seeking a review of the trial by the TTRAG and TTMAC.

TTRAG discussed AFMA's request for advice on whether any changes to the trial arrangements are necessary to ensure sufficient information is collected to inform a future decision to amend or retain the current hook limit in the CSZ including:

- revisiting key data/information priorities having now convened the intended two-year trial and noting the original purpose of the hook limit was to reduce soak time and increase black and blue marlin survivability at haul and post release;

- the methodology for collecting data to address key data/information priorities. The current trial arrangements rely on collecting information during normal fishing. Data collection is therefore contingent on the level and nature of fishing effort;

- analysis and review of trial performance. To date AFMA has produced basic summaries of fishing data during the trial. The Small Working Group has annually reviewed the trial outcomes and MAC and RAG have been provided periodic updates;

The RAG agreed that whilst the trial has been successful in providing some data on the possible impacts of increasing the hook limit in the CSZ, the data is limited by the reduced fishing effort that occurred over the trial. The RAG recognised that the reduced effort and uptake of using sets with greater than 500 hooks was driven by several operational externalities, including COVID 19 impacts.

Noting that the arrangements for the trial were carefully designed and included safeguards to minimise impacts on marlin (catch based management triggers, together with an annual stakeholder review process) the RAG supported continuation of the trial to collect further information. The RAG agreed however that there is a risk that if fishing effort remains low (in particular fishing effort using the sets with increased hook numbers) during the trial extension, the data collected may be insufficient to determine the likely impacts of increasing the hook limit on interactions with marlin species and TEPS (in particular turtles).

Noting support from the relevant RAG scientific members, the RAG **RECOMMENDED** that scientific advice be developed out-of-session by the Scientific Members of the Small Working Group (Dr Ashley Williams, Dr Ian Knuckey and Dr Julian Pepperell) on an appropriate sampling design to determine the impacts of increasing the CSZ hook limit on interactions with marlin species and TEPS (in particular turtles). The RAG understood from AFMA that it would then be a matter for industry to meet the requirements of the final sampling design during the trial extension and that if the sampling requirements were not met, the trial may be discontinued until such time that industry has the capacity to complete the sampling. The RAG noted and supported AFMA's recommendation for future data analysis to be undertaken by scientific experts.

Agenda Item 8 TTRAG Priorities and Meeting Schedule

The RAG discussed, and provided advice on, key RAG priorities for the short to medium term. The RAG supported the draft list of priorities tabled by AFMA and provided additional guidance as necessary for some items (**Table 1).** To ensure ongoing review of priorities the RAG agreed for TTRAG priorities to be a standing agenda item for the March RAG meeting.

Table 1 TTRAG priorities tabled by AFMA with corresponding advice from TTRAG

Priority	Description	RAG advice
Provide advice on TACCs	This is a key standing priority for the RAG. The Commission has agreed a process for monitoring and providing advice on TAC in the ETBF and WTBF comprising a mix of an indicator and harvest strategy approach. Undertaking the analysis necessary to support the RAG advice is proposed in the CSIRO funding application to be considered under Agenda Item 5.	**Supported as a priority** The RAG noted that AFMA requires this to be a standing priority of RAG.
Review CPUE standardisation	Continue to refine data inputs that inform the CPUE indices which in turn inform advice for recommending total allowable commercial catches (TACC's). Further work on the CPUE standardisation is proposed in the CSIRO funding application to be considered under Agenda Item 5.	**Supported as a priority** The RAG noted the recent work undertaken by CSIRO aligns with this priority.
Review the Swordfish Harvest Strategy	The Swordfish Harvest is due for review. The ETBF Management Strategy, commits AFMA to reviewing the harvest strategy 3 years after implementation to assess if the harvest strategy is functioning in a manner consistent the results of the MSE and CHSP requirements and at the same time providing settings that meet AFMAs objectives and industries preferences of	**Supported as a priority with clarification** The RAG emphasised the need for the RAG to provide guidance to the eventual project team on the nature and extent of the harvest strategy review together with ongoing peer review and feedback.

	stability/reactivity. A review of the harvest strategy is proposed in the CSIRO funding application to be considered under Agenda Item 5.	
Review process for recommending TACs for Tuna species	At the last RAG (July) /MAC meeting (October), it was discussed whether process/analysis for recommending TACs for tuna species could be refined. A review of the current approach is proposed in the CSIRO funding application to be considered under Agenda Item 5.	**Supported as a priority with clarification** As above the RAG emphasised the need for the RAG to provide guidance to the eventual project team on the nature and extent of the review together with ongoing peer review and feedback.
Review impact of international fisheries on the fish resources	This has been a standing priority for the RAG and MAC and is proposed in the CSIRO funding application to be considered under Agenda Item 5.	**Supported as a priority with clarification.** This priority relates to the ongoing 'evaluation' of impacts of international fisheries on the fish resources as opposed to a unique review.
Review data needs	Based on relevant research (for example the EM/Logbook congruence study), reviews (CPUE standardisation), risk assessments (ERA) and future harvest strategies, the data needs and programs for collecting that data should be reviewed. This can be addressed as a standalone body of work or done on an as needs basis in response to new information.	**Supported as a priority** The RAG agreed to review data needs in the fishery at its meeting in March 2023.
Coral Sea hook trial	To be discussed under Agenda Item 7. RAG advice and oversight, where appropriate, of the ongoing evaluation of increasing the hook limit in the Coral Sea Zone will be required to ensure an informed management decision can be made.	**Supported as a priority** Refer to outcomes under agenda item 7.
Pulse event	At its meeting on October TTMAC (meeting 28) agreed for a working group to be formed to explore species specific pulse events and to consider the aspects of such events that could lead to the implementation of any management arrangements. TTRAG advice will likely be	**Supported in principle a priority** The RAG noted that the need for specific RAG advice will be informed by ongoing discussions between AFMA and industry to identify possible management options to better maximise returns from pulse abundance events.

	required to guide an evaluation of feasible management options.	Once preferred options have been identified the RAG can then advice on the likely ecological impacts.
Ecological Risk Assessment and response	The Wildlife Trade Operation approval is subject to conditions that by 2024 (July; ETBF) and (November; WTBF) AFMA must publish an updated Ecological Risk Assessment. The data used to inform the updated Ecological Risk Assessment includes fishing operations data collected since the implementation of electronic monitoring in the fishery. Updating the ETBF and WTBF ERAs are included in the priority fishery's for completion by CSIRO 2023/24.	**Supported as a priority**
Performance review of seabird management arrangements	The Seabird TAP is currently under review. AFMA will need to assess its management arrangements against any changes to the Seabird TAP that might be agreed following the review. In preparation and consistent with good practice, AFMA will seek advice from both the RAG and MAC on the performance of current seabird management arrangements.	**Supported in principle as a priority** Further advice is expected from AFMA on the need for specific RAG advice. This will be informed by work planned by AFMA to review the performance of seabird management arrangements in the fishery.
Responding to outcomes of the ETBF EM and Logbook Congruence Project	To be discussed under Agenda Item 4.3. The ETBF EM and Logbook Congruence Project may: 1. inform and improve scientific analyses in the ETBF such as CPUE standardisation; and 2. guide improvements, if needed, to logbook and/or EM data collection programs (including for specific species, vessels or sectors).	**Supported in principle as a priority** This priority is to be revisited following the consideration of the project outcomes which was scheduled after the RAG's consideration of this agenda item.
Climate Change Adaptation program	To be discussed under Agenda Item 6. The ultimate objective of the AFMA's Climate Change Adaptation program is to ensure climate change information is incorporated into fisheries management advice and decisions in AFMA's Commonwealth fisheries.	**Supported as a priority** Refer to outcomes under Agenda Item 6.

Agenda Item 9 Other Business

There was no other Business identified for the meeting.

Agenda Item 10 Next Meeting

The RAG was invited to agree on a date and venue for the next meeting. The RAG agreed for:

- an inter-sessional meeting to be held online in June 2023 to consider and agree on the final settings for the fishing strategies co-variate to be used by CSIRO in the CPUE standardisation model; and
- TTRAG 38 to be held in person between 12-13 July 2023.

Attachment 1a

Member, invited participant and observer's declarations of interest as advised to date.

Position	Membership	Declared Interests
Dr Cathy Dichmont	Chair	Has a consulting company but has no pecuniary interests in the tuna fisheries. Is the current Commonwealth Research Advisory Committee (ComRAC) chair.
Ms Kate Martin	AFMA Member	Employee of AFMA, which includes a salary. Is the Manager of the tropical tuna fisheries. No pecuniary interest in tropical tuna fisheries.
Ms Selina Stoute	AFMA, Senior Manager, Tuna and International Fisheries	Employee of AFMA, which includes a salary. Is the Senior Manager of the Tuna and International section. No pecuniary interest in tropical tuna fisheries.
Mr Lachlan Farquhar	Executive Officer	Employee of AFMA, which includes a salary. Is a Senior Management Officer in the tropical tuna fisheries team. No pecuniary interest in tropical tuna fisheries.
Ms Laura Tremblay Boyer	Scientific Invited Participant	Employee of CSIRO, no pecuniary interest in Australian tropical tuna fisheries. Is the Co-investigator for the *Scientific advice management of Tropical Tuna and Billfish Fisheries* project Declared an interest in Agenda item 5 and was excluded from formalising any recommendations
Dr Julian Pepperell	Scientific/Recreational Member	Independent fisheries consultant and representative of the recreational fishing sector. Is currently undertaking research into gamefishing. Is involved in projects including the monitoring of fish landed at game fishing tournaments and pop-up satellite tagging on juvenile Black Marlin.
Dr Ian Knuckey	Scientific Member	Has a consulting company with interests in electronic reporting in the tuna fisheries, and is a member on several other AFMA Committees. Is working on a commercial, recreational and indigenous capacity building project with DAWE. Involved in a project regarding threaten endangered and protected species (TEP) interactions in the small pelagic fishery.
Dr Rich Hillary	Scientific Member	Employee of CSIRO, no pecuniary interest in Australian tropical tuna fisheries. Is the Co-investigator for the *Scientific advice management of Tropical Tuna and Billfish Fisheries* project Declared an interest in Agenda item 5 and was excluded from formalising any recommendations
Dr Ashley Williams	Scientific Member	Employee of CSIRO, no pecuniary interest in Australian tropical tuna fisheries. Is the PI for the project on *Data Management, Assessment and implementation of Harvest Strategy for Australia's Tropical Tuna and Billfish Fisheries.* Declared an interest in Agenda item 5 and was excluded from formalising any recommendations
Dr James Larcombe	Scientific Member	Employee of ABARES, involved in fisheries research, primarily through engagement with the Western Central Pacific Fisheries Commission. Has no pecuniary interest in the Australian Tropical Tuna Fisheries.
Mr David Ellis	Industry Invited Participant	Is currently the CEO of the industry association, Tuna Australia which includes a salary paid by industry. Declared an interest in Agenda item 5.
Mr Gary Heilmann	Industry Member	Industry member, director of a processing company, no longer holds ETBF boat or quota SFRs. Member of Tuna Australia.
Mr Paul Williams	Industry Invited Participant	Director of a company that holds an ETBF boat SFR, ETBF quota SFRs. Member of Tuna Australia. Declared an interest in Agenda item 5.

Mr Terry Romaro	Industry Invited Participant	Director of a company that owns Eastern Tuna and Billfish Fishery (ETBF) boat statutory fishing rights (SFRs), minor line SFRs, ETBF longline SFRs, Western Tuna and Billfish Fishery (WTBF) boat SFRs, WTBF longline SFRs, Western Skipjack Tuna Fishery (WSTF) purse seine permit, Small Pelagic Fishery (SPF) purse seine, mid-water trawl SFRs, and SPF quota SFRs. Shareholder of a company that owns shares in a proposal to fish with foreign longliners in the WTBF. Industry member on Southern Bluefin Tuna (SBT) and Tropical Tuna MAC, Invited participant for TTRAG, and industry representative at the Commission for the Conservation of SBT (CCSBT) & IOTC. Invited participant for squidRAG and squid concession holder. Director of a company who owns a fish processing facility in Port Lincoln. Member of Tuna Australia. Declared an interest in Agenda item 5.
Mr Robert Curtotti	Economics Member	Employee of ABARES, involved in fisheries economic research related to the Eastern Tuna and Billfish Fishery. Has no pecuniary interest in the Australian tropical tuna fisheries.
Dr Jason Hartog	Observer, CSIRO	Employee of CSIRO, no pecuniary interest in Australian tropical tuna fisheries. Is actively engaged in Oceanography research project. Declared an interest in Agenda item 5 and Agenda item 5 and was excluded from formalising any recommendations.
Dr Tim Emery	Observer, ABARES	Employee of ABARES, involved in fisheries scientist EM vs logbook congruence project. Has no pecuniary interest in the Australian tropical tuna fisheries. Only present during Agenda item 4.4.
Ms Alice McDonald	Observer, AFMA	Employee of AFMA, which includes a salary. Climate Adaptation Senior Program Manager. No pecuniary interest in tropical tuna fisheries.
Dr Karen Evans	Observer, CSIRO	Employee of CSIRO. No pecuniary interest in Australian tropical tuna fisheries. Has been a PI on multiple projects focused on tuna and billfish species in the past funded through AFMA and FRDC but leads no projects at present. Was a past member on the AFMA Commonwealth Fisheries Marine Mammal Working Group. Only present for agenda items 4.2 and 4.3.
Ms Jessica Bolin	Observer, University of the Sunshine Coast	Student of University of Sunshine Coast, no pecuniary interest in Australian tropical tuna fisheries. Is an PhD student investigating the incidence of jellymeat in swordfish. Only present for agenda items 4.2 and 4.3.
Dr Don Bromhead	Observer, ABARES	Employee of ABARES, involved in fisheries science EM vs logbook congruence project. Has no pecuniary interest in the Australian tropical tuna fisheries. Only present during Agenda item 4.4.

Attachment 1b

Tropical Tuna Resource Assessment Group

Meeting 37 14-16 March 2023

Venue – Maroochy RSL – Boardroom 2
105 Memorial Avenue, Maroochydore QLD

Tuesday 14 March – Thursday 16 March 2023

Day 1. Tuesday: 1030 – 1630 hrs

Day 2. Wednesday: 0900 – 1700 hrs

Day 3. Thursday: 0830 – 1300 hrs

1. Preliminaries

1.1 Welcome and apologies
1.2 Declaration of interests
1.3 Adoption of agenda
1.4 Actions arising from previous meetings
1.5 Out of session correspondence

2. Member updates

2.1 Industry, recreational fishing and scientific member update
2.2 AFMA Management update/international meeting update

3. ETBF Catch Per Unit Effort (CPUE) standardisation

3.1 CPUE 101
3.2 A proposed approach to identify changing fishing strategies through time in the ETBF
3.3 Impact of effort metric on standardised CPUE for broadbill swordfish in the ETBF
3.4 Preliminary analysis of the effects of eddies on catch rates for tuna and billfish in the ETBF
3.5 Characterisation of changes to the distribution of key CPUE covariates during the COVID period.

4.Research project updates

4.1 Tuna Australia Research Projects Update (Tuna Australia)
4.2 Forecasting *Kudoa* sp. in broadbill swordfish within the ETBF (CSIRO/University of the Sunshine Coast)
4.3 Update on FRDC Oceanography Project (CSIRO)
4.4 Comparative analysis between electronic monitoring and logbook data (ABARES)

5. AFMA Research Committee – tropical tuna research funding application

The RAG will be asked to provide further advice on the research funding proposal received for the ETBF and WTBF from CSIRO titled: *Scientific advice for management of Tropical Tuna and Billfish Fisheries*.

6. AFMA's Climate Adaptation Program

AFMA is implementing a program of work to better integrate climate impacts into management of Commonwealth fisheries (AFMA's Climate Adaptation Program). Foundational actions in this program of work include sharing fishery specific results of the sensitivity analyses and projections, adding a Climate Change agenda item to RAG and MAC meetings, and developing Climate and Ecosystem Status reports for key fisheries. AFMA management will present this initiative to the RAG.

7. Coral Sea Zone Hook Trial

AFMA has extended the Coral Sea Zone (CSZ) Hook Trial for the 2023 and 2024 fishing seasons. Noting, the trial results to date, AFMA management is seeking RAG advice on the need to change any of the trial arrangements.

8.TTRAG Priorities and Meeting Schedule

The RAG will be asked to provide advice on key RAG priorities for the short to medium term. Having agreed priorities and a corresponding work plan aims to achieve a more efficient RAG process

9. Other Business

Members will be invited to raise any other Business agreed by the Chair. Note there is no meeting paper for this item

10. Next Meeting

The RAG will be invited to agree on date and venue for the next meeting. Note there is no meeting paper.

Attachment 1c

Table 1. Actions Items Prior to TTRAG 37

Number	Action	Meeting Raised	Responsibility	Status at TTRAG 37
1	In relation to the ETBF data dictionary: a. CSIRO to provide AFMA with a copy of the CSIRO Tuna Legacy Data as described in the Data Dictionary. b. AFMA to provide more details for the ADC line tables to CSIRO	TTRAG 29	AFMA	**COMPLETE:** Since TTRAG 31, AFMA has confirmed they have a copy of the Tuna Legacy database, AFMA will continue to liaise with CSIRO on additional data tables.
2	AFMA to update the Significant Events spreadsheet with the suggestions made by the RAG	TTRAG 32	AFMA	**COMPLETE:** AFMA sought guidance on whether this remains an applicable action item for the RAG. The RAG agreed to remove this as an action item as it will be a standing agenda item presented in July TTRAG meetings.
3	AFMA to include Dr Robert Campbell's WCPFC SC paper that contains explanatory notes for significant events in the fishery alongside the Significant Events spreadsheet in future.	TTRAG 32	AFMA	**COMPLETE:** AFMA sought guidance on whether this remains an applicable action item for the RAG. The RAG agreed to remove this as an action item as it will be a standing agenda item presented in July TTRAG meetings.
4	Future data summaries to a. remove the linear trend line from the catch plots and b. provide more information of discards such as including life status and context around discards relative to effort, and c. present future size data summaries to show trends over time (e.g. by year) rather than by quarter.	TTRAG 32	CSIRO	a. **COMPLETE**: Linear trend line was removed from catch plots and presented in the ETBF size summary paper at TTRAG36. b. **COMPLETE:** AFMA sought guidance and the RAG agreed to keep this as an ongoing action item, due to the importance progressing the action item into the future with AFMA and CSIRO. c. **COMPLETE**: Annual trends in size data were presented in the ETBF size summary paper at TTRAG36

5	ABARES to pursue options to take account of SBT in the catch figures and calculations of GVP and NER for the ETBF and include SBT in future ETBF economic indicators for TTRAG considerations.	TTRAG 33	ABARES	**IN PROGRESS:** Economics Member Robert Curtotti to provide update at TTRAG39.
6	AFMA to investigate, if possible, whether bait changes have been experienced by NZ and the Spanish.	TTRAG 33	AFMA	**IN PROGRESS**: AFMA will investigating the potential data and will provide an update at TTRAG38.
7	AFMA to add collection/updating of recreational catch data for Australia and NZ, particularly non-club take of yellowfin and striped marlin for consideration as a future research priority.	TTRAG 33	AFMA	**COMPLETE:** AFMA sought guidance and the RAG agreed to remove as an action item as ComRAC have put a call for research proposals for alternate sources of recreational catch data for Tropical Tunas & Billfishes. Additionally, TTRAG conducts annual and 5 yearly research plans for the ETBF and WTBF at July RAG meetings. This recommendation is considered by the RAG through its normal business.
8	AFMA to work with Tuna Australia to develop operationally feasible options to capture discard sizes for swordfish. i.e. (E-log comment section, tick box for fish between 10-20kg, head only, small, medium or large).	TTRAG 34	AFMA & Tuna Australia	**COMPLETE:** AFMA sought advice from the RAG, the RAG agreed to keep this as an ongoing action item, due to work currently being undertaken with CPUE standardisation and noted this agenda may inform future data priorities.
9	TTRAG to be provided an update in the new year on the Management Procedure for big eye tuna.	TTRAG 35	ABARES/AFMA	**IN PROGRESS:** Management Procedure for bigeye tuna to be presented at TTRAG 38.
10	To collate comments for the Draft Five-Research Strategic Document and Annual Research Plan and provide an update at TTRAG 36	TTRAG 35	AFMA	**IN PROGRESS**: Members comments were collated out of session, however the AFMA research strategic plan was endorsed in November last year. RAG to finalise tropical tuna five-year strategic research plan at TTRAG38.
11	AFMA and CSIRO to investigate the differences and potential inconsistences in set times, including auto-time adjustments from what is being recorded in electronic logs entries and the AFMA database.	TTRAG 35	AFMA/CSIRO	**IN PROGRESS**: AFMA is continuing to investigate the inconsistencies in set times relating to the AFMA database.

12	The modified harvest strategy will be reviewed 2023, the review must include assessing the continuation if the low recruitment within the fishery; if under-catch remains low and continues due to the market conditions; and review the percentage of Australian catch relatively to other countries fishing at/near the Australian EEZ has been incorporated adequately.	TTRAG 35	AFMA	**NOTED:** AFMA sought guidance on whether this remains an applicable action item for the RAG. The Harvest Strategy is due for review and subject to funding will commence in 2023. The review will consider TTRAG advice, including this recommendation. TTRAG agreed to remove this as an agenda item.
13	TTRAG to revisit the regions used in considerations of TACC for ETBF target species to ensure they are consistent with the needs of the RAG.	TTRAG 36	TTRAG	**IN PROGRESS:** To be discussed in TTRAG38.
14	ABARES to examine congruence between logbook and CDR data in the ETBF over time to determine if there is a need to alter the calculation of CPUE to ensure a consistent factor for GVP calculations.	TTRAG 36	ABARES / Economics Member	**IN PROGRESS:** To be provided at TTRAG39.
15	AFMA to distribute and confirm TTRAG meeting dates for 2023	TTRAG 36	AFMA	**COMPLETE:** Meeting dates confirmed.

Table 2. Action Items Relating to CPUE as of TTRAG37

	Item	Meeting Raised	TTRAG comments
1.	CPUE analyses: CSIRO to contact ABARES scientists regarding their 'clustering' analyses work to determine if it may provide insights for improving the CPUE analyses (and vice versa).	TTRAG 21 TTRAG 22	**COMPLETE:** CSIRO is implementing a modified version of the ABARES approach in the updated analysis of fishing strategy. Presented at TTRAG37.
2.	CSIRO will look to explore potential changes in fishing practices (particularly with the start of set location) associated with the introduction of Marine Parks, and determine potential implications for CPUE standardisations.	TTRAG 23	**COMPLETE:** AFMA sought guidance and the RAG agreed to keep this as an ongoing action item, due to work being undertaken with CPUE standardisation and noted this agenda item may inform future data priorities.
3.	TTRAG to consider development of Time Depth Recorder (TDR) based research and/or data collection in the ETBF to better understand and account for (in CPUE analyses) the relationship between fishing strategies (including vessel log speed, shooter speed and dropper lengths etc) and fishing depth.*	TTRAG 23	**COMPLETE:** AFMA sought guidance and the RAG agreed to keep this as an ongoing action item, due to work being undertaken with CPUE standardisation and noted this agenda item may inform future data priorities.
4.	AFMA to examine VMS data to check and verify sets reported on logbooks as having mainline lengths greater than 100km. TTRAG to consider frequency distributions of values for all factors used in CPUE standardisations and provide advice regarding the removal of outliers.	TTRAG 24	**ONGOING**: At TTRAG 37, CSIRO presented distributions of variables used in the CPUE standardisation to identify appropriate thresholds for outliers/erroneous entries.
5.	TTRAG 29 discussed how e-logs may allow better collection of gear information through the ability to prepopulate fields that do not regularly change, and the need for the fleet to form good reporting habits at the start of the elog transition relating to additional potential fields, specifically, those required by WCPFC logbooks and ROP, fields relevant to collecting data on depredation, and shape of mainline set.	TTRAG 29	**COMPLETE:** AFMA sought guidance and the RAG agreed to keep this as an ongoing action item, due to work being undertaken with CPUE standardisation and noted this agenda item may inform future data priorities.

Australian Government
Department of Agriculture, Water and the Environment
ABARES

TTRAG March 2023 RFMO Update

James Larcombe

IOTC - Scientific Committee (5 to 9 December 2022)

- **New stock assessments** for bigeye, albacore, blue marlin and Indo-Pacific sailfish.
- Note IOTC uses MSY-based reference points to define status (< Bmsy = overfished).

  Hence some of the red stocks would <u>not</u> be defined as overfished under the domestic CHSP (i.e. below 20%) (see asterisks)

Table 1. Stock status of IOTC key species, derived from MSY-based reference points defined by the IOTC. The only exception is skipjack tuna, for which depletion-based reference points are used.

	Stock	IOTC Status Determination (and assessment year)	Estimated depletion[1]	
new	Bigeye tuna	Subject to overfishing and overfished (2022)	SB_{2020} / SB_0 (80% CI) = **0.25** (0.21-0.34)	*
	Yellowfin tuna	Subject to overfishing and overfished (2021)	SSB_{2020} / SSB_0 (80% CI) = **0.31** (0.24-0.38)	*
	Skipjack tuna	Not subject to overfishing and not overfished (2020)	SB_{2019} / SSB_0 = **0.45** (0.38-0.5)	
new	Albacore	Not subject to overfishing and not overfished (2022)	SB_{2020}/SB_0 = **0.36** (0.26-0.45)	
	Swordfish	Not subject to overfishing and not overfished (2020)	SB_{2018}/SB_{1950} (80% CI) = **0.42** (0.36–0.47)	
	Black marlin	Uncertain (2021)	B_{2019}/B_0 (80% CI) = **0.73** (0.53-0.95)	
new	Blue marlin	Subject to overfishing and overfished (2022)	B_{2020}/B_0 (80% CI) = **0.36** (0.26 – 0.50)	*
	Striped Marlin	Subject to overfishing and overfished (2021)	SB_{2019}/SB_0 = **0.06 - 0.12** (0.05–0.19)[2]	
new	Sailfish	Not subject to overfishing and not overfished (2022)	B_{2019}/B_0 (80% CI) = **0.58** (0.47 - 0.71) **CHECK**	
	Longtail tuna	Subject to overfishing and overfished (2020)	n.a.	
	Spanish mackerel	Subject to overfishing and overfished (2020)	n.a.	

IOTC - Scientific Committee (5 to 9 December 2022)

Harvest strategies/Management procedures

- Bigeye. The management procedure was run:
  - recommended TAC of 80,583t per year for 2024 and 2025, which requires a 15% catch reduction from the 2021 catch level.
  - IOTC still needs a mechanism to implement catch limits, in line with the TAC (Commission meeting in May 2023?).

- Skipjack.
  - Recent catches have been exceeded the TACs from the agreed MP (by ~18-26%).
  - The skipjack MP is being redeveloped. MSE through 2023 with adoption of an MP proposed for 2024

- Yellowfin.
  - MSE and MP development for yellowfin tuna is currently on hold pending further consideration of an alternate approach to the operating model.

- Albacore and Swordfish. MSE work continuing.

IOTC - Scientific Committee (5 to 9 December 2022)

Bycatch

- Seabird mitigation - The SC recommended that the Commission include hook-shielding devices as an additional option for seabird bycatch mitigation in Resolution 12/06.
- Billfish - The SC recommended that the Commission review and update the catch limits for striped marlin, black marlin and Indo Pacific sailfish in Resolution 18/05 + consider non-retention conditions for blue marlin.

Monitoring and reporting

- Electronic monitoring standards - The SC recommended that the Commission adopt the EM terms and definitions, Program standards and Data standards.

IOTC – Other meetings

- Technical Committee on Allocation Criteria (TCAC11), 30 Jan-2 Feb.
- Special Session of the IOTC (Commission), 3-5 Feb 2023. Focused on FAD management,

Upcoming

- Working Group on Electronic Monitoring Standards, Mar 2023
- Management Strategy Evaluation Task Force, Mar 2023
- Technical Committee on Management Procedures (TCMP), May 2023
- **IOTC Commission meeting, May 2023**

WCPFC - Commission Meeting (28 Nov to 3 Dec 2022)

(See also the summary provided in the TTRAG meeting docs – page 16-17)

- Swordfish
  - FFA, lead by AUS, tabled a new measure designed to ensure the future of the stock and it's dependant fisheries. "Action now while we are in good shape."
  - Contained a set of management controls designed to constrain all sources of mortality.
  - Good progress on the controls for the longline bycatch fleets.
  - Opposition from the EU (target fleet) meant now agreement.

- New Shark conservation measure adopted.
  - Ban on the use of both wire leader and "shark lines" in the equatorial area (20S to 20N)
  - Driven by the ongoing poor status of silky and oceanic whitetip.
- Climate Resolution
  - Consider the potential impacts on tuna/billfish and impacts to national food security and livelihoods. ++

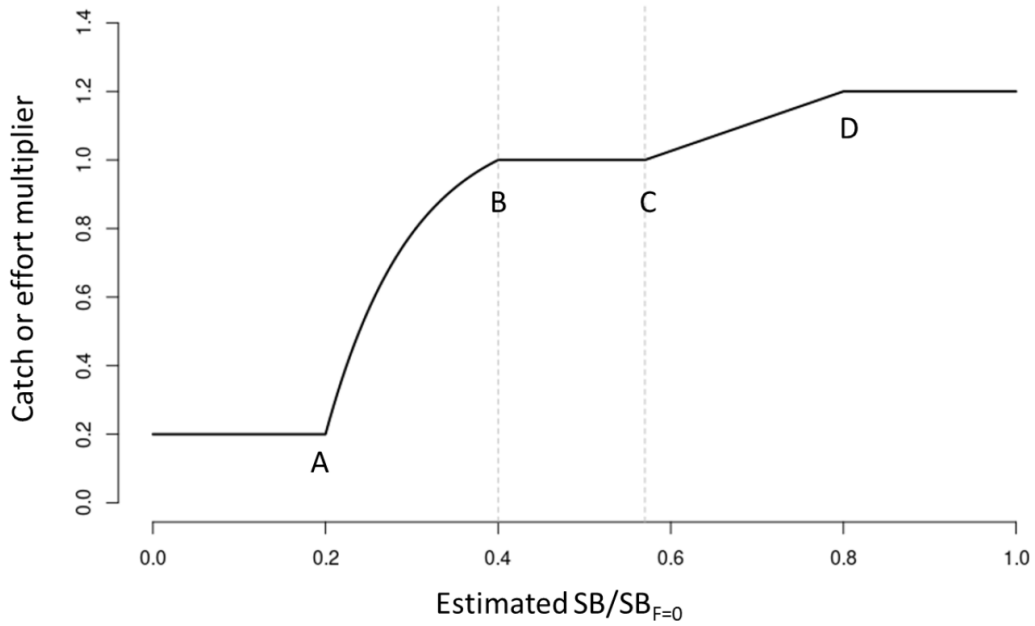
WCPFC - Commission Meeting (28 Nov to 3 Dec 2022)

Harvest strategies/Management Procedures

- Skipjack Management Procedure adopted
  - Significant step.
  - Implications for MSC certification of (not just for skipjack.
  - Demonstrated WCPFC is working towards implementing harvest strategies so implications for other species (e.g. SWO).

- Albacore next priority
  - Revised TRP 2023
  - Adopt MP in 2024

- YFT and BET further off



Skipjack harvest control rule

WCPFC – Other meetings

Upcoming

- Various Forum Fisheries Agency (FFA) meetings. Focus on South Pacific albacore.

- **WCPFC Scientific Committee meeting, August 2023.**
  - Scheduled updates to yellowfin and bigeye stock assessments (following peer review)

CPUE 101

Key concepts in CPUE standardisation informing ETBF abundance indices

Laura Tremblay-Boyer & Ashley Williams

Presentation to TTRAG 37

Maroochydore, March 14th to 16th 2023

Introduction

- CPUE standardisation is a modelling approach used to derive an index of abundance from catch-and-effort data
- Key technique underpinning the management of ETBF fisheries: it is used to monitor the status of albacore tuna, bigeye tuna, yellowfin tuna, broadbill sworfish and striped marlin, and informs the harvest strategy of broadbill swordfish

Introduction

- Ongoing changes in 2022 and 2023 to the approach used to standardise CPUE:
  - addressing feedback from the TTRAG
  - utilise modern statistical techniques to model complex relationships
  - switch to more comprehensive oceanography dataset (e.g. ACCESS-S2 from BOM)
  - streamline process to improve implementation and reproducibility

Overview

- CPUE (the amount of catch per unit of effort) should be proportional to local abundance pending everything else is equal
- It is the ratio of catch to the amount of fishing effort
- Unit of catch and effort should be chosen to be reflective of fishing practices
- In the ETBF, we use:
  - catch in number of individuals
  - effort in hooks
  - number of individuals per hook is 'conventional' units for longline fisheries because of the configuration of the fishing gear
  - effort could be another metric, e.g. fishing set or mainline length

Overview

- Nominal CPUE: raw catch rates, e.g. from the logbooks
- Standardised CPUE: based on a statistical model that predicts nominal CPUE as a function of environment and fishing covariates, predicts change in nominal CPUE if we artificially held everything else equal

Overview

- Standardised CPUE is a relative index of abundance: it does not tell us how many animals are in the water, but it tells us if the number is increasing or decreasing compared to a reference period *(e.g., 1998 in the ETBF)*
- Catch rates can vary because of factors impacting local density or catchability

  - Local density: season, daily weather, location, moon phase, etc.
  - Catchability: gear configuration, skipper experience/skill, bait type, moon phase, etc.
  - **… and luck!**

- When catch rates change because of changes of catchability (different bait types, good skippers leaving the fleet, etc.), nominal CPUE is not reflective of abundance

Overview

- Goal of CPUE standardisation: to remove the effects of catchability changes from the nominal CPUE data, i.e. distangle the effects of catchability vs. density effects on CPUE
- Luck (or noise) is why we need statistical models: even in ideal conditions, catch rates are variable---need to separate signal from noise

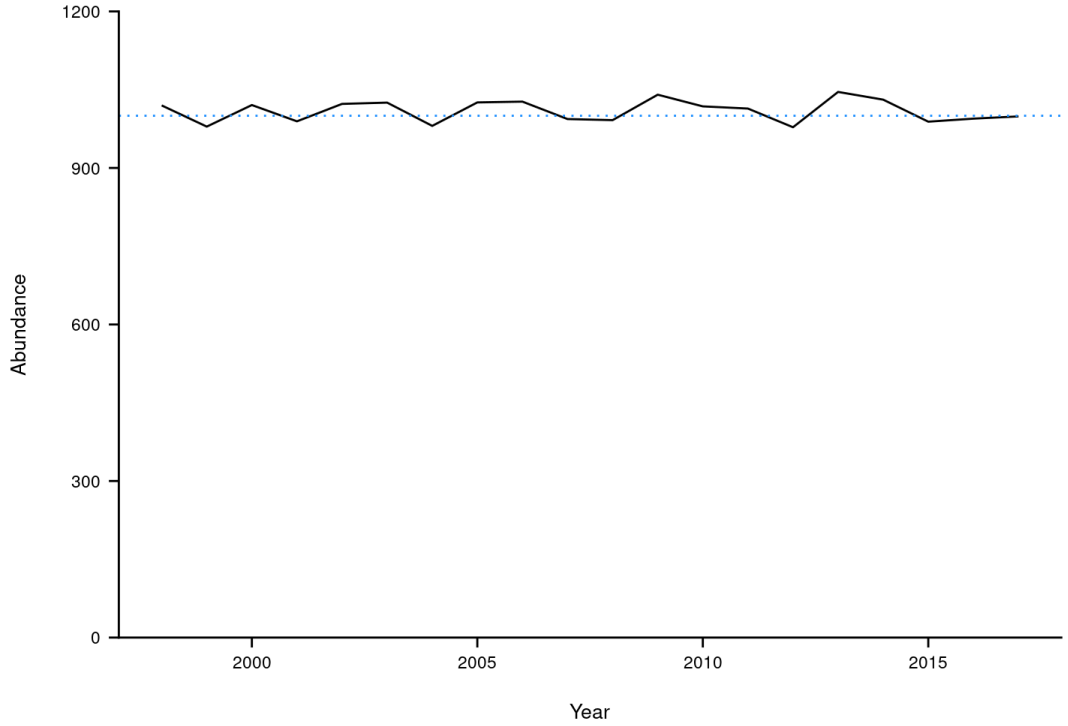
How do we standardise CPUE?
Terminology

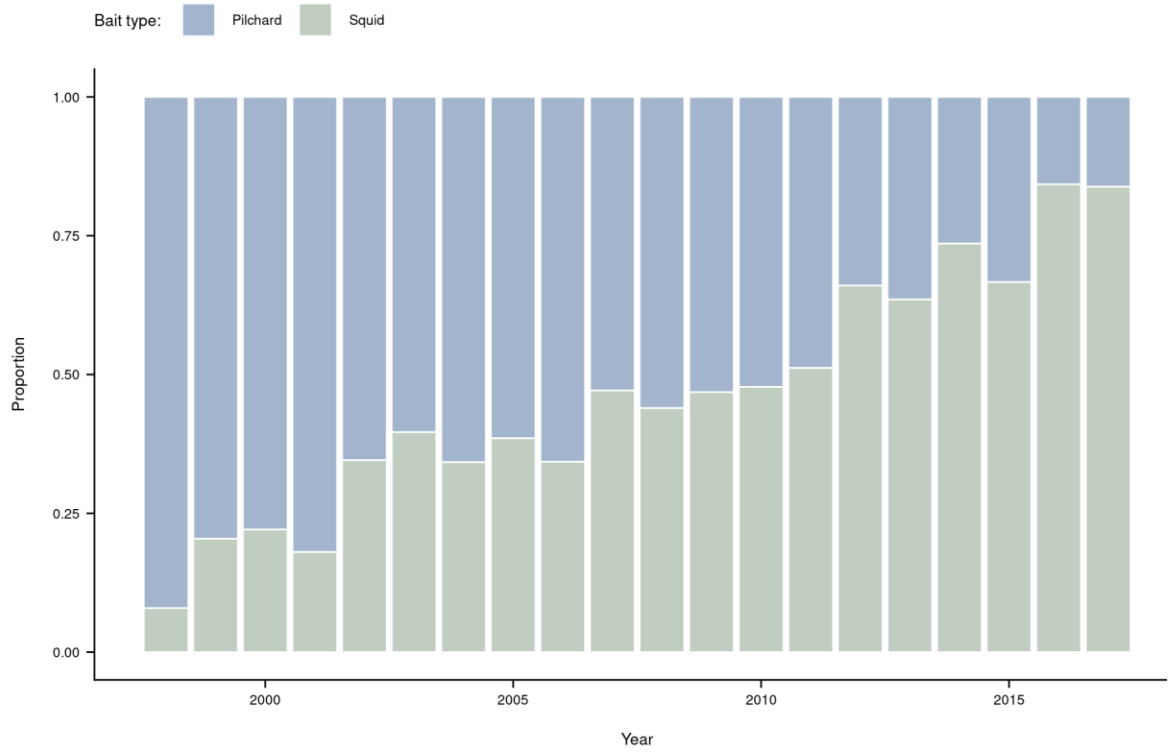
- **Covariate**: Fields in the logbook data that we are using to explain the CPUE
- **Categorical variable**: A covariate with distinct values, independent from each other, e.g. bait, area, El Niño phase
- **Levels:** The different values of a categorical variable, e.g. for bait: squid, pilchard, mackerel, etc.

- **Continuous variable**: A numerical covariate with values along an axis, e.g. number of hooks, mainline length, SST
- **Bins / binning:** Splitting a continuous variable into independent categories, e.g. 0-100 hooks, 100-200 hooks, etc.

How do we standardise CPUE?

- Example: let us assume there is no trend in abundance---i.e. stock size is constant over time
- But bait type has progressively changed from pilchard to squid

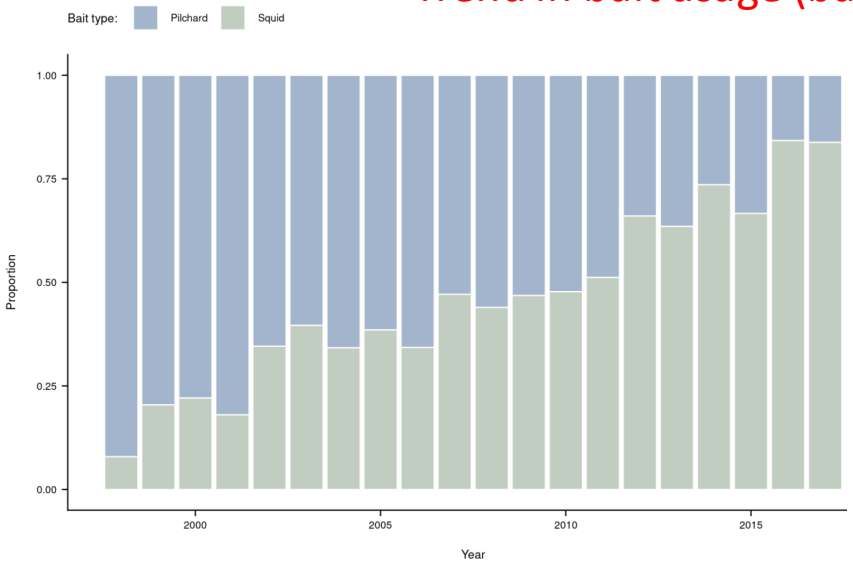




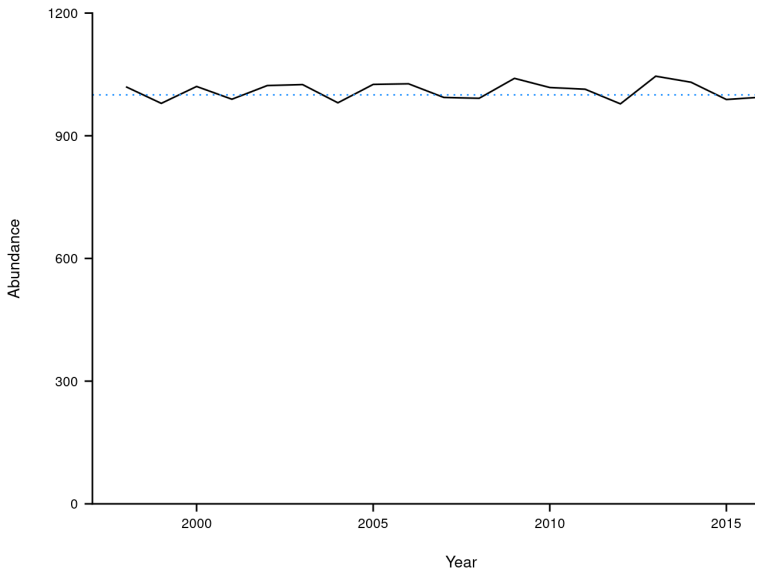
- Also: when squid bait is used, there is an improvement in catch rates of +2 individuals/1000 hooks

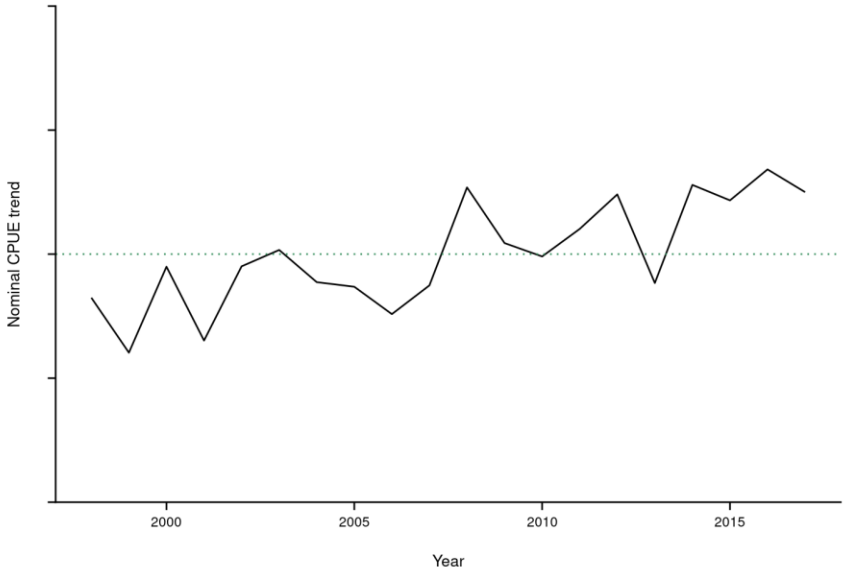
How do we standardise CPUE?

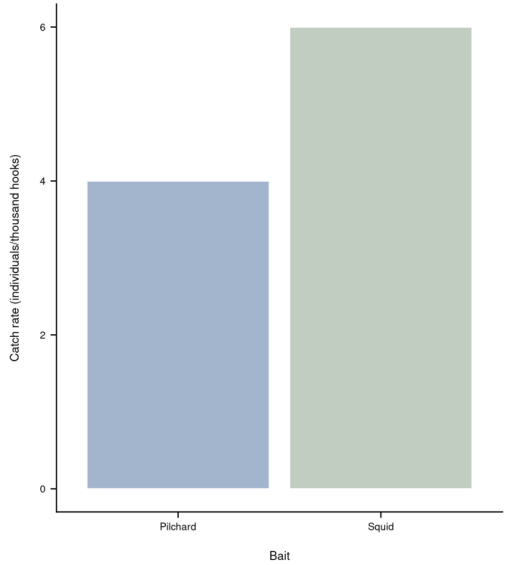
Trend in bait usage (bait = CPUE "covariate")



= nominal CPUE not proportional to abundance



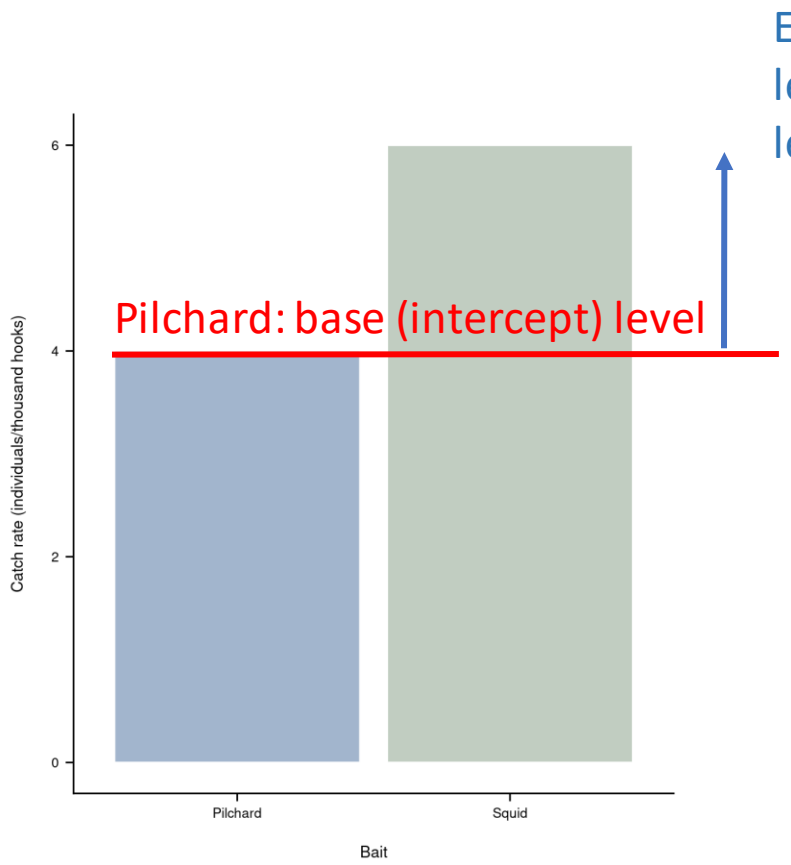


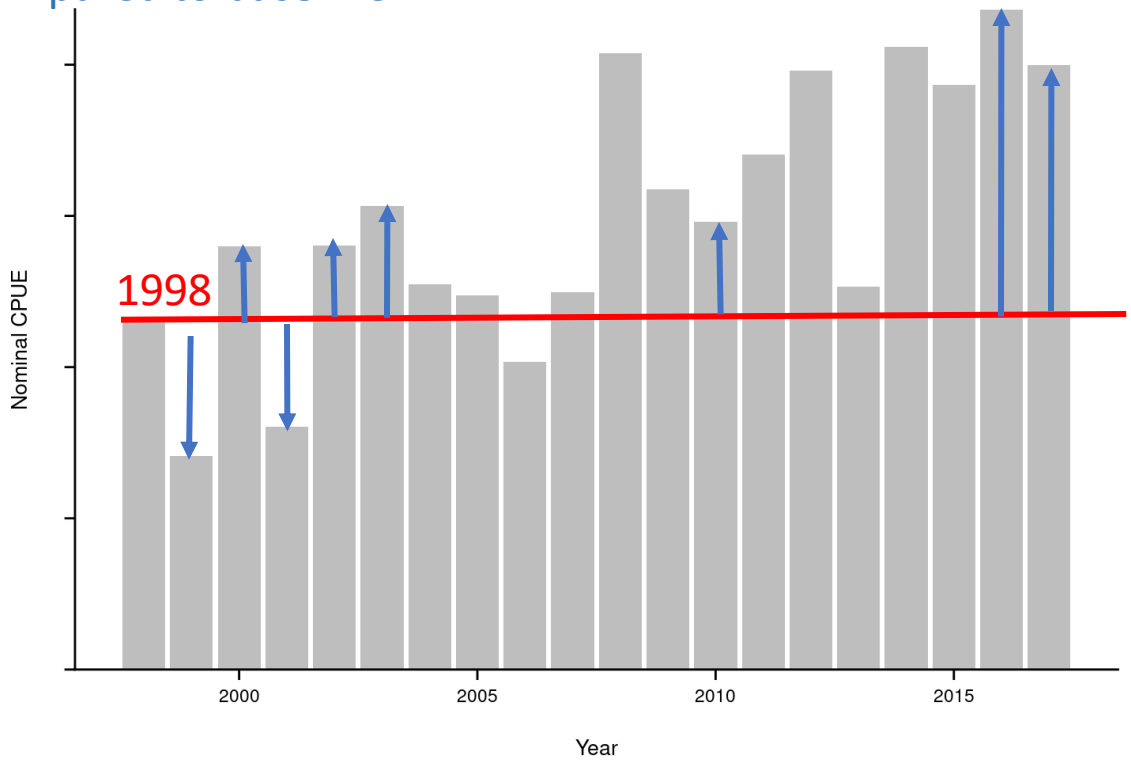


+ effect of covariate in CPUE

How do we standardise CPUE?
In practice:

- Groom dataset (remove about 8% of records, e.g. if covariates are missing---bait, mainline length, hooks) ~ about 170,000 records left for 1998 to 2021
- Split records according to levels

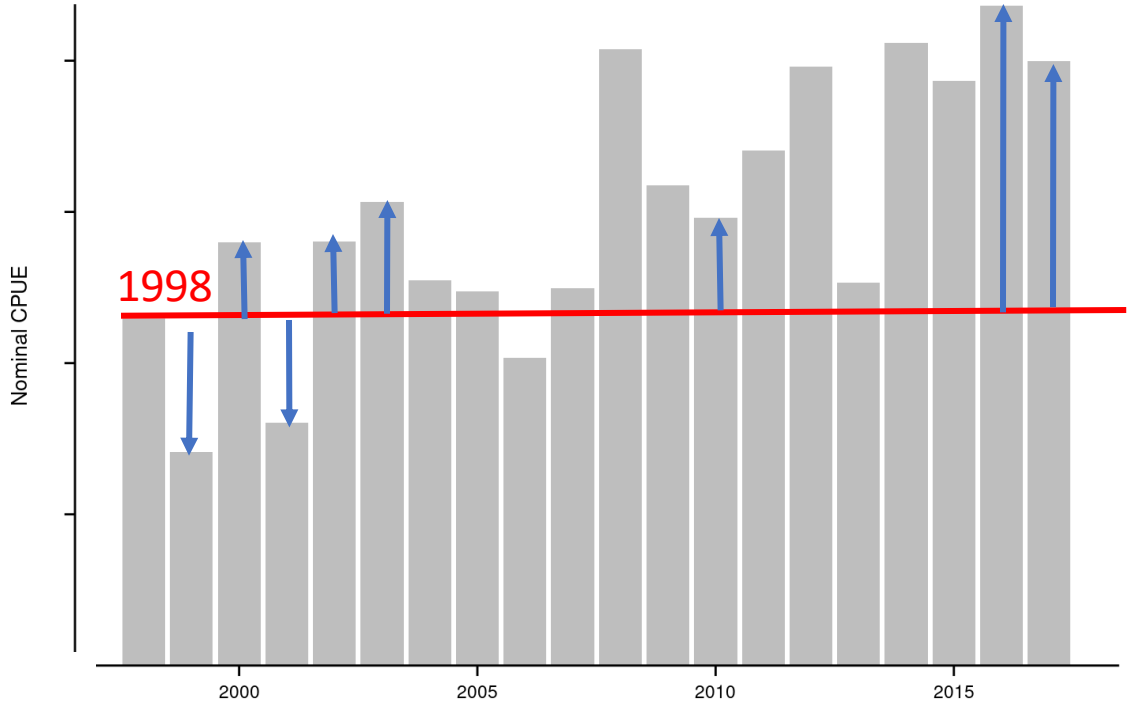


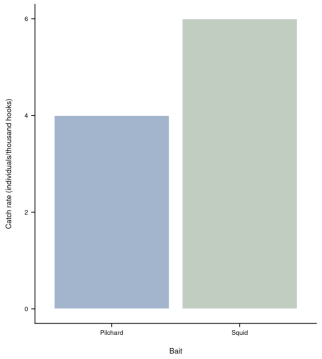


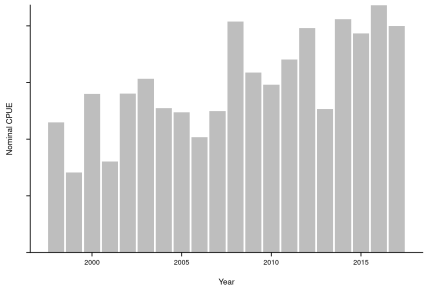
How do we standardise CPUE?
In practice:

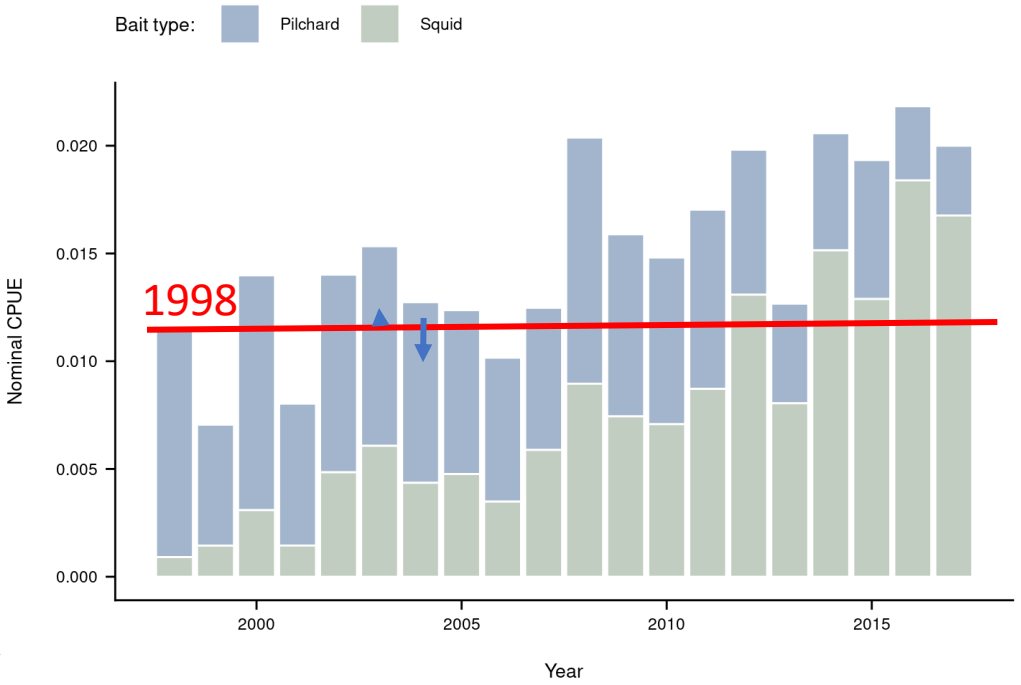
Model 1: CPUE ~ Year --> Effect of year = nominal CPUE

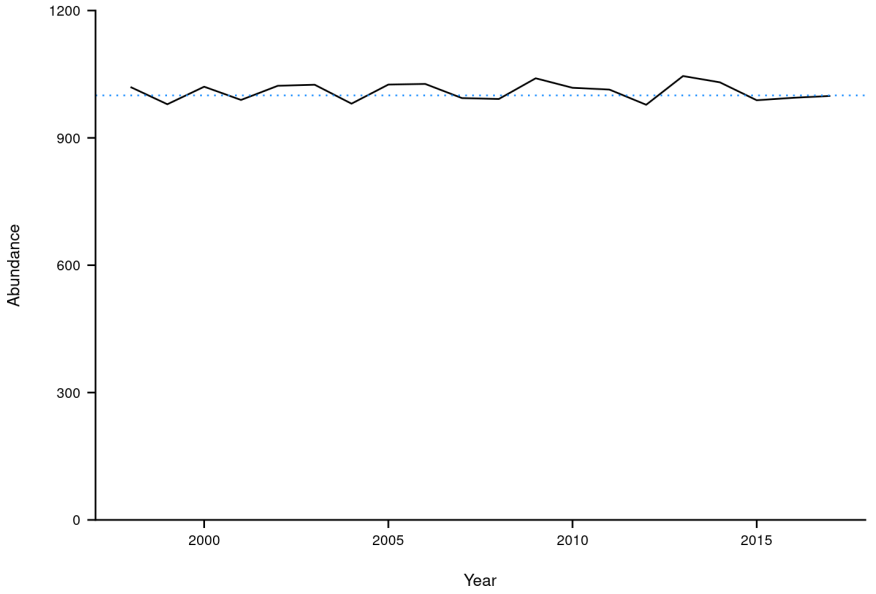
Model 2: CPUE ~ Year + bait -->
Effect of year now adjusted for bait







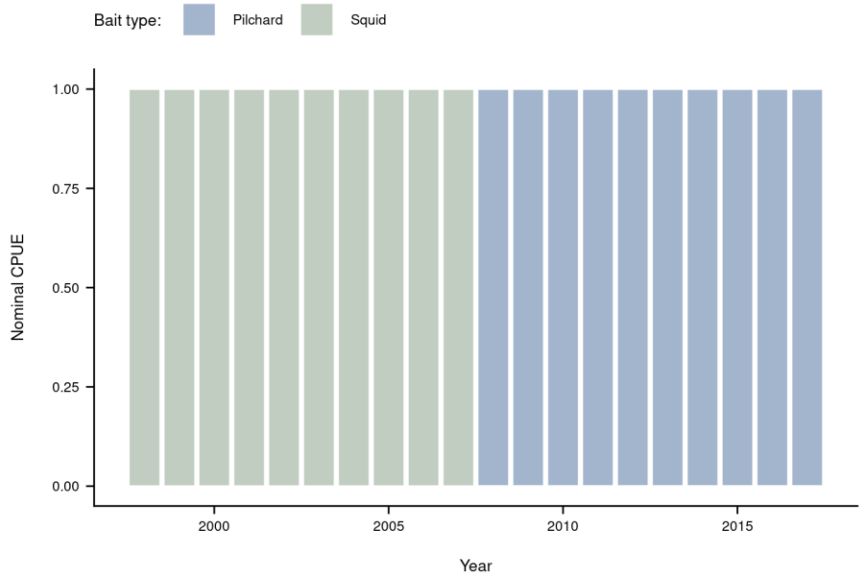




How do we standardise CPUE?

In practice:

- Case 1: no trend in covariate, no effect of covariate --> *no standardisation effect*
- Case 2: trend in covariate, no effect of covariate --> *no standardisation effect*
- Case 3: no trend in covariate, effect of covariate --> *standardisation effect, but no trend*
- Case 4: trend in covariate, effect of covariate --> *strong standardisation effect*
- Case 5: abrupt change in covariate --> *can't standardise*, model can't tell if change in CPUE is due to change in covariate or abundance levels that year



ETBF standardisation

- Many more covariates, e.g. ETBF indices have 20+ covariates
- Need to use modelling framework able to untangle effects of many covariates on response variable (signal vs. noise)
- GLMs vs. GAMs:

How ETBF standardisation works

overall annual, seasonal (qtr) and area effect retained to build the index

allows CPUE to vary for each quarter X year combination and each quarter X area combination

```
pres ~ year + qtr + area_SP + year:qtr + qtr:area_SP +
     HOOKS +
     tripclustercat +
     clights + bait + start + hpb + hpkmcat + bubble + maincat + bubble:maincat +
     dvescat + mvescat +
     bathycat + soicat + mldcat +
     windcat + sstcat + curUcat + curVcat + cSPDcat + cDircat +
     mldcat:area_SP + soicat:area_SP + sstcat:area_SP +
     phasex + phasey + phasex:phasey
```

"targeting" based on proportion of species in trip catch

operational covariates split by bins

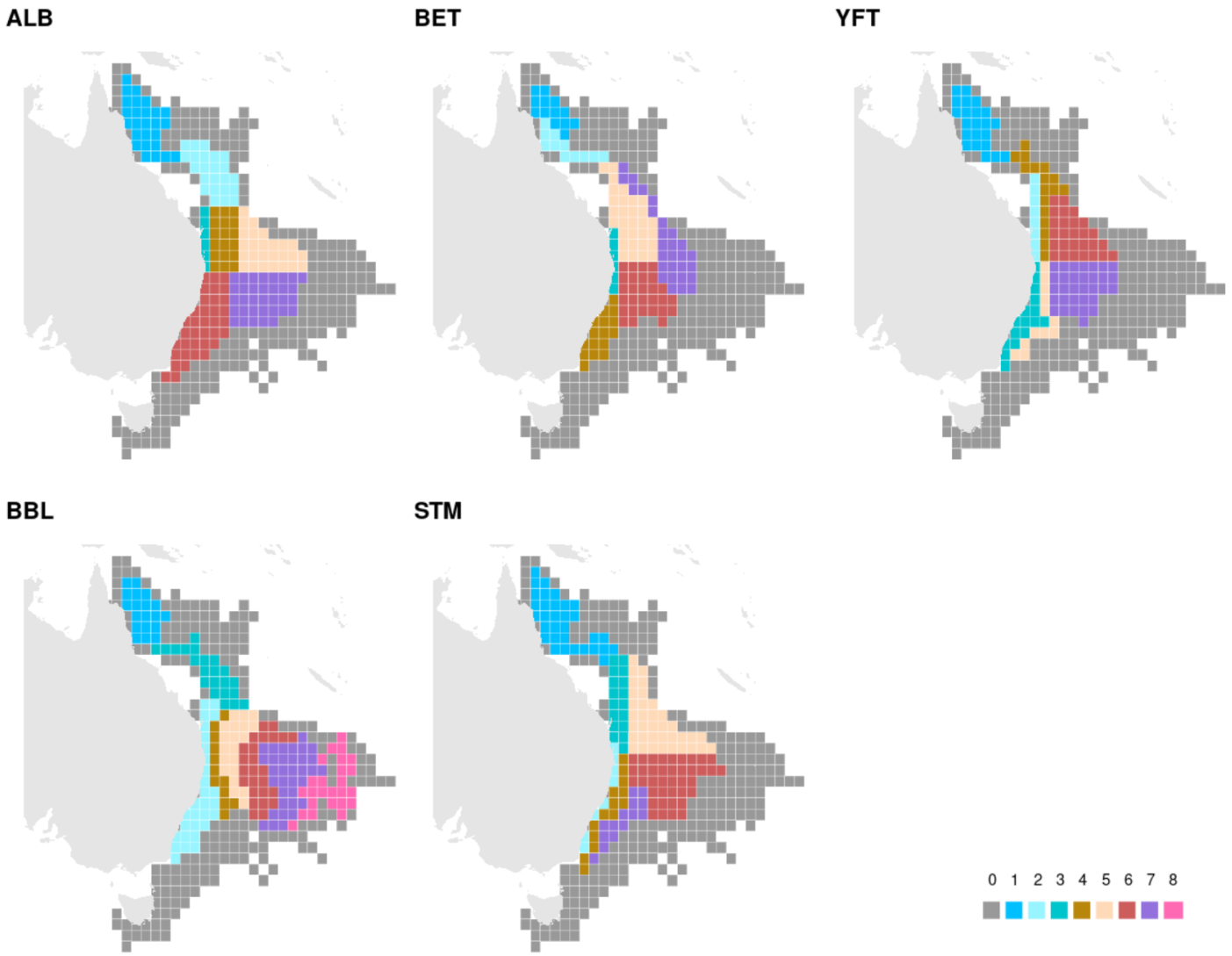
metric of individual vessel effort

oceanography covariates split by bins

phase of the moon
(cyclical; split into three variables)

shape of the relationship between CPUE and oceanography covariates
(mld, SOI, SST) allowed to vary by area

Areas



Issues that have been raised at TTRAG

- Hook not appropriate as a metric of effort
- Economic drivers changing targeting strategy
- Importance of oceanography covariates (e.g. eddies)
- Effect of COVID on targeting
- Are species pulses accounted for?

What's next?

This year:

- A proposed approach to identify changing fishing strategies through time in the ETBF
- Investigation of possible changes in the distribution of key CPUE covariates during the COVID period
- Impact of effort metric on standardised CPUE for broadbill swordfish in the ETBF
- Preliminary analysis of the effects of eddies on catch rates for tuna and billfish in the ETBF

Next year?

Revisiting simulation testing

Spatial effects (how to deal with area effect)

Attachment 3.3

Impact of effort metric on standardised CPUE for broadbill swordfish in the ETBF

Laura Tremblay-Boyer, Nick Hill & Ashley Williams

Presentation to TTRAG 37

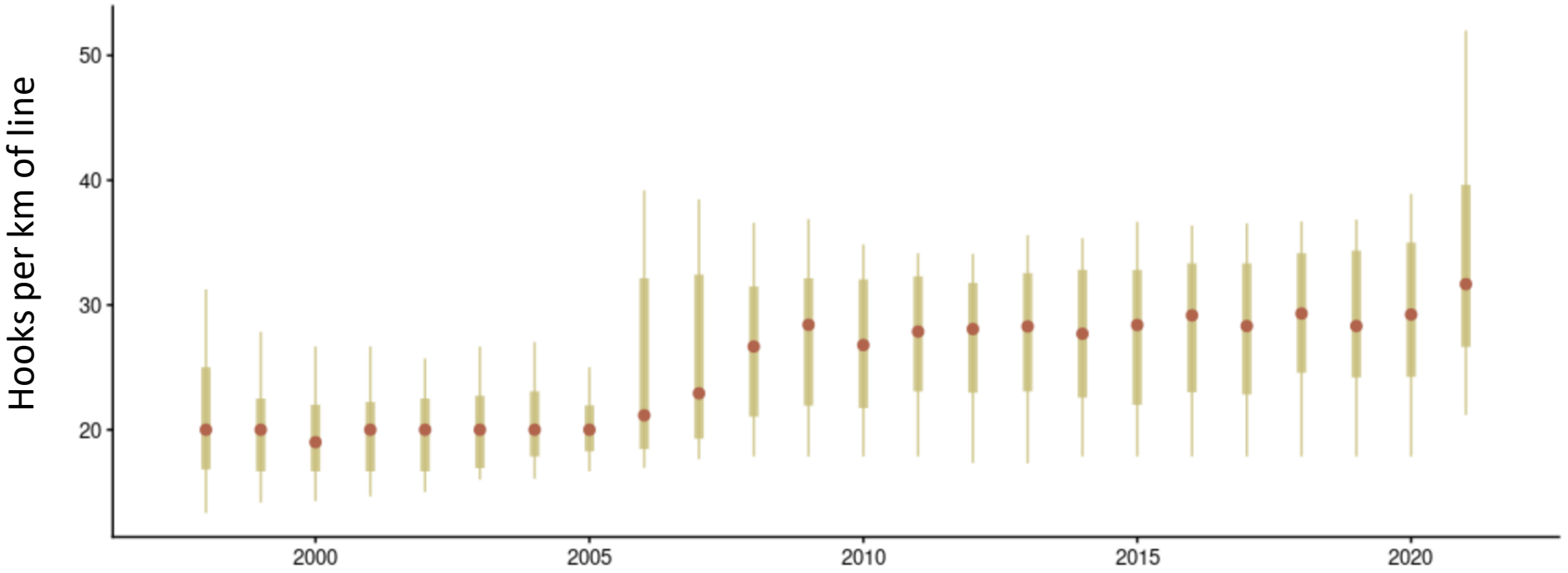
Maroochydore, March 14th to 16th 2023

Context

- Catch-per-effort standardisation in the ETBF focuses on individuals per hook
- Traditional unit of catch and effort for longline fishing cf. set configuration
- Issues with hook as effort metric raised at previous TTRAGs
- Increasing hook density in swordfish sets a strategy to target more byproduct species; swordfish catch does not increase when hooks are too dense
- i.e. assumption that catch increases linearly with effort not respected once hook density increases past threshold

Options to address issue

- Use hook density covariate in CPUE standardisation model (current approach)
- Use a different effort metric (fishing set, mainline length?)
- Important to address as meets two conditions for standardisation effect: covariate changes through time + effect on catch rate



CPUE models test vs. effort metric

Model 1:

Catch/hook ~ usual covariates **+ hook density**

Model 2:

Catch/shot ~ usual covariates **+ number of hooks**

--> Used BBL Prime index that informs HS

CPUE models vs. effort metric

Model 1:

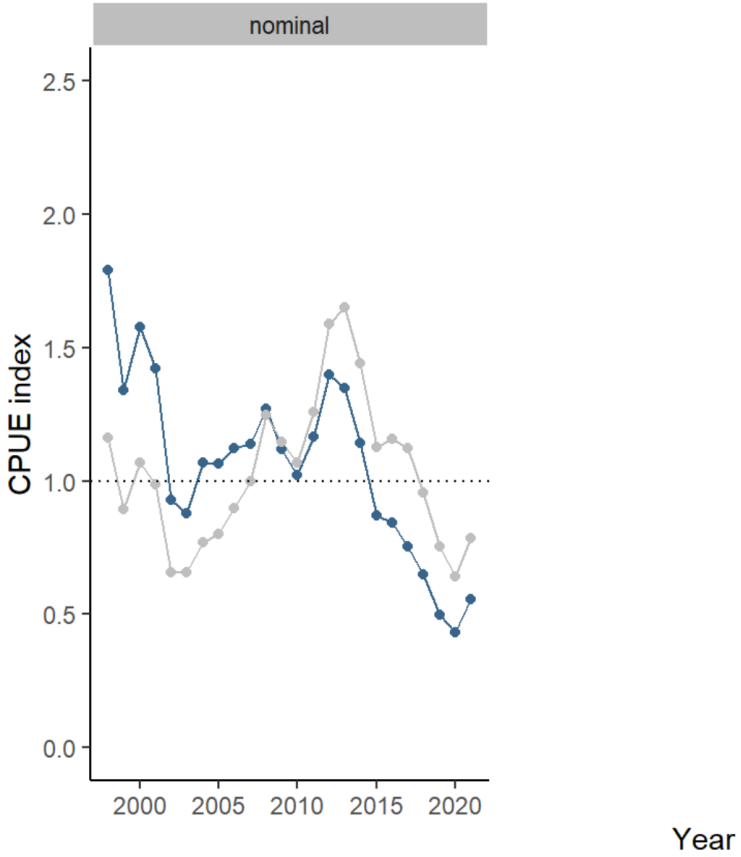
Catch/hook ~ usual covariates **+ hook density**

Model 2:

Catch/shot ~ usual covariates **+ number of hooks**

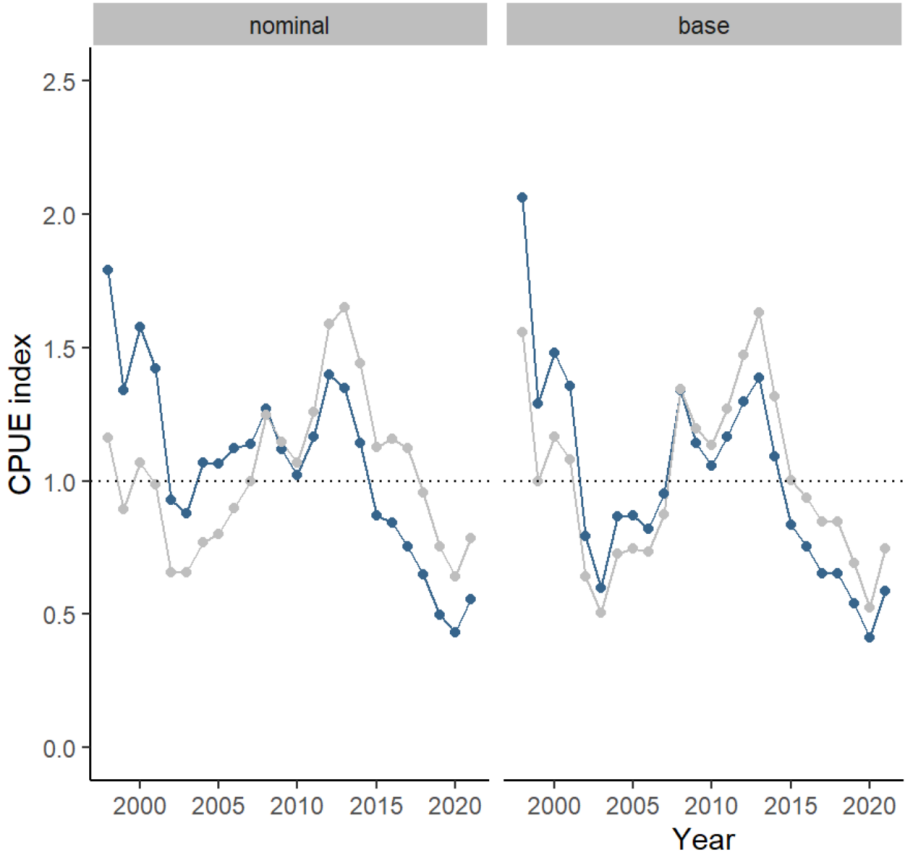
CPUE models vs. effort metric

Prime BBL nominal CPUE depending on effort metric



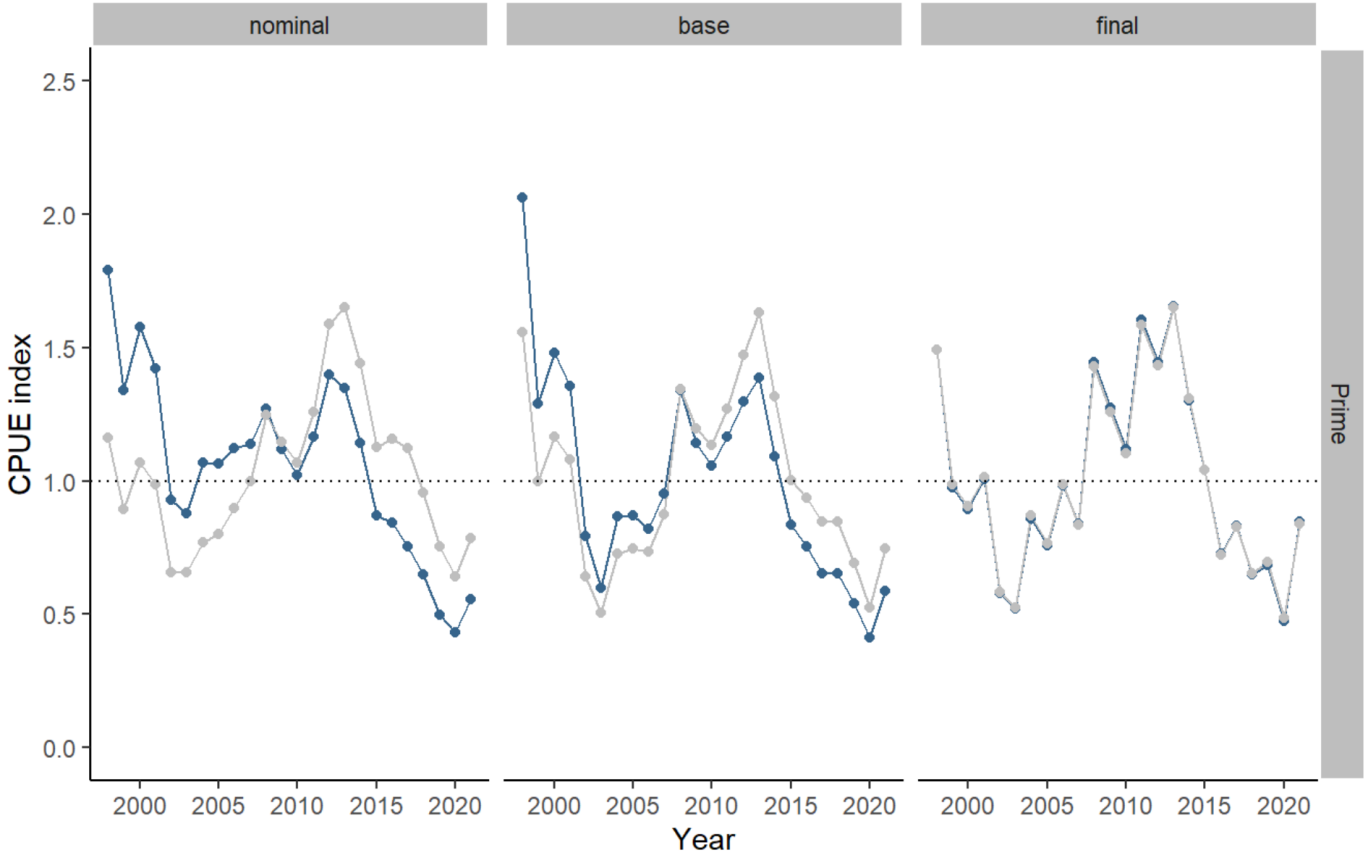
CPUE models vs. effort metric

+ standardised index *if model does not include gear configuration covariates*



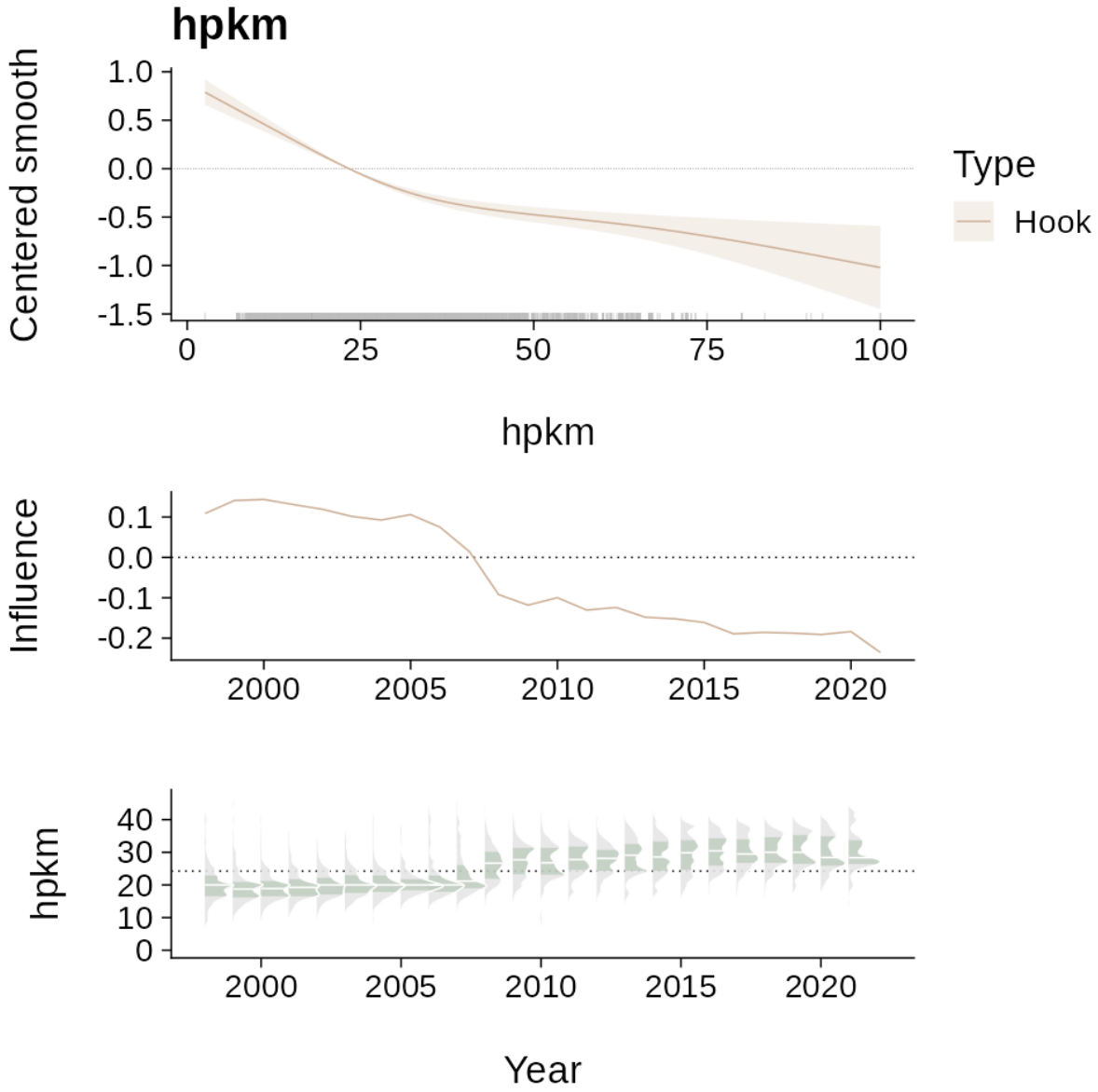
CPUE models vs. effort metric

+ standardised index once model includes gear configuration covariates



Why do they match?

Peek under the hood of the catch-per-hook model



Conclusion

- Hook density is an important covariate in the swordfish standardisation model
- Standardised indices similar for CPUE using effort as hook or set as long as gear covariates are included in the standardisation model
- Model using fishing set as effort could be considered, but probably not necessary

Tuna Australia – Research projects update

FRDC 2020-041 Improving the effectiveness, efficiency, and safety of mitigation tools for protected species interactions in the ETBF.

- data collection on tori lines and shortened safety leads is complete.
- safety bars, safety screens, and novel line weighting devices will be tested through a "flyback" simulation at the Australian Maritime College (Underwater Collision Research Centre). This is scheduled for late March / early April 2023.

FRDC 2021-063 Future proofing: Integrating community quota, product supply, product innovation and market diversification in Australia's Tropical Tuna Industry

- this work expands on the findings of the Market Diversification and Resilience project
- the project is currently synthesising information regarding "on boat" processing and quality control, supply chain logistics and developing a consolidated community quota pool for existing and new fishery entrants.

FRDC 2021-078 Improving the management of wildlife interactions in pelagic longline fisheries

- This project has had a number of financial setbacks delaying some aspects of project work
- EM review for toothed whale component of project is complete.
- First phase of sea trials completed last week. Data collection on novel line weighting regimes completed, further speed / shooter setting and live bait work will require another sea trip.

Tuna Australia Ltd
PO Box 1220
Buderim QLD 4556

T. +61 427 837 966
E. ceo@tunaaustralia.org.au

W: tunaaustralia.org.au

ABN. 45 613 897 439

Size monitoring data project

- Recent work includes realigning data outputs to better connect with CSIRO database structure.
- Some members have redesigned their data capture to provide information to this project in a more user friendly form.
- Data collection for the next phase of reporting is complete and on track for next milestone date.

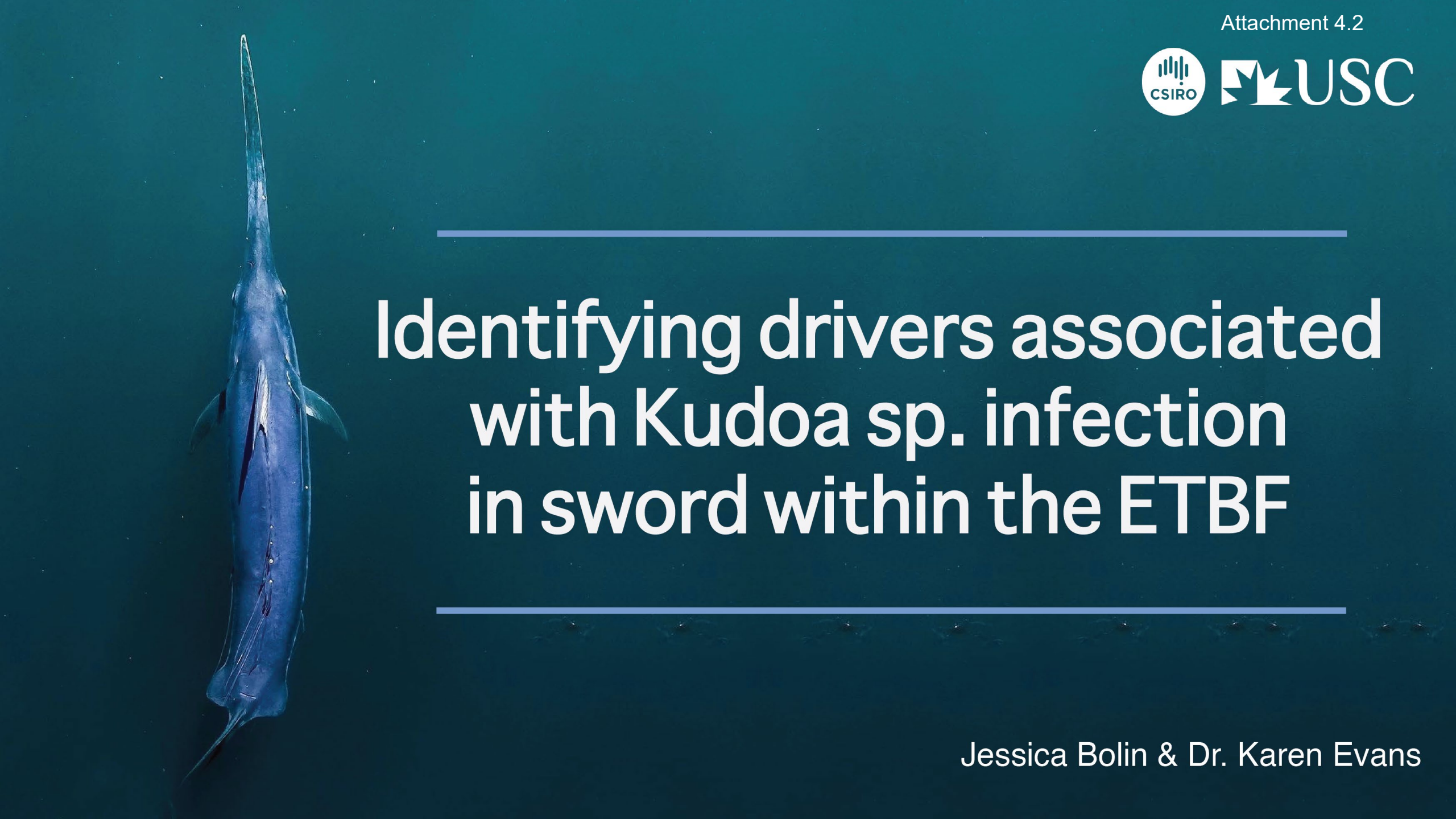
MSC – General management

- Failure of WCPFC member countries to agree on harvest strategies for tropical tunas has forced Tuna Australia to transition its tropical tuna certified species to the new MSC Fisheries Standard 3.0 to avoid suspension.
- As per above, this is relevant for all WCPO certified tuna fisheries. A meeting of affected parties to implement these transitional arrangements will occur May 2023. This coincides with Tuna Australia's annual surveillance audit.
- The recent assessment of a client wishing to include WCPO swordfish as an "in scope" species has resulted in a failed score (<60). The failure of swordfish to meet minimum standard is due to the lack of regional harvest strategy for swordfish. This has direct implications for Tuna Australia's swordfish certification as the scores for our certification are required to be harmonized with this new assessment.
- This issue is currently being debated between the assessment bodies and MSC.

MSC bait project

- This project analysed the historical bait use in the ETBF
- Developed an artificial bait for trial in the fishery,
- Implement a code of practice for the sourcing and use of sustainable squid.
- This project is now complete, and we are awaiting final feedback and project closure instructions.

Attachment 4.2



Identifying drivers associated with Kudoa sp. infection in sword within the ETBF

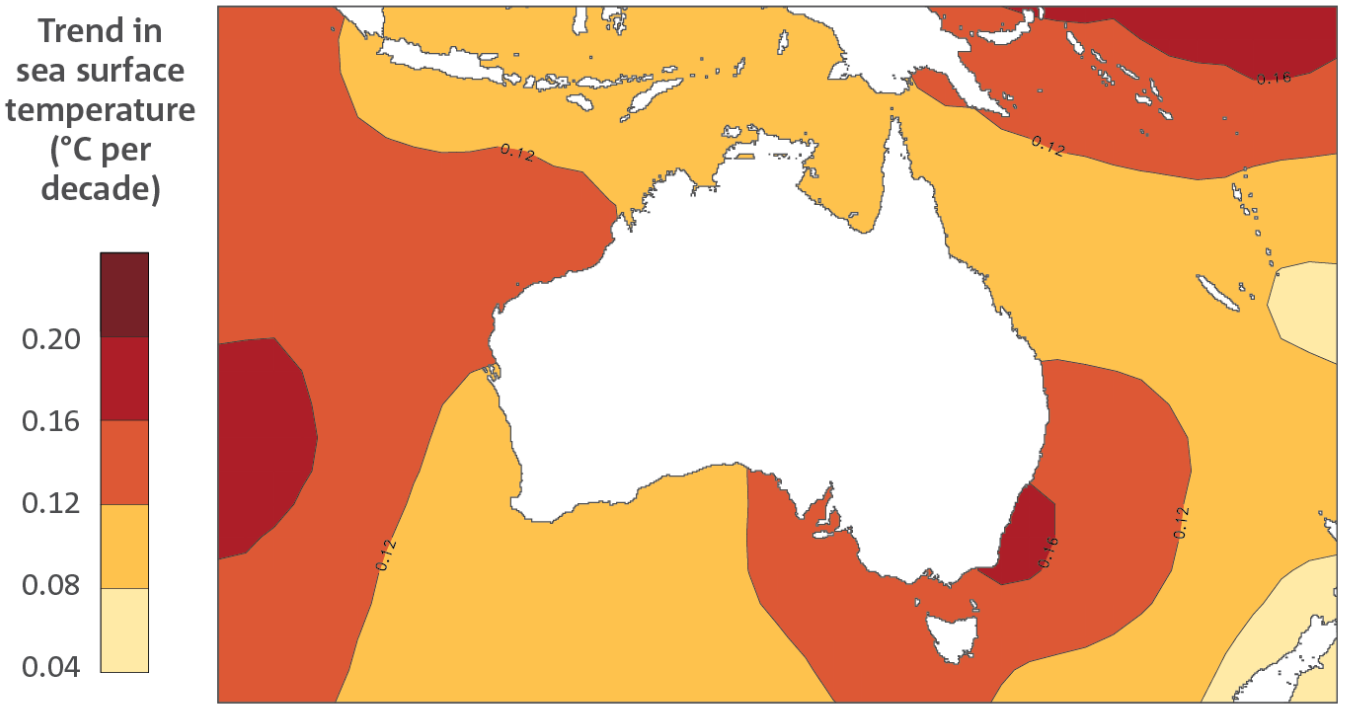
Jessica Bolin & Dr. Karen Evans

Project team and industry partners

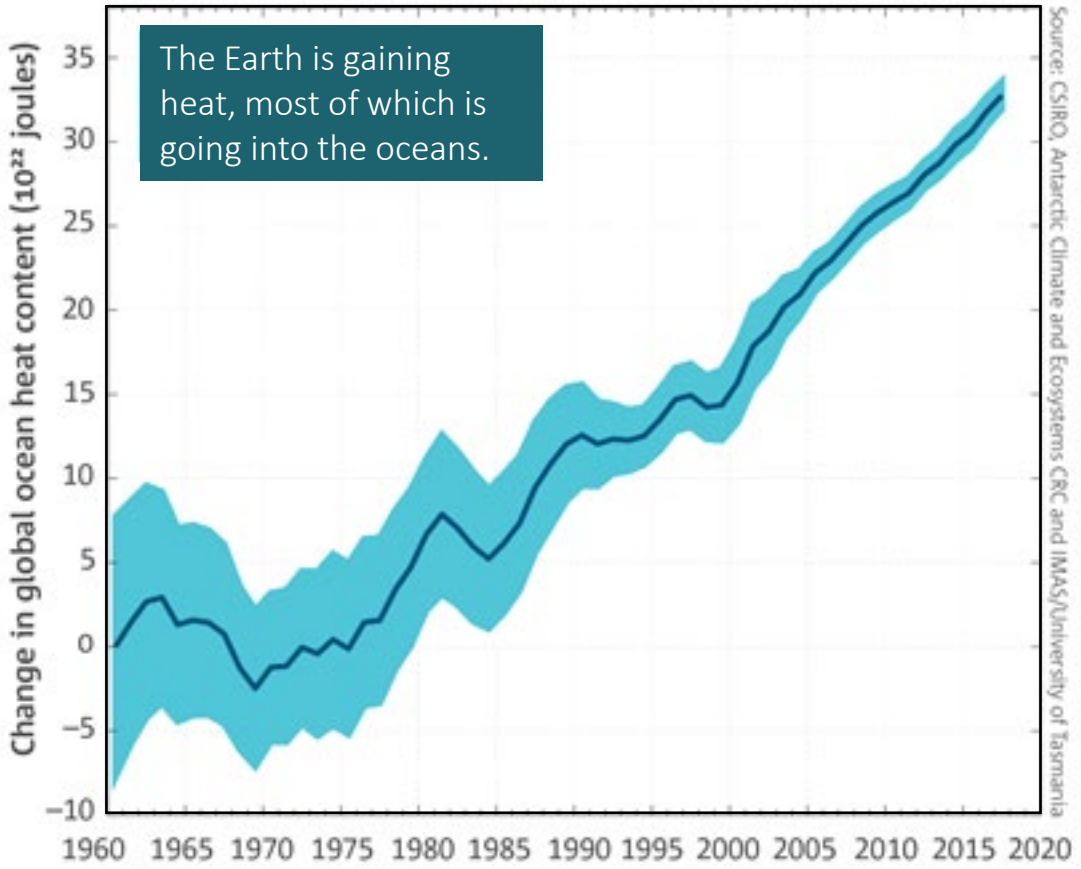
- Jessica Bolin (PhD Student 2019-2023)
- Dr. Karen Evans
- A/Prof. Kylie Scales
- Prof. David Schoeman
- Dr. Claire Spillman
- Dr. Jason Hartog
- Dr. Thomas Moore
- Prof. Scott Cummins

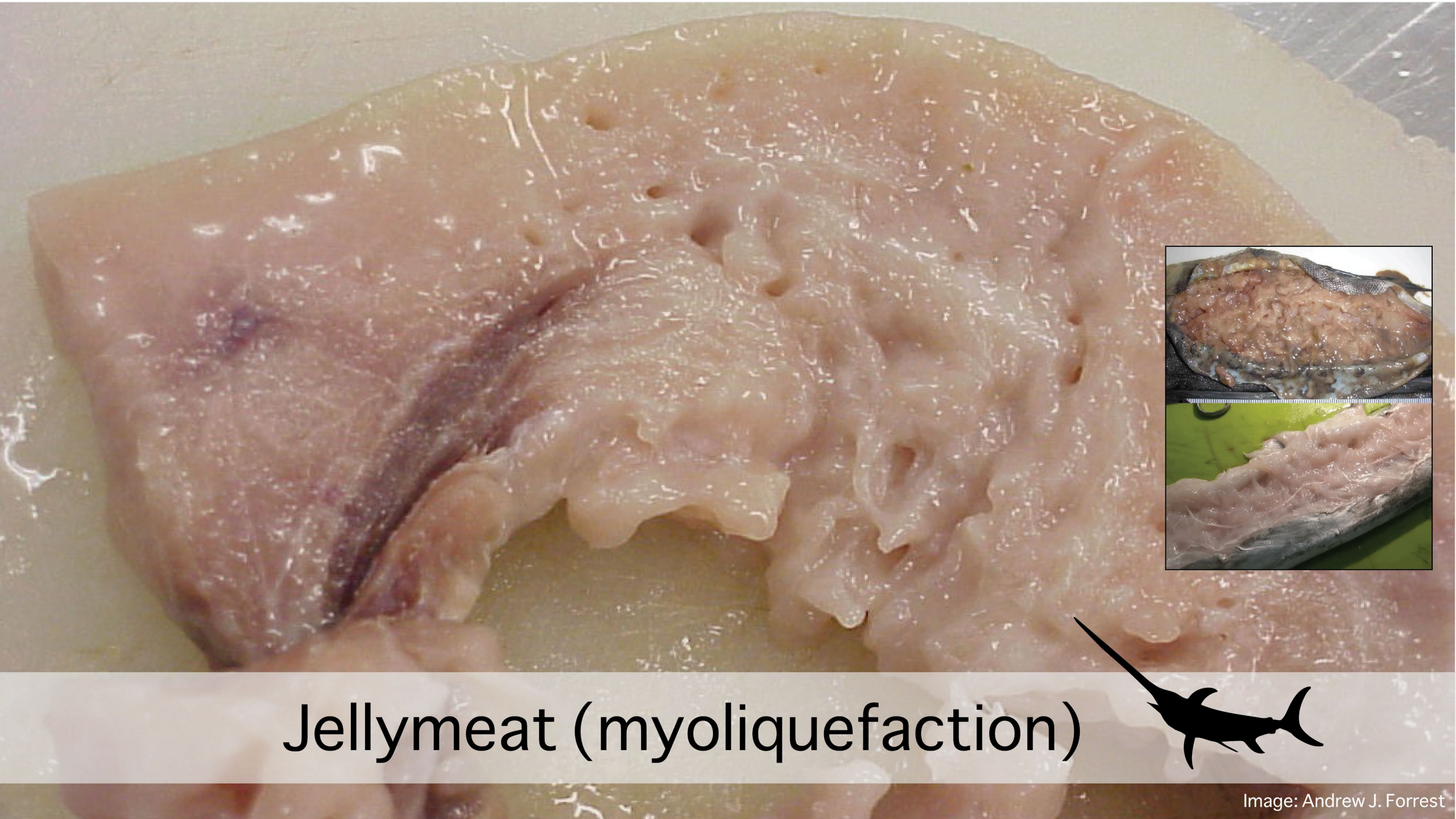
Project motivation

The ocean surface around Australia has warmed in recent decades.



The Earth is gaining heat, most of which is going into the oceans.

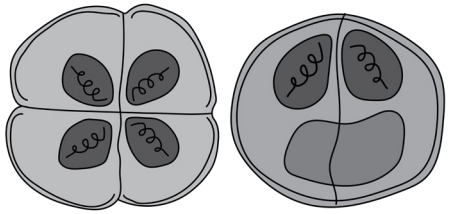




Jellymeat (myoliquefaction)

Image: Andrew J. Forrest

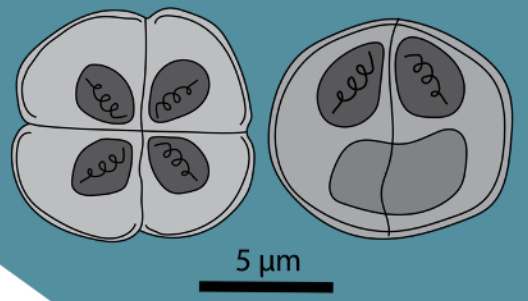
Kudoa sp.



- Parasitic cnidarians (Myxozoa)
- 100+ species, global distribution
- Known for secreting enzyme into fish tissue *post-mortem*, causing jellymeat
- ~24 – 72 hours to “jellify”

Image: Paolo Cipriani, Hiroshi Yokoyama

Kudoa musculoliquefaciens

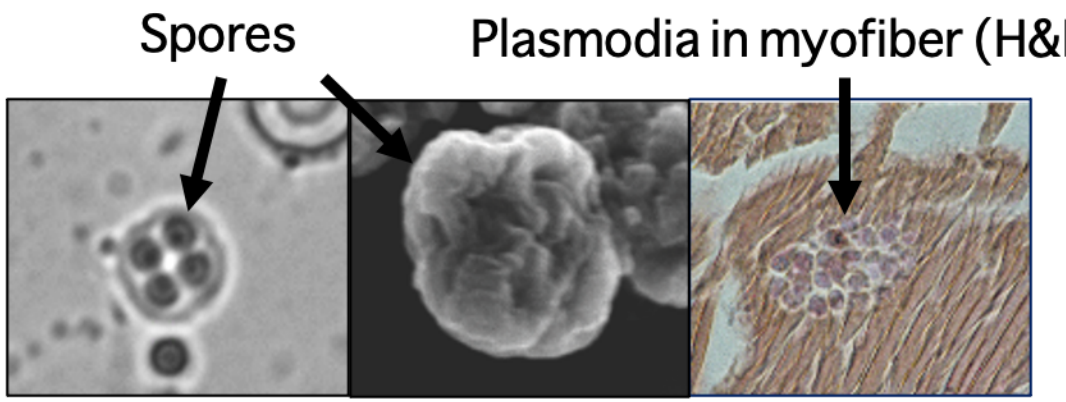


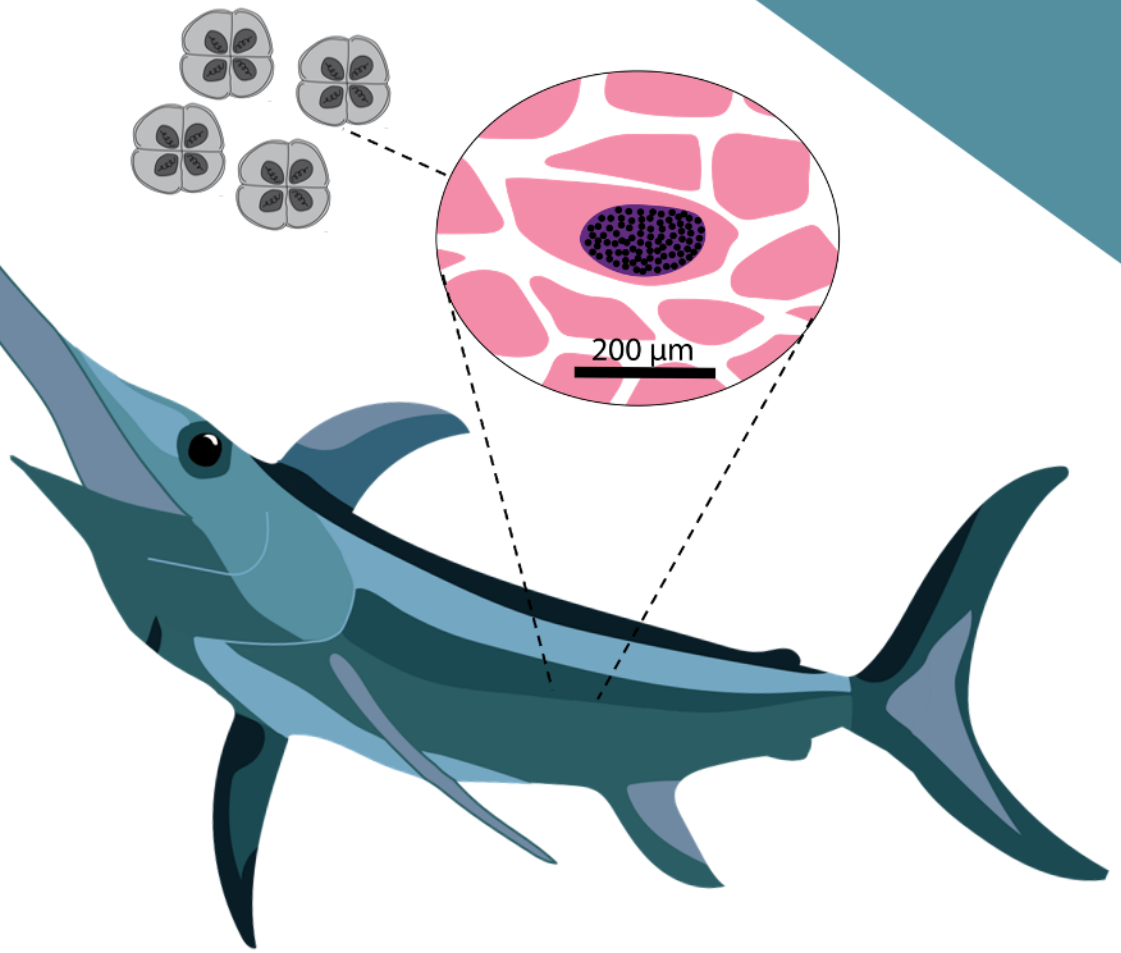
Parasitology Research (2021) 120:2493–2503
https://doi.org/10.1007/s00436-021-07206-8

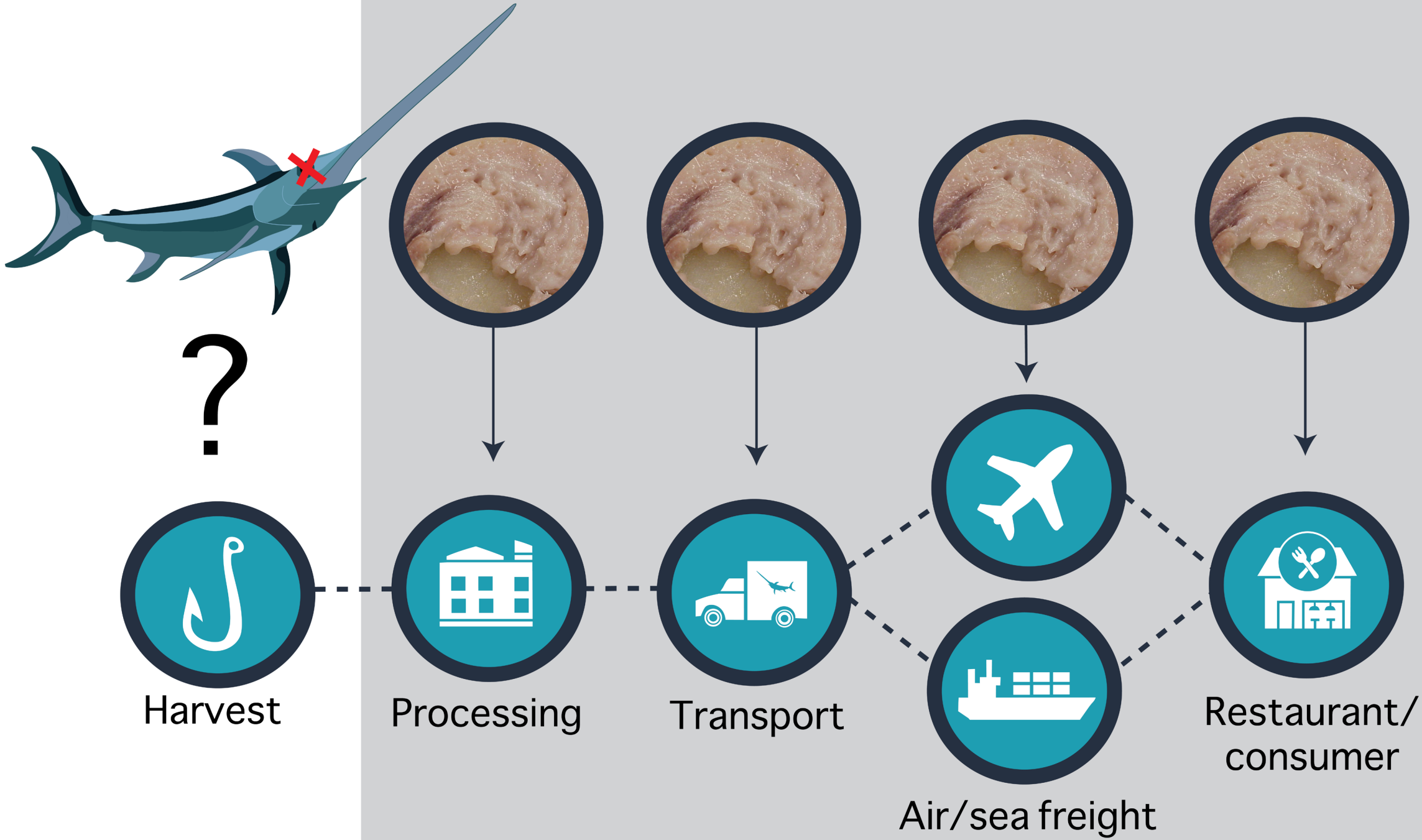
FISH PARASITOLOGY - ORIGINAL PAPER

First report of *Kudoa thunni* and *Kudoa musculoliquefaciens* affecting the quality of commercially harvested yellowfin tuna and broadbill swordfish in Eastern Australia

Jessica A. Bolin[1,2] · Scott F. Cummins[1,3] · Shahida A. Mitu[1,3] · David S. Schoeman[1,4] · Karen J. Evans[2] · Kylie L. Scales[1]






?
Harvest
Processing
Transport
Air/sea freight
Restaurant/
consumer

Sampling swordfish

Oct. 2019 – Feb. 2022

WSA and 4 Seas

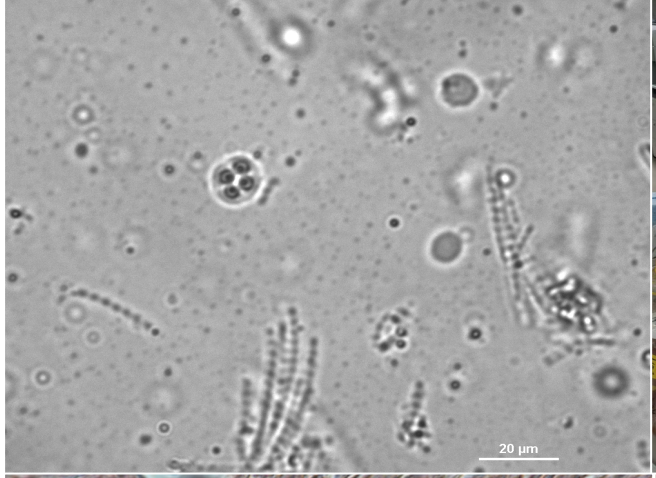

FIRE
HOSE
REEL

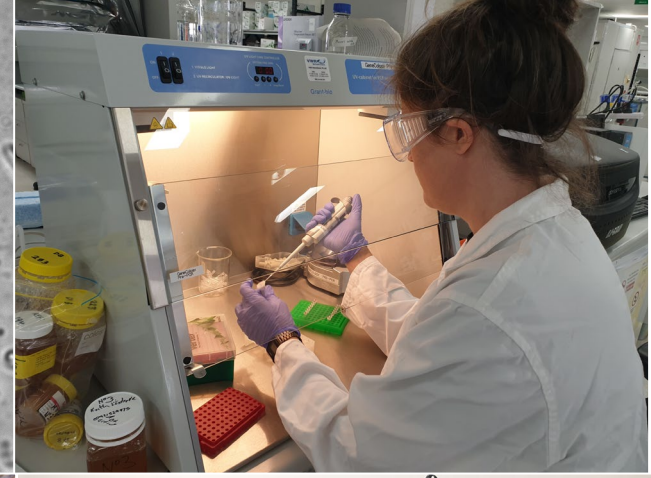

ETHANOL

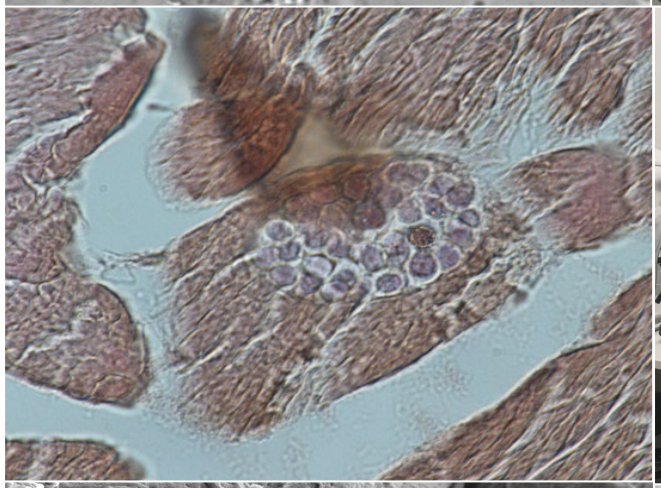

CAUTION
DECK IS
SLIPPERY
WHEN WET
ONLY AUTHORISED
PERSONNEL ALLOWED
ON THIS VESSEL

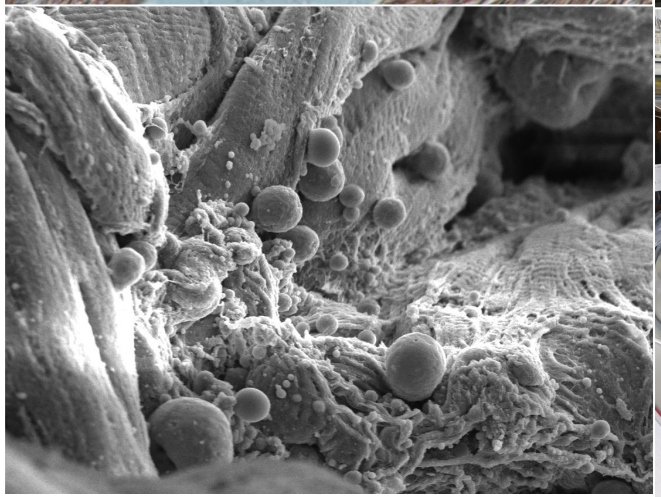
Multiple methods to identify infection:

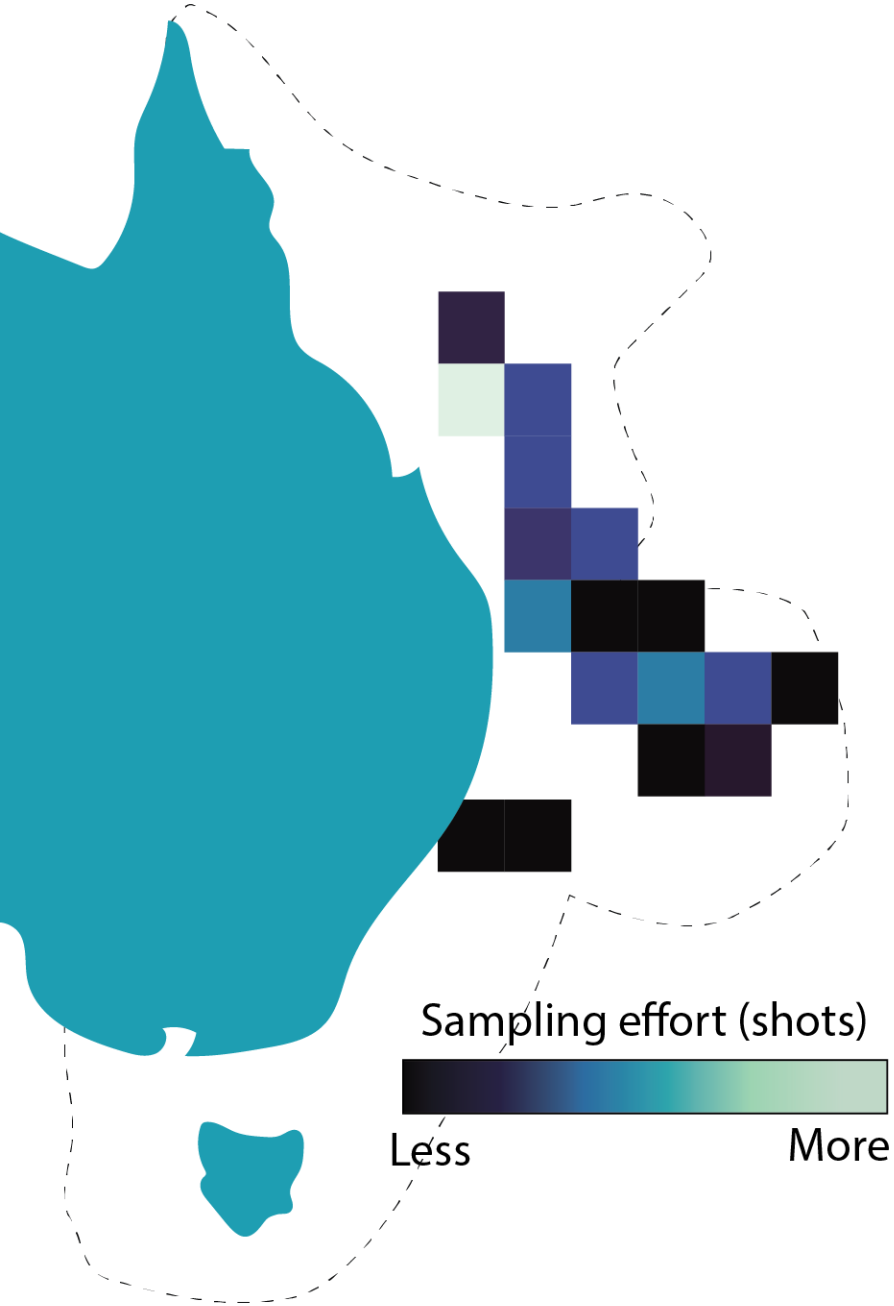
- Light microscopy + hemocytometer
- 18S rDNA sequencing (i.e., COVID test)
- Scanning electron microscopy
- Histology
- Phylogeny (i.e., genetic family tree)











~1600

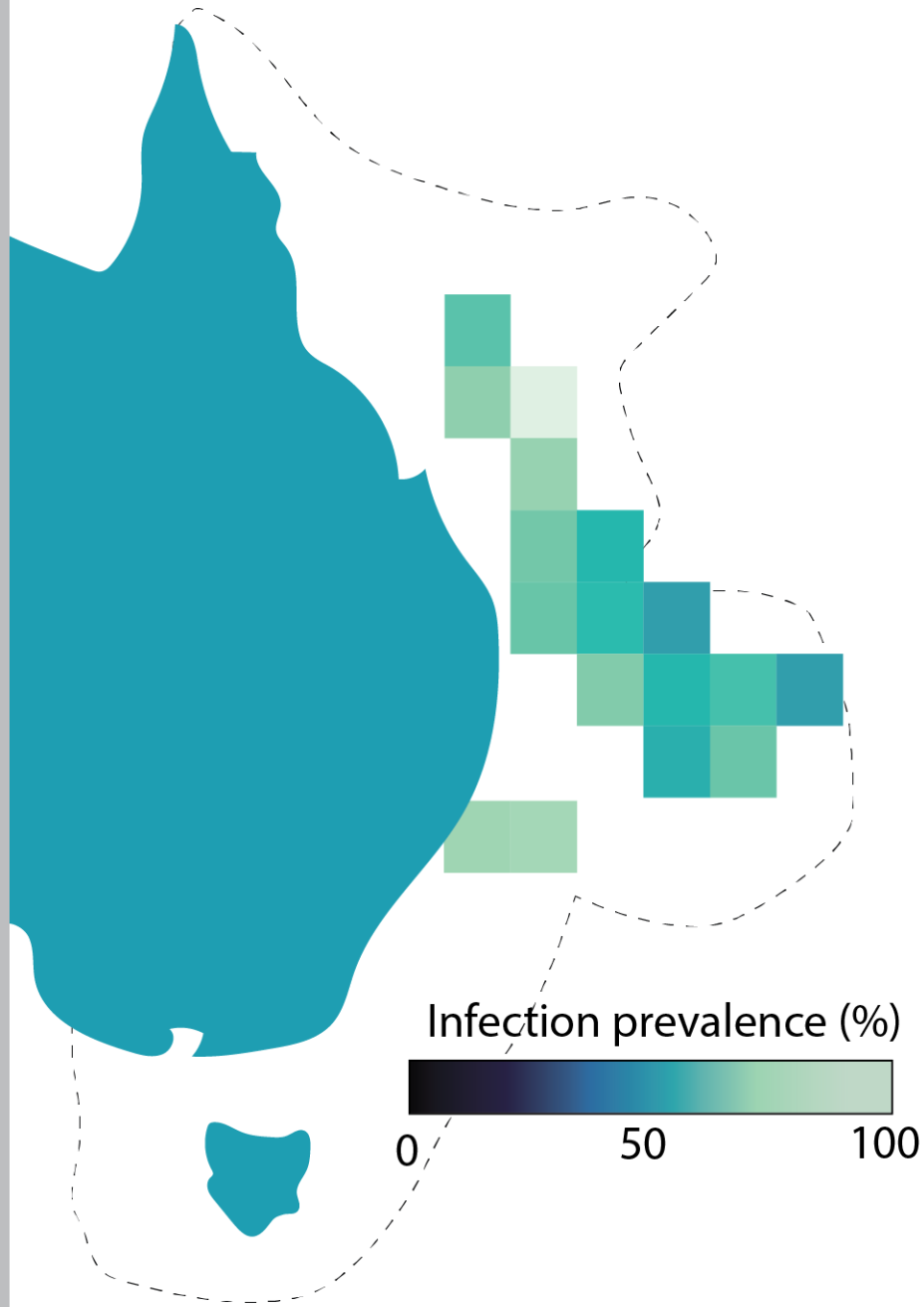
swordfish sampled

79%

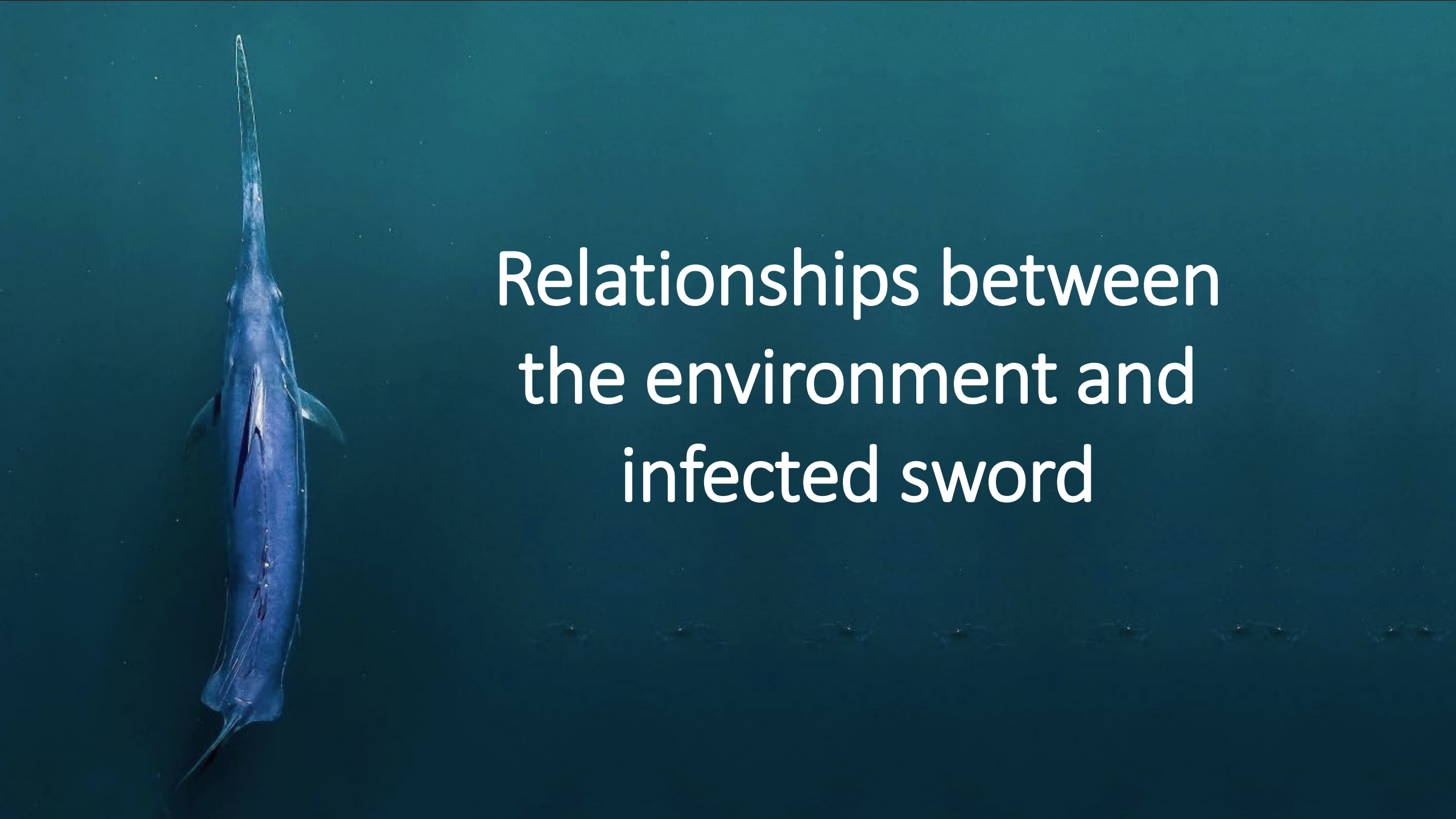
of sword infected with Kudoa sp.

>50%

of every haul infected with Kudoa sp.



[Raw data of infection prevalence and intensity through time presented in-person]



Relationships between the environment and infected sword

Variables we modelled (ACCESS-S2)

- SST
- SST anomaly
- Distance to the EAC
- Heat content in upper 300m
- Degree heating days (i.e., thermal accumulation over past three months)
- Heating rate
- SST climatology
- Variability of SST climatology

- Eddy kinetic energy
- Current velocity
- SSHa
- Depth and rugosity
- Distance to seamount
- Salinity
- Chlorophyll-*a* (MODIS)
- Mixed layer depth
- Season
- Month

Modelling infected swordfish

1) Infected and non-infected catch data from industry partners

2) Combine with variables of ocean state and bathymetry

Dynamic variables described previously

Bathymetry

Chl-*a*

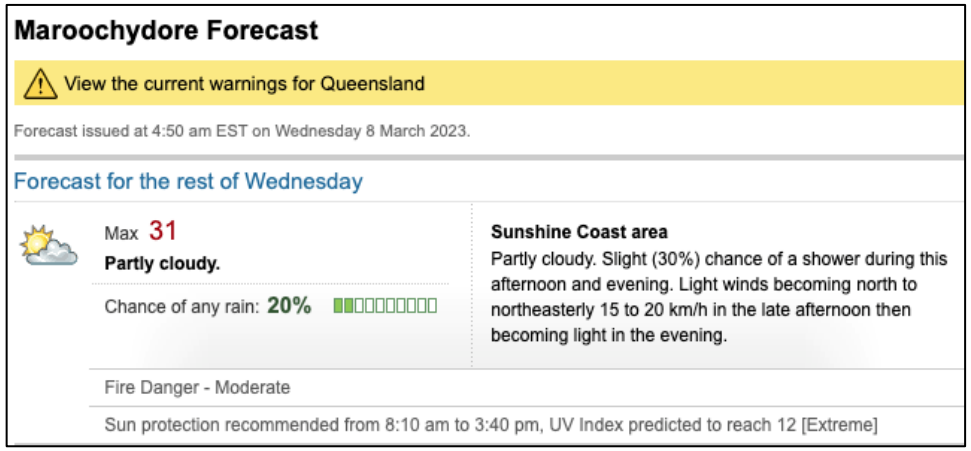
3) Model the **prevalence** and **intensity** of infected sword

- Generalised linear mixed models
- Random intercept for vessel

[Model results presented in-person]

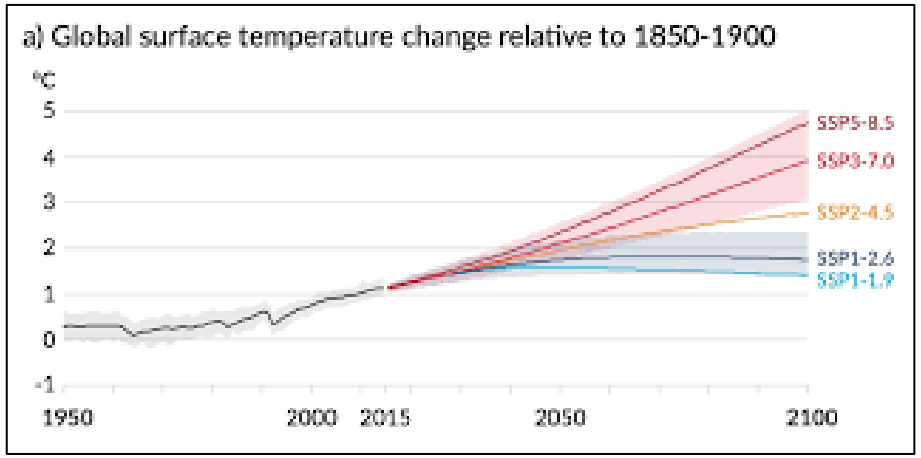
Forecast

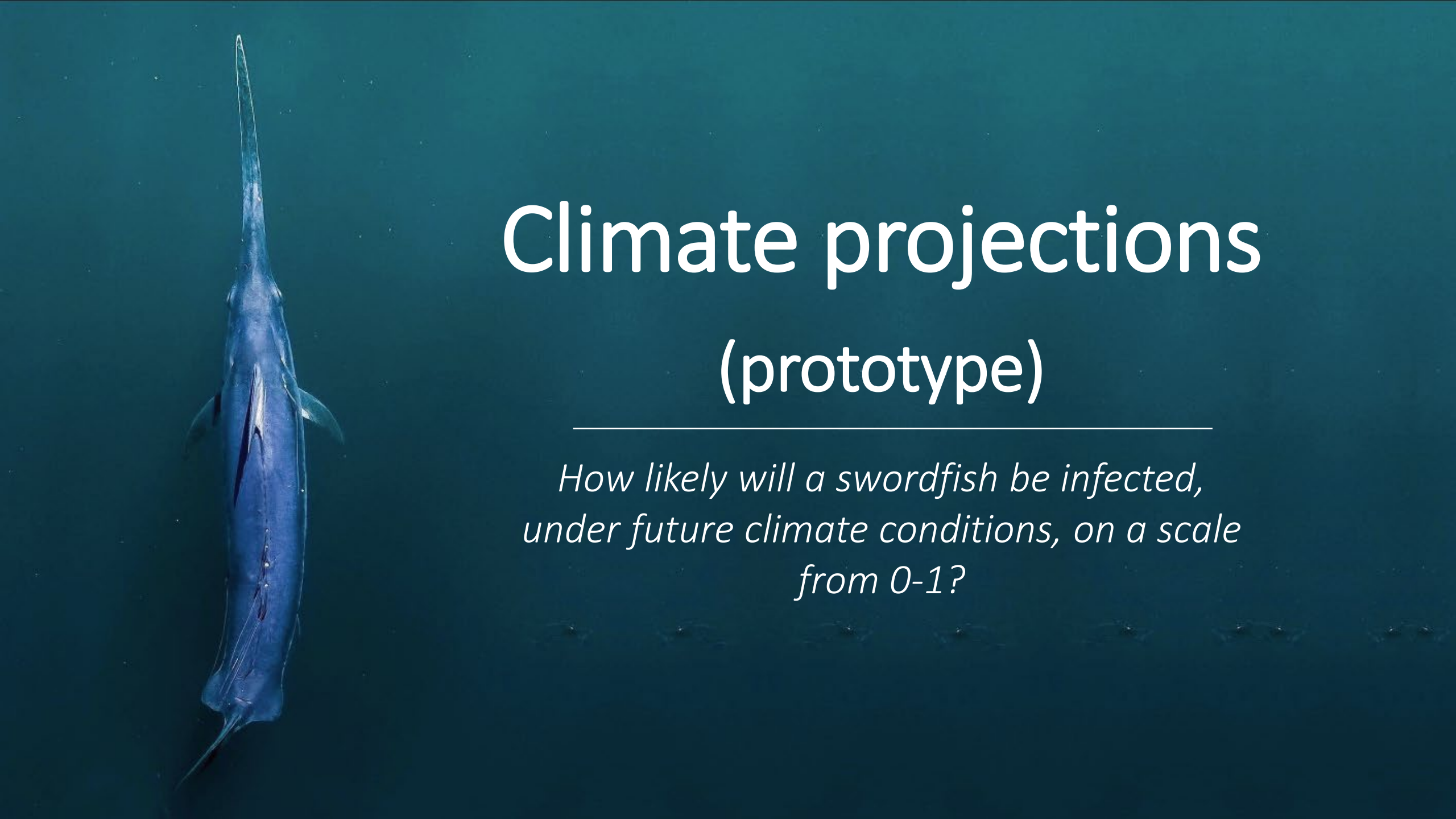
- A prediction in the near-term
- Daily, weekly, seasonal
- E.g., weather forecast



Projection

- A prediction in the long-term
- Decades to centuries out
- E.g., climate projection of temperature for 2100



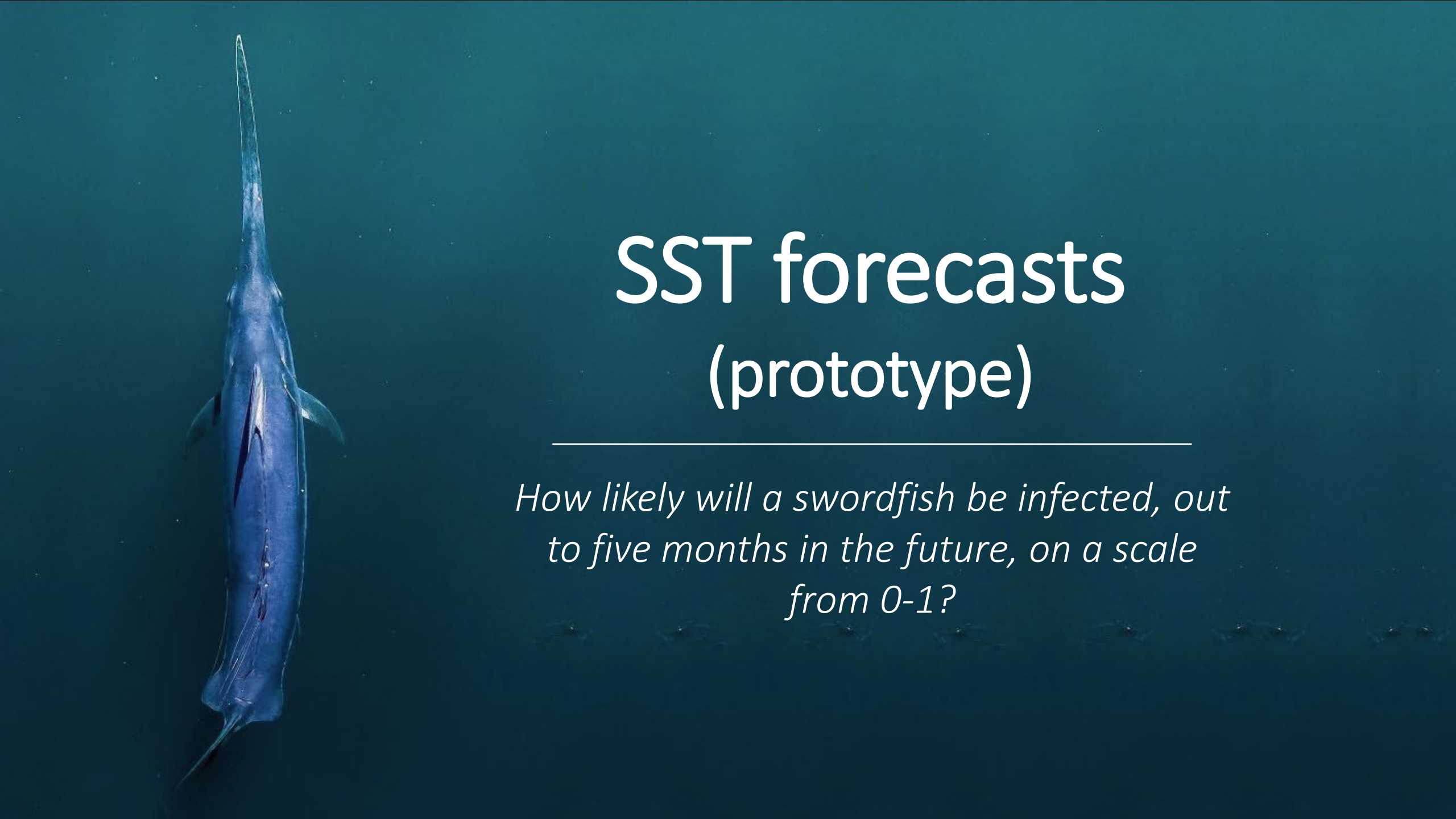


Climate projections

(prototype)

How likely will a swordfish be infected, under future climate conditions, on a scale from 0-1?

[Example climate projection presented in-person]



SST forecasts (prototype)

How likely will a swordfish be infected, out to five months in the future, on a scale from 0-1?

[Example SST forecasts presented in-person]

We want to work with you

This is a first go at understanding risk of prevalence and intensity of *Kudoa*

To validate, refine and improve future models:

- Better understand the link between infection and progression to jellymeat at all stages of supply chain
- Semi-regular meetings with contact points across the industry
- Physiological understanding of the parasite-host interaction (i.e., life cycle, host immunity etc.)

Attachment 4.3

Australia's National Science Agency

Investigate oceanographic and environmental factors impacting on the ETBF

FRDC 2017-004

Jason Hartog | 14/March/2023

J. Paige Eveson, Thomas Moore, Kylie Scales, Toby Patterson, Shane Baylis, Bernadette Sloyan, Ash Williams, Claire Spillman, Alistair J. Hobday

Outline

- Project aims
- Methods
- Results
- Key findings
- Project outputs
  - Ongoing update of project website…

Project Aims

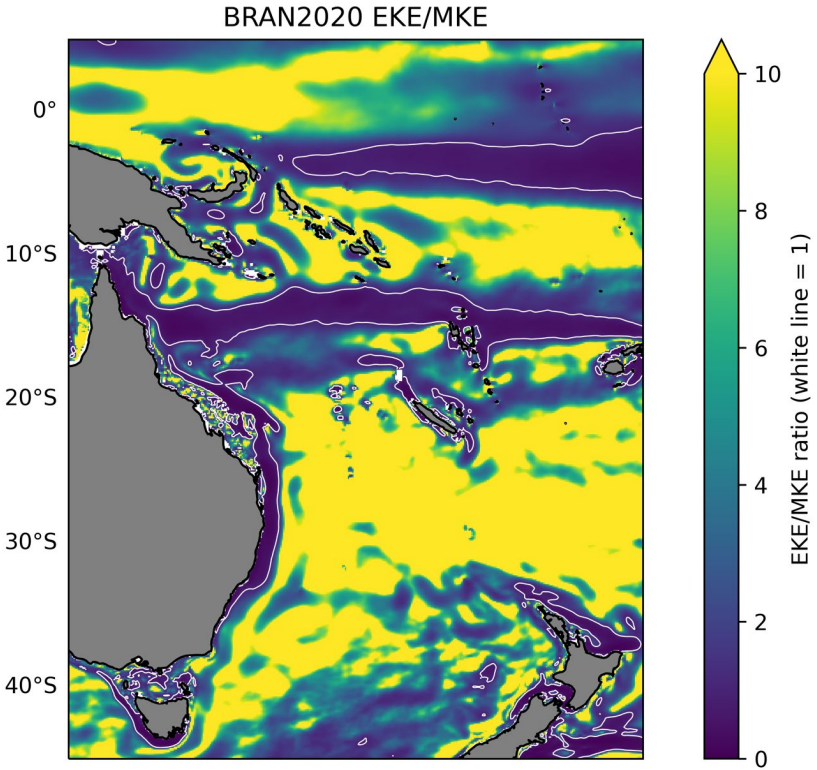
The specific project objectives were:

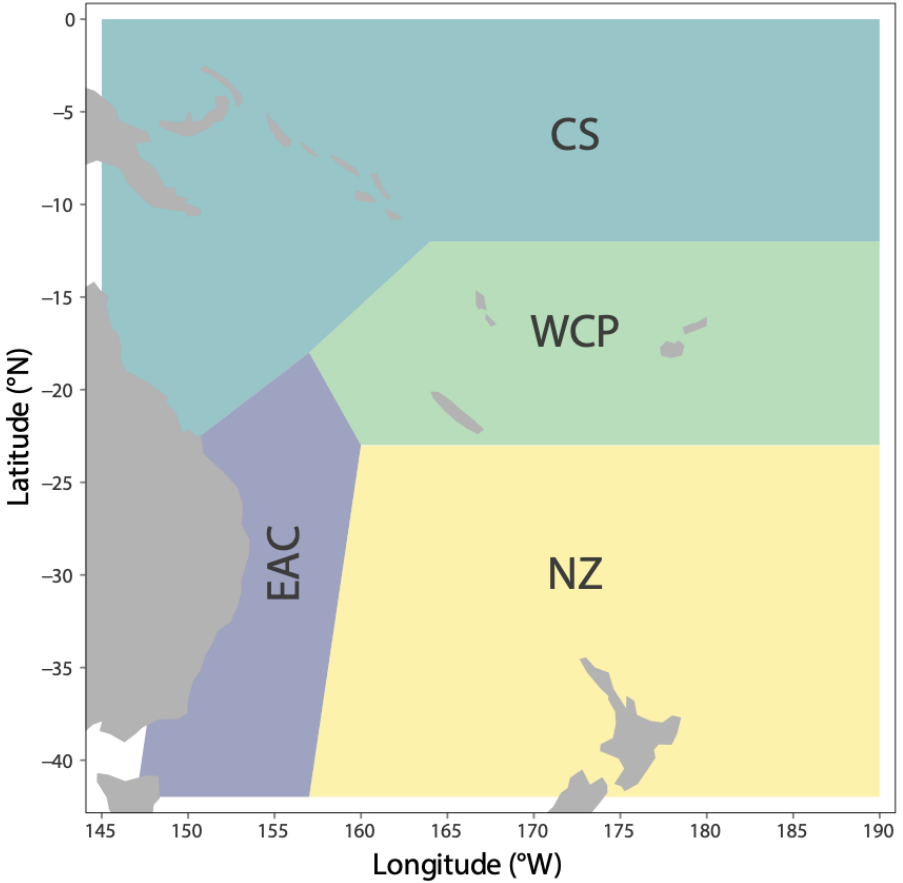
- Enhance AFMA and industry understanding of influence of climate-ocean system drivers upon the spatial and temporal variability of key ETBF species;
- Develop and deliver predictive models at seasonal and decadal time scales to assist management and industry planning;
- Provide operational forecasts of habitat distribution for Australia and the regional partners within the life of the project;
- Inform harvest and allocation discussions at national and international scales.

Methods

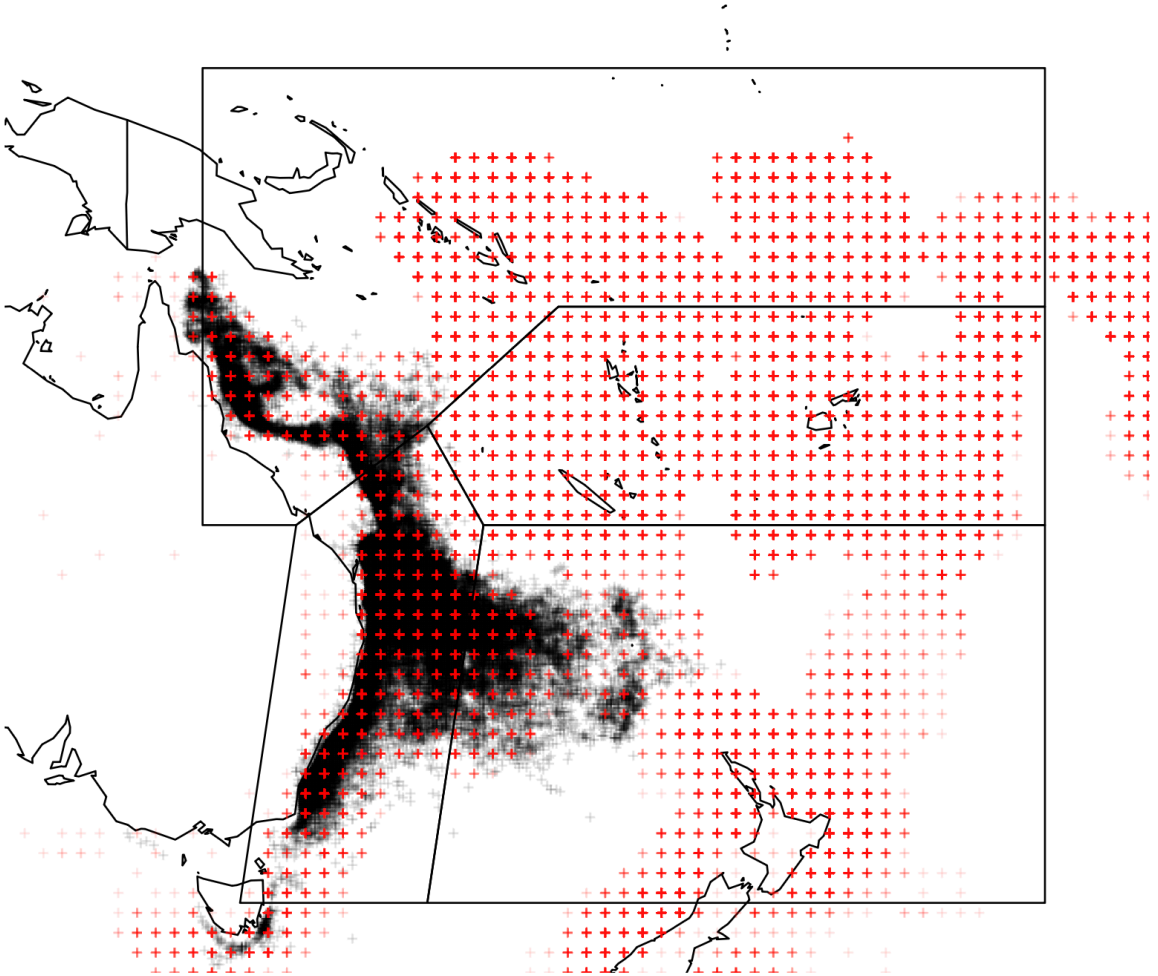
- Review of existing literature and research
- Project workshops (AFMA, SPC) to reveal current understanding of the focal species distribution.
- Collation of fisheries and ocean data to enable this investigation to be done.
- We initially applied habitat models that had been developed in other marine domains to test how well these models performed in our system.
- After this assessment we focused our efforts on applying the best model from this initial process to the wider domain and for all five species.
- We also investigated a new time-series modelling framework that allowed us to include environmental information from both the region being investigated and also including time lagged environmental data from neighbouring regions to assess influence of conditions in one region on an adjacent region in the future.
- All of these models were subsequently run using oceanographic input variables that can be forecast, and the results presented as example forecast case studies.

Regions


BRAN2020 EKE/MKE
0°
10°S
20°S
30°S
40°S
10
8
6
4
2
0
EKE/MKE ratio (white line = 1)


CS
WCP
EAC
NZ
Latitude (°N)
Longitude (°W)
0
−5
−10
−15
−20
−25
−30
−35
−40
145
150
155
160
165
170
175
180
185
190

Catch data Coverage

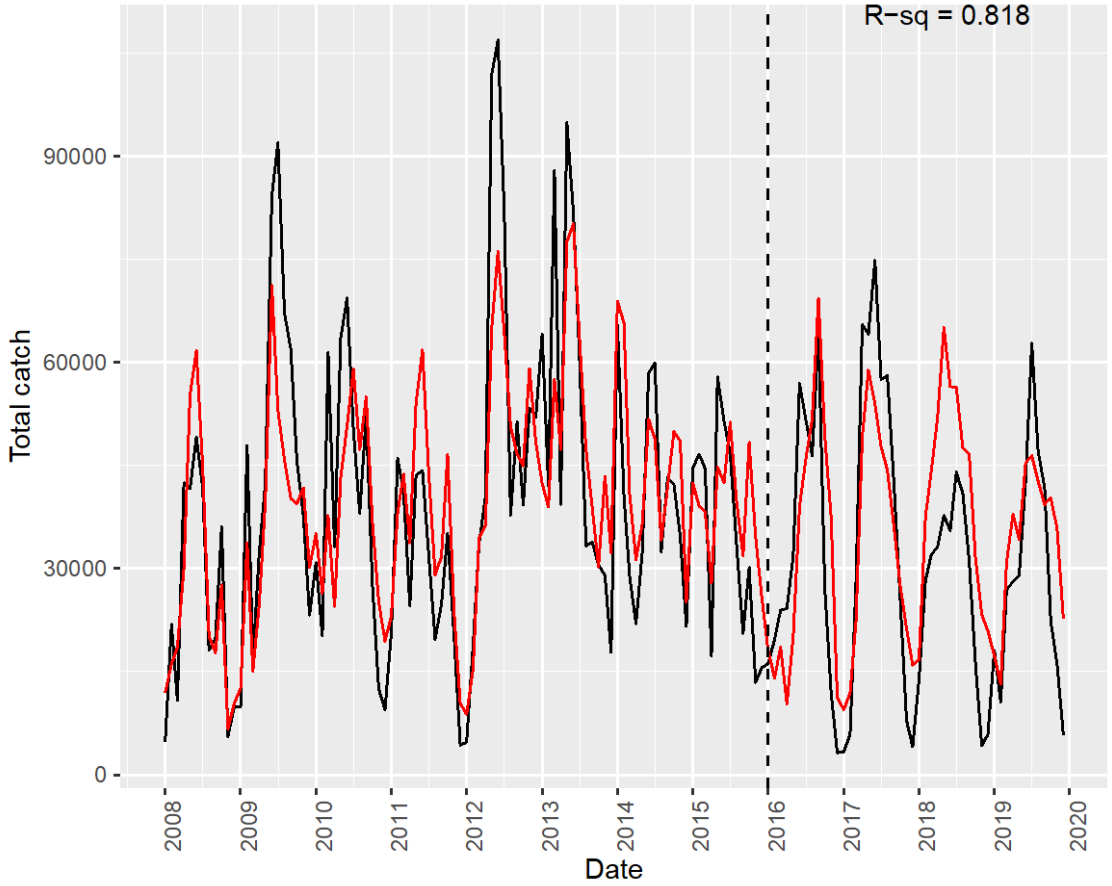


Environmental variables

Reanalysis model	Product	Description
CAFE60 variable	sss	Sea Surface Salinity (PSU)
	sst	Sea Surface Temperature (°C)
	temp50	Seawater Potential Temperature at 50m (°C)
	temp100	Seawater Potential Temperature at 100m (°C)
	temp200	Seawater Potential Temperature at 200m (°C)
	temp500	Seawater Potential Temperature at 500m (°C)
	u100	x velocity at 100m (m/s)
	v100	y velocity at 100m (m/s)
	mld	Mixed layer depth (m)
CAFE60 derived variable	u100_300	x velocity depth weighted mean over 100 - 300m (m/s)
	v100_300	y velocity depth weighted mean over 100 - 300m (m/s)
	D20	Depth of the 20C isotherm (m)
	eke300	Eddy kinetic energy depth weighted sum over upper 300 m (cm^2/s^2)
	eke2000	Eddy kinetic energy depth weighted sum over upper 2000 m (cm^2/s^2)
	hc200	Heat content upper 200 m (J/m^2)
	hc300	Heat content upper 300 m (J/m^2)

ACCESS-S2 variable	sss	Sea Surface Salinity (PSU)
	sst	Sea Surface Temperature (°C)
	temp50	Seawater Potential Temperature at 50m (°C)
	temp100	Seawater Potential Temperature at 100m (°C)
	temp200	Seawater Potential Temperature at 200m (°C)
	temp500	Seawater Potential Temperature at 500m (°C)
	u100	x velocity at 100m (m/s)
	v100	y velocity at 100m (m/s)
	D20	Depth of the 20C isotherm (m)
	hc300	Heat content upper 300 m (J/m^2)
	td	Thermocline Depth (m)
	ssh	Sea Surface Height (m)
	mld1	Kara Mixed Layer Depth (m)
	mld2	Mixed Layer Depth 0.01 (m)
ACCESS-S2 derived variable	eke300	Eddy kinetic energy depth weighted sum over upper 300 m (cm^2/s^2)
	eke2000	Eddy kinetic energy depth weighted sum over upper 2000 m (cm^2/s^2)
	u100_300	x velocity depth weighted mean over 100 - 300m (m/s)
	v100_300	y velocity depth weighted mean over 100 - 300m (m/s)

Modelled Catch (training, validation)



Deviance Explained (all variables)

	ALL	EAC	CS	WCP	NZ
YFT	0.60	0.66	0.64	0.46	0.62
BET	0.52	0.65	0.57	0.39	0.71
ALB	0.67	0.69	0.66	0.74	0.82
MLS	0.32	0.45	0.18	0.22	0.59
SWO	0.68	0.60	0.30	0.22	0.81

Observed versus predicted CPUE

	Training dataset						Validation dataset				
	ALL	EAC	CS	WCP	NZ		ALL	EAC	CS	WCP	NZ
YFT	0.13	0.17	0.08	0.08	0.36		0.10	0.08	0.04	0.04	0.09
BET	0.15	0.17	0.12	0.05	0.15		0.10	0.07	0.04	0.03	0.11
ALB	0.11	0.26	0.19	0.11	0.30		0.11	0.19	0.13	0.09	0.17
MLS	0.18	0.20	0.12	0.12	0.24		0.16	0.08	0.04	0.12	0.10
SWO	0.38	0.35	0.16	0.05	0.39		0.35	0.21	0.14	0.04	0.23

Deviance Explained (forecast variables)

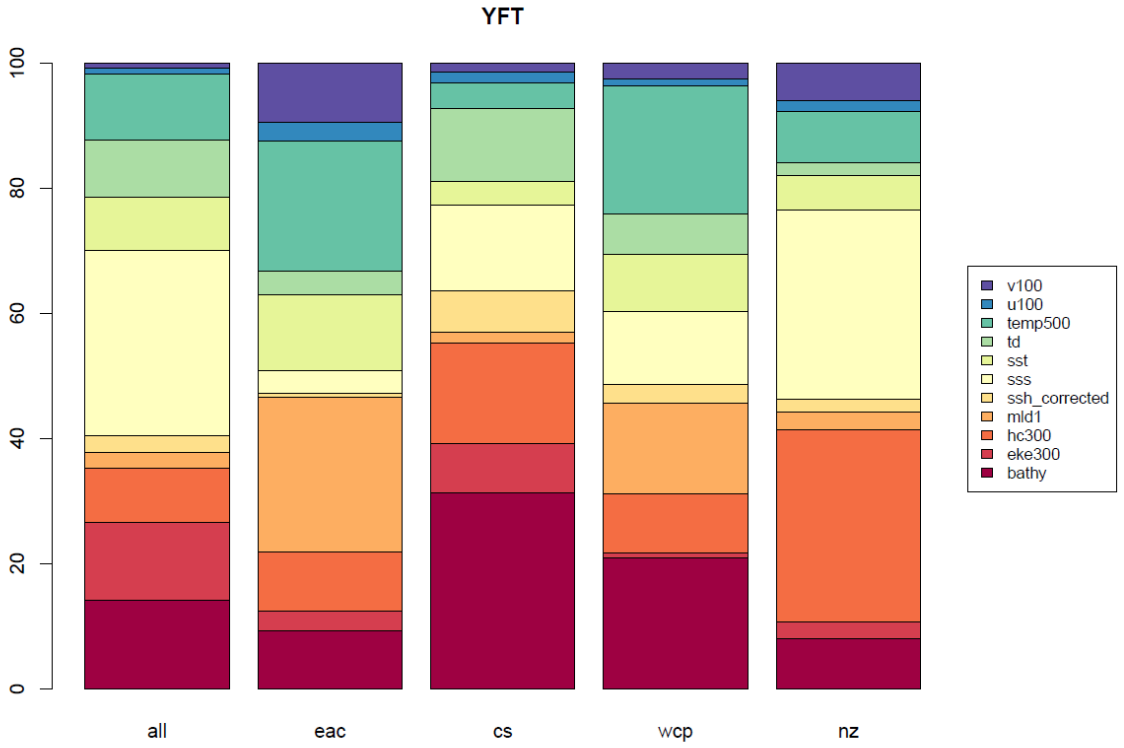
	ALL	EAC	CS	WCP	NZ
YFT	0.56	0.61	0.61	0.45	0.56
BET	0.47	0.61	0.53	0.38	0.67
ALB	0.65	0.65	0.61	0.72	0.80
MLS	0.29	0.44	NA	0.21	0.58
SWO	0.62	0.55	0.25	0.20	0.80

Observed versus predicted CPUE (forecast)

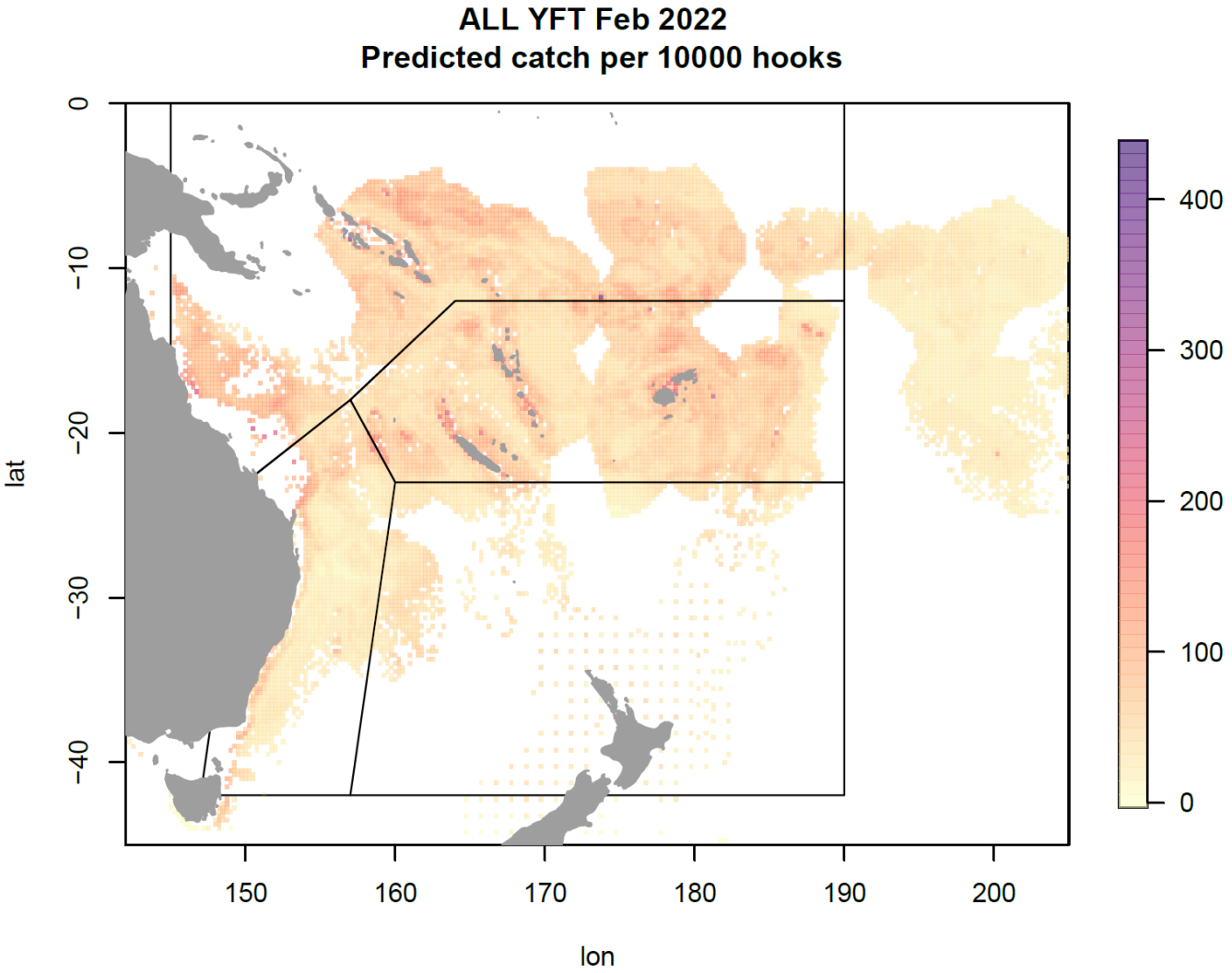
	Training dataset						Validation dataset				
	ALL	EAC	CS	WCP	NZ		ALL	EAC	CS	WCP	NZ
YFT	0.09	0.12	0.06	0.07	0.31		0.07	0.05	0.03	0.03	0.08
BET	0.10	0.13	0.10	0.04	0.11		0.06	0.06	0.03	0.02	0.11
ALB	0.07	0.22	0.13	0.07	0.26		0.08	0.17	0.08	0.06	0.21
MLS	0.16	0.20	NA	0.11	0.23		0.13	0.08	NA	0.10	0.11
SWO	0.31	0.27	0.11	0.04	0.37		0.29	0.16	0.12	0.04	0.23

Key Findings

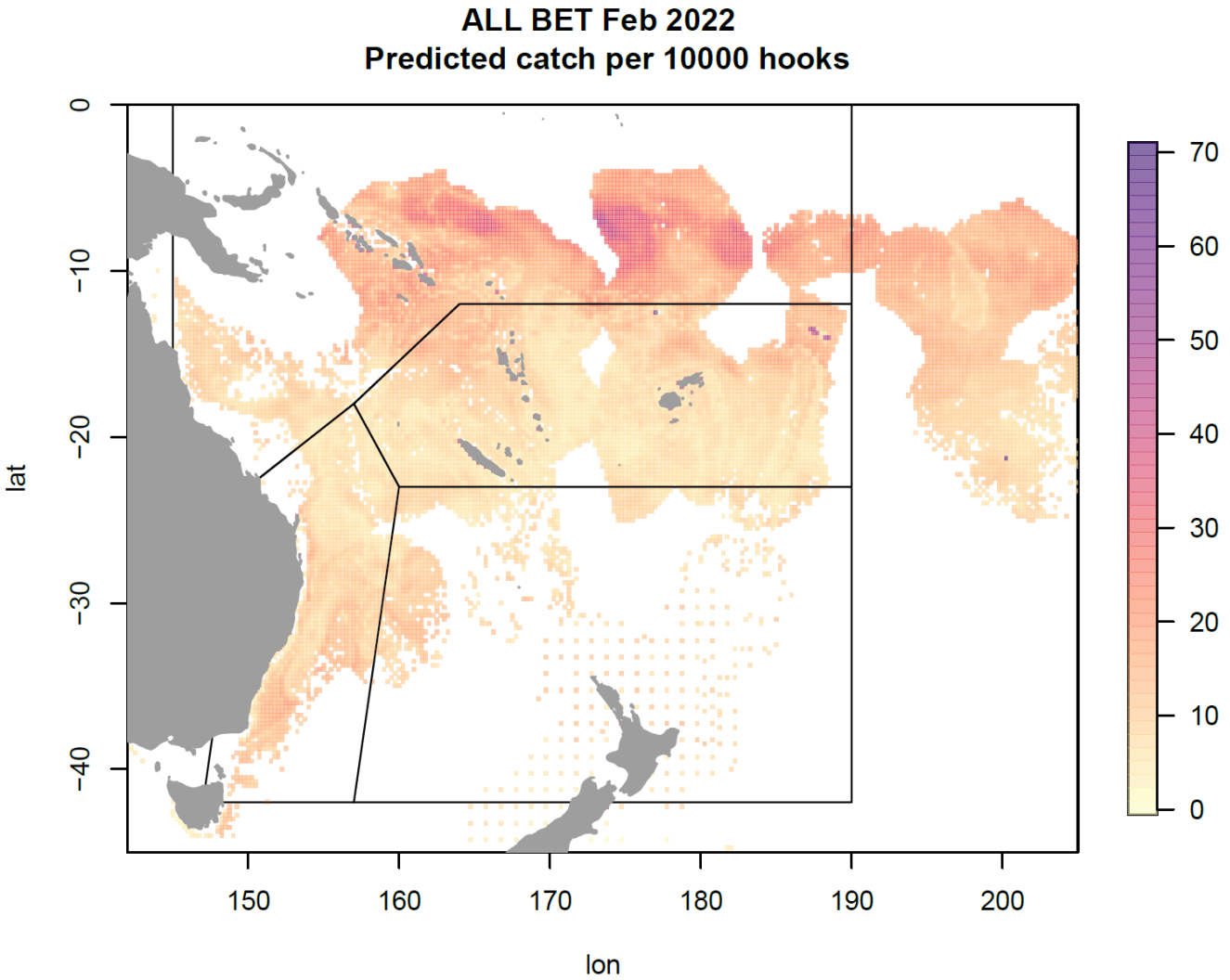
- Sub surface variables play an important part in explaining the variance in catch



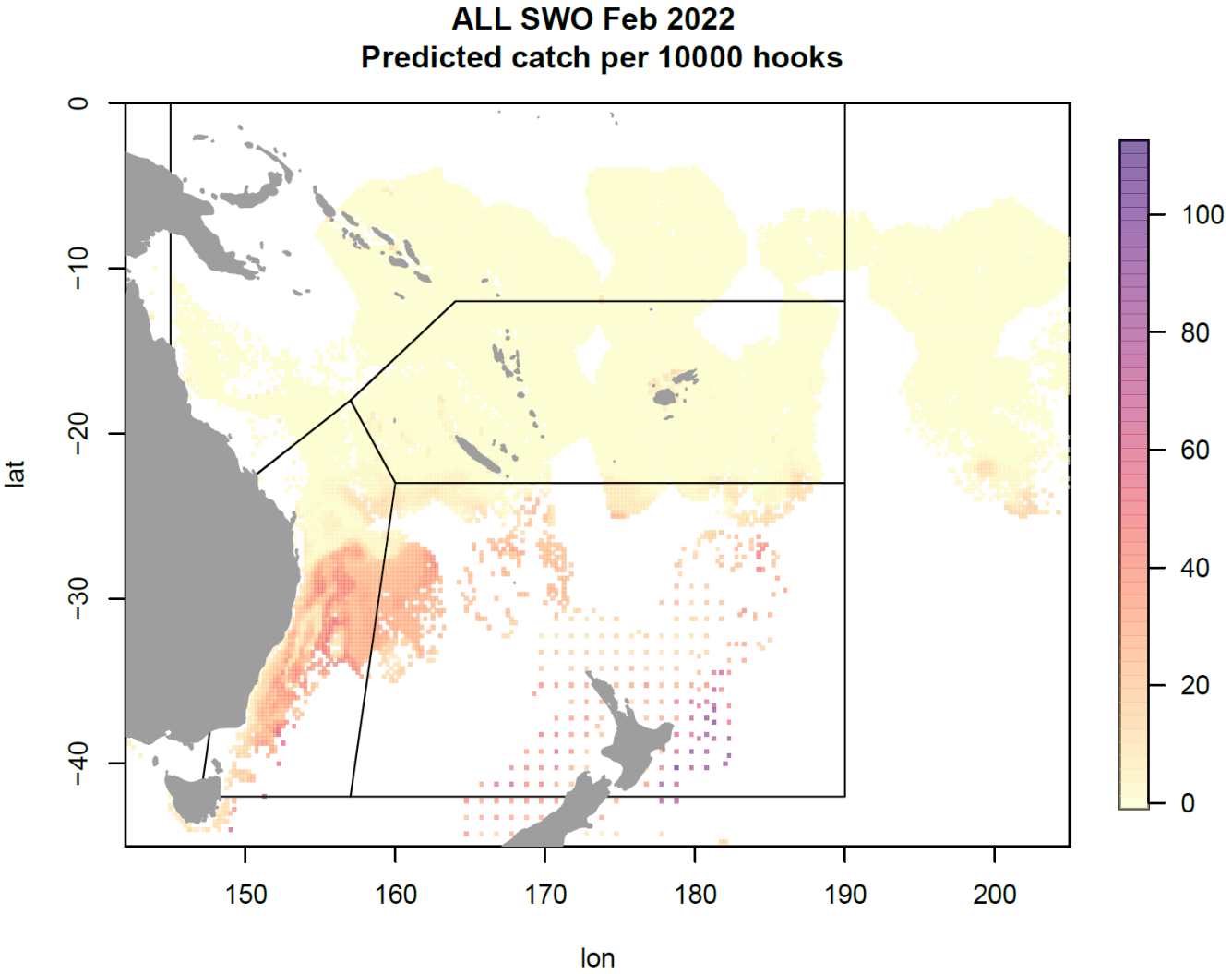
Forecasts


ALL YFT Feb 2022
Predicted catch per 10000 hooks
lat
0
−10
−20
−30
−40
150
160
170
180
190
200
lon
400
300
200
100
0

Forecasts

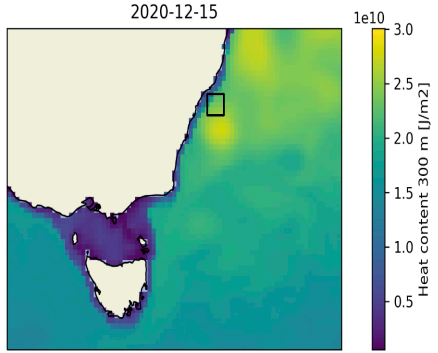

ALL BET Feb 2022
Predicted catch per 10000 hooks
lat
0
−10
−20
−30
−40
lon
150
160
170
180
190
200
70
60
50
40
30
20
10
0

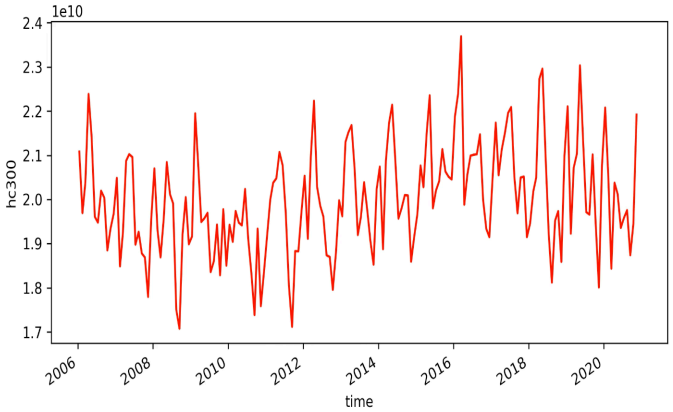
Forecasts


ALL SWO Feb 2022
Predicted catch per 10000 hooks
lat
0
−10
−20
−30
−40
150
160
170
180
190
200
lon
100
80
60
40
20
0

Project outputs

- 6 project updates to this TTRAG and some to SPC via Simon Nicol.
- Work presented at ASFB, World Fisheries Congress, AMOS, Tuna Conference.
- Collation of ACCESS-S reanalysis datasets into a packaged environmental data file, updated as needed for use in other applications (CPUE standardization).





Project outputs

- Paper accepted at Fisheries Oceanography

"Forecast-ready models to support fisheries adaptation to global variability and change"

Kylie L. Scales[1], Thomas S. Moore II[2], Bernadette Sloyan[2], Claire Spillman[3], J. Paige Eveson[2], Toby A. Patterson[2], Ashley Williams[2], Alistair J. Hobday[2], Jason R. Hartog[2]

[1]School of Science, Technology and Engineering, University of the Sunshine Coast, Queensland, Australia.
[2]CSIRO Oceans & Atmosphere, Castray Esplanade, Hobart, Tasmania, Australia.
[3]Bureau of Meteorology, Melbourne, Victoria, Australia.

Project outputs

- Article written for SPC newsletter

Forecasts of future ocean state and potential application to tuna availability

Jason R. Hartog,[1] J. Paige Eveson,[2] Thomas Moore[2], Kylie L. Scales[3], Toby Patterson[2], Shane Baylis[2], Bernadette Sloyan[2], Ash Williams[2], Claire M. Spillman[3], Grant Smith[4] and Alistair J. Hobday[2]

Background

Commercially valuable species targeted by Australian longline fisheries (bigeye tuna, *Thunnus obesus*; yellowfin

the five target species, boosted regression trees (BRTs) were used to model the observed catch in each 0.25-degree grid cell in each month, assuming a Poisson distribution. The number of hooks was included as an offset and the selected

Investigating ocean indices of specific value to fisheries modelling off eastern Australia

PRESENTER:

Thomas Moore (CSIRO)

T Moore[1], K Scales[2], B Sloyan[1], J Hartog[1], C Chapman[1], A Black[1], R Cowley[1]

MOTIVATION: Ocean variability influences the distribution and abundance of target species in Australia's Eastern Tuna and Billfish Fishery (ETBF) and associated fisheries of Pacific Island nations, yet impact of oceanographic factors is still poorly understood creating uncertainty for industry and managers.

The Decadal Climate Forecasting Project (DCFP)

- A mission to improve multi-year climate forecasts for the benefit of Australia.
- A new multi-decade coupled climate reanalysis with 96 ensemble members.
- Ensemble hindcast / forecast products that extend seamlessly beyond seasonal into multi-year prediction.
- DCFP data products* become publicly available starting later in 2021 via AWS.

*O'Kane et al, 2021 in press

DCFP collaboration in FRDC project assisting the development of habitat models built on ocean reanalysis and exploring multi-year habitat forecasting.

Ocean reanalysis and forecasting to explore multi-year predictions of fishery conditions for governments, industry, and other stakeholders

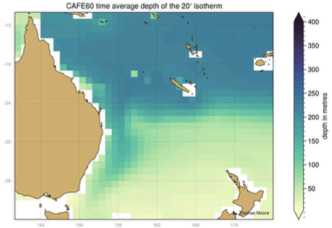
hypothesis	species	timescale	space-scale	products
upper ocean temperature impacts spawning	yellowfin tuna (YFT)	summer & year round depending on location	Coral Sea and Equatorial Pacific. Depth range typically 0-200m. YFT are creatures of the mixed layer.	ACCESS-D mixed layer temperature and upper ocean heat content
...	...	...	...	...

Building and testing hypotheses linking ocean physics to the fishery dynamics of commercially important species like yellowfin tuna (YFT)

Take a picture to view a presentation

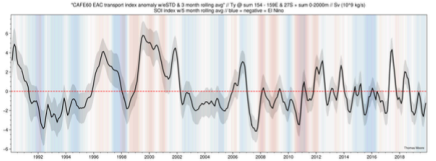
Take a picture to email the presenter

ACCESS-D CAFE60 spatial metrics and indices



Moving beyond purely satellite derived products, the ACCESS-D ocean reanalysis & forecasts provide sub-surface metrics that represent the upper ocean structure where the ETBF species live and feed. Here, the depth of the 20° isotherm is chosen given it's likely relation to the distribution of thermally sensitive species like yellowfin tuna (YFT).

Decades of reanalysis also provide long timeseries of key ocean indices - here, the anomaly of an index of East Australian Current strength, as it is represented in the 1° ACCESS-D model.

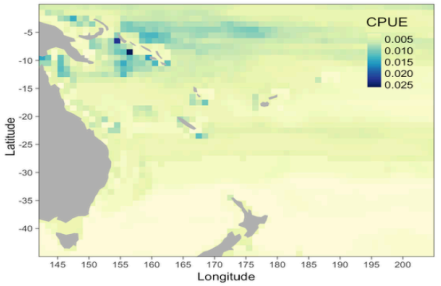


BRT modelling of YFT:

Kylie Scales (USC)

Model	Deviance explained	R-squared on training set (2000-14)	R-squared on validation set(2015-19)
Sub-surface	78.1%	0.69	0.55

Variables	Relative variable contribution
OHC (0 - 200m)	30.0%
Temp @ 50 m	17.9%
Z20 isotherm	15.0%
SSS	10.7%
MLD	6.1%
EKE (0 – 300m)	5.4%
V @ 100m	4.8%
Temp @ 100 m	4.1%
U @ 100m	2.6%
SST	2.4%
Temp @ 200 m	1.1%

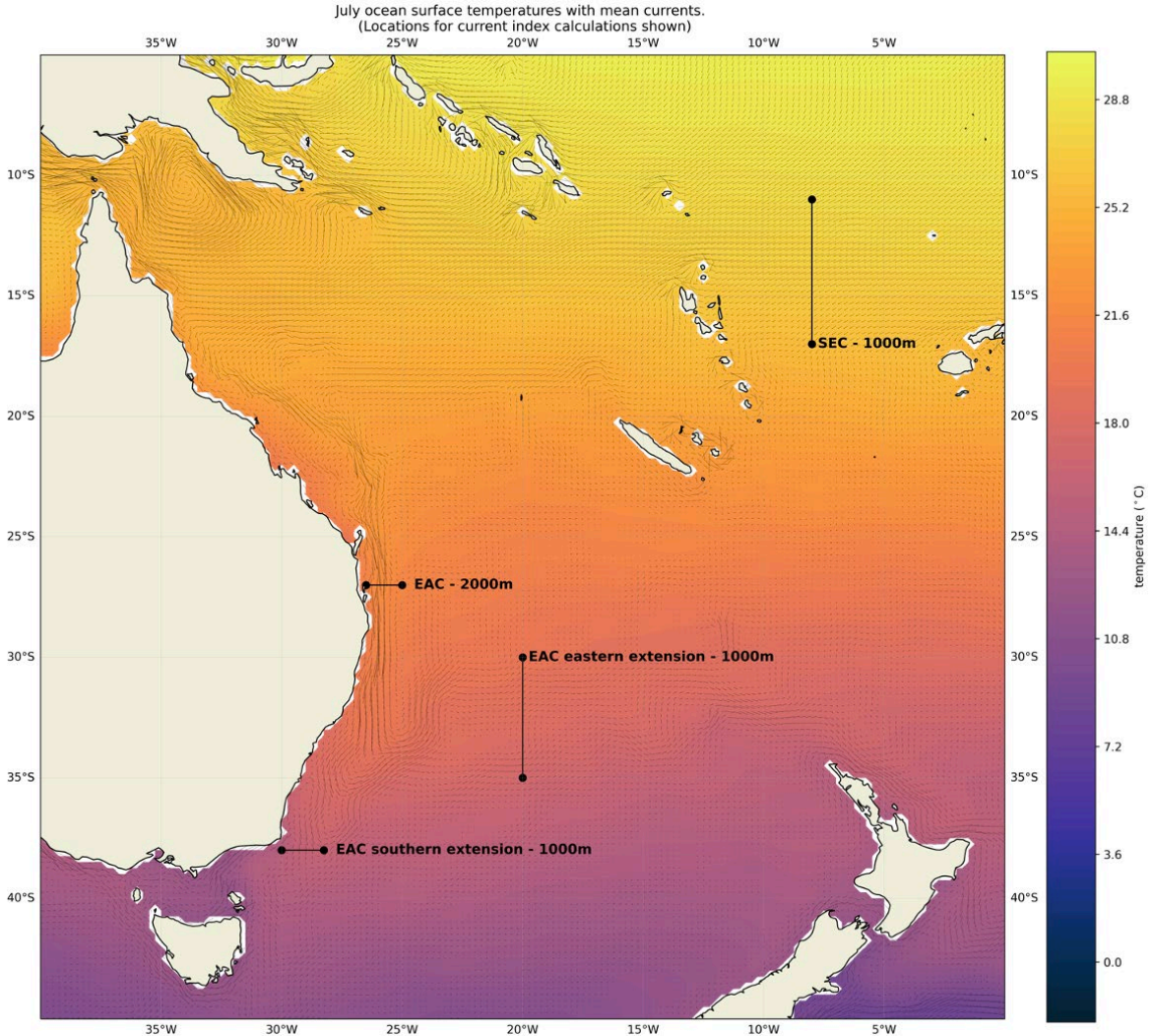


Spatial prediction of YFT distribution for 09-2018. This dummy forecast is based on the best performing model evaluated using metrics of deviance explained, R^2, and root-mean-square error for a set of ACCESS-D CAFE60 spatial metrics. Sub-surface ocean variables that represent the upper ocean temperature structure and heat content contribute the most to the model. (CPUE = Catch per unit effort).

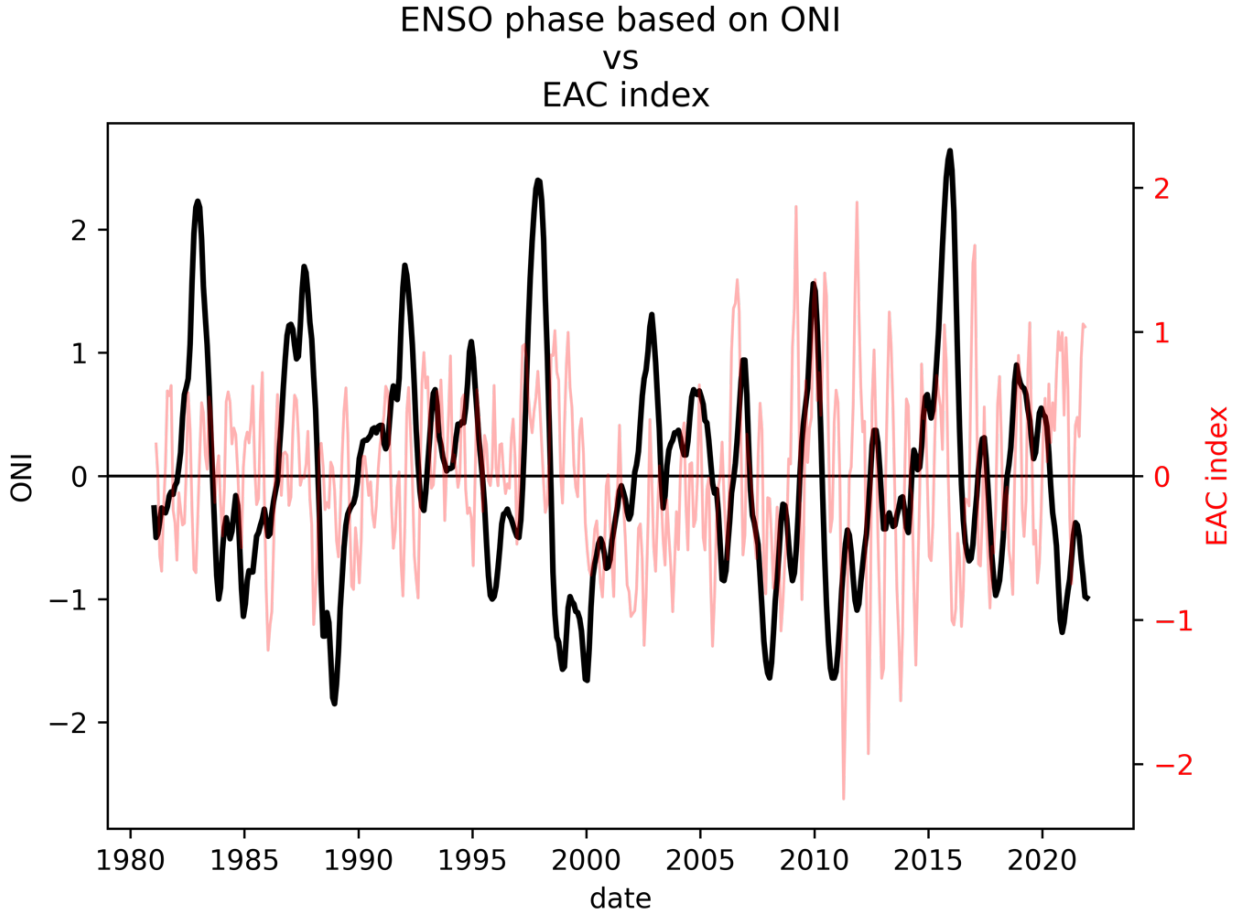
1 CSIRO 2 USC

FRDC PANGEO

Indices


July ocean surface temperatures with mean currents.
(Locations for current index calculations shown)
35°W
30°W
25°W
20°W
15°W
10°W
5°W
10°S
15°S
20°S
25°S
30°S
35°S
40°S
SEC - 1000m
EAC - 2000m
EAC eastern extension - 1000m
EAC southern extension - 1000m
28.8
25.2
21.6
18.0
14.4
10.8
7.2
3.6
0.0
temperature (°C)

Indices


ENSO phase based on ONI
vs
EAC index
ONI
EAC index
date
2
1
0
−1
−2
1980
1985
1990
1995
2000
2005
2010
2015
2020

Ocean variable forecast

- http://poama.bom.gov.au/access-s/etbf/
- Username: etbf
- Password: tuna

Recommendations

- The outputs of the modelling work show that primary (e.g., temperature at 500m) and derived (e.g., depth of the 20°C isotherm, heat content in the upper 300m, and mixed layer depth) sub-surface oceanographic variables are important, and yet these are limited in their availability to be forecast. Many of these variables are yet to be fully assessed for forecast skill (a measure of accuracy), and when this has been done, efforts to make these available should be pursued.
- The analysis-ready datasets produced by this project should be considered in the regular workflow of the TTRAG for use in standardising CPUE and providing updates of current ocean state.
- Ongoing development of operational systems and engagement with the Bureau of Meteorology (and continued provision and assessment of additional ocean variables) that include the sub-surface variables of interest should be pursued.

Further Development

- A substantial limitation in assessing the environmental influence on tuna and billfish availability in the ETBF and surrounding regions is the limited or absent fishery independent data such as that obtained from electronic tags.
- There is a need for targeted studies of species of interest in the Australian region to explore the influences in more detail.
- Catch data are clearly influenced by decisions made by fishers and managers, primarily to do with economics (e.g., distance from port, market price or demand), or harvest controls, which confound the ocean influences on fish distribution.

Australian Government

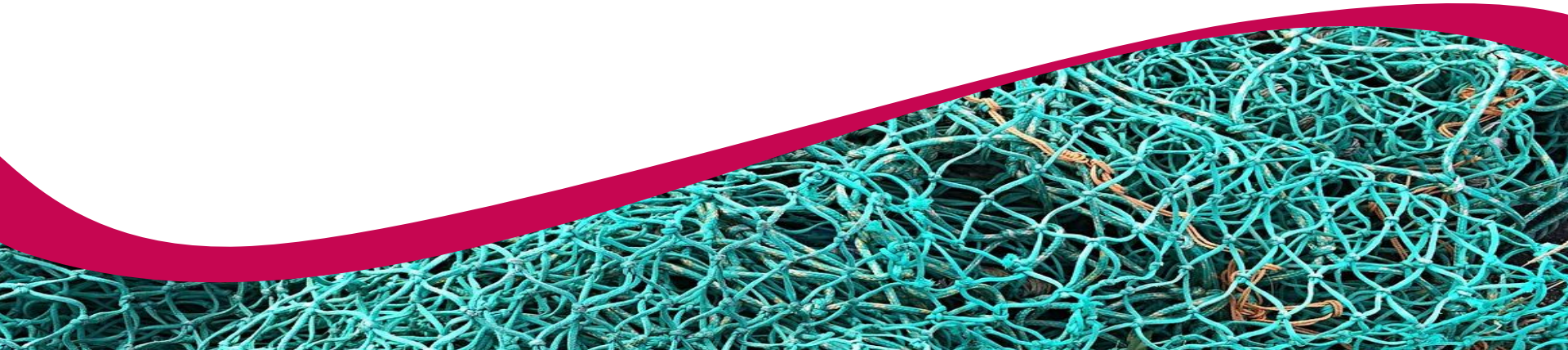
Australian Fisheries Management Authority

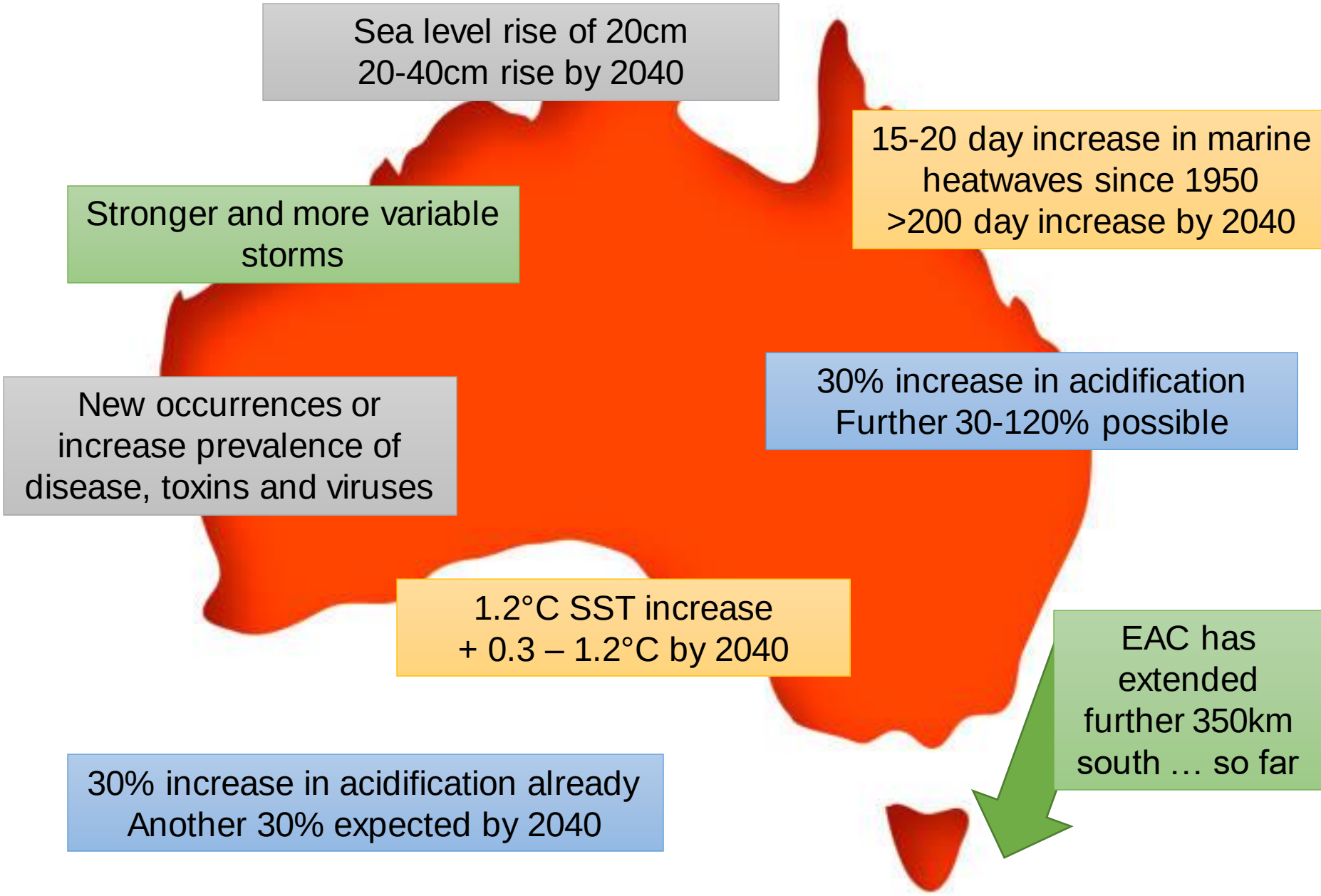
AFMA's Climate Adaptation Program

Adapting Commonwealth fisheries management to climate change

Tropical Tuna RAG

March 2023

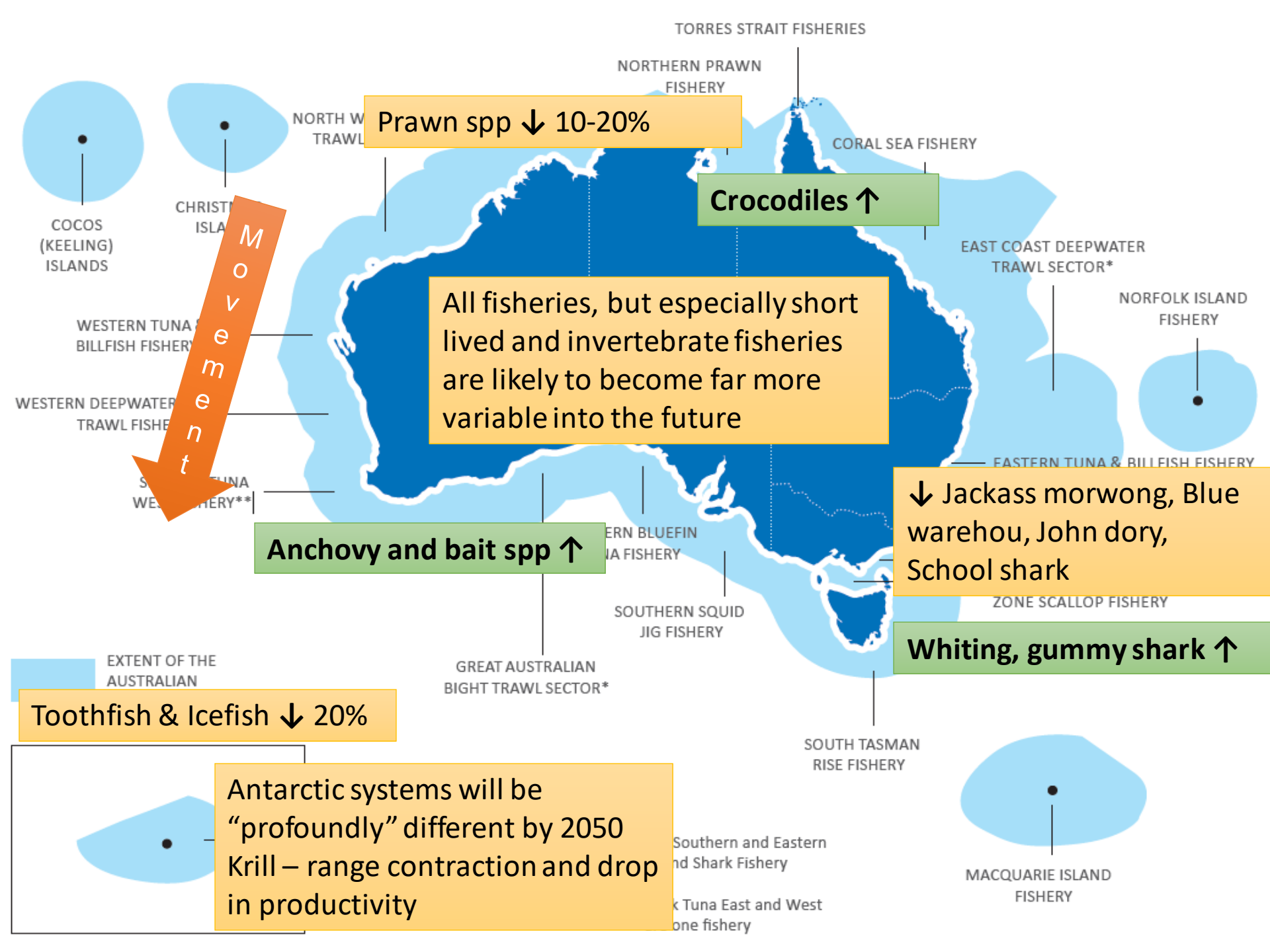



Sea level rise of 20cm
20-40cm rise by 2040
15-20 day increase in marine heatwaves since 1950
>200 day increase by 2040
Stronger and more variable storms
30% increase in acidification
Further 30-120% possible
New occurrences or increase prevalence of disease, toxins and viruses
1.2°C SST increase
+ 0.3 – 1.2°C by 2040
EAC has extended further 350km south … so far
30% increase in acidification already
Another 30% expected by 2040

Impact of climate change on fisheries resources

1. Distributional change
2. Productivity change
3. Species composition change

Distribution, productivity and species composition are key factors that underpin the way we manage our fisheries.


TORRES STRAIT FISHERIES
NORTHERN PRAWN FISHERY
Prawn spp ↓ 10-20%
CORAL SEA FISHERY
Crocodiles ↑
COCOS (KEELING) ISLANDS
EAST COAST DEEPWATER TRAWL SECTOR*
NORFOLK ISLAND FISHERY
Movement
All fisheries, but especially short lived and invertebrate fisheries are likely to become far more variable into the future
WESTERN TUNA & BILLFISH FISHERY
WESTERN DEEPWATER TRAWL FISHERY
EASTERN TUNA & BILLFISH FISHERY
↓ Jackass morwong, Blue warehou, John dory, School shark
Anchovy and bait spp ↑
SOUTHERN SQUID JIG FISHERY
ZONE SCALLOP FISHERY
Whiting, gummy shark ↑
GREAT AUSTRALIAN BIGHT TRAWL SECTOR*
EXTENT OF THE AUSTRALIAN
Toothfish & Icefish ↓ 20%
SOUTH TASMAN RISE FISHERY
Antarctic systems will be "profoundly" different by 2050
Krill – range contraction and drop in productivity
MACQUARIE ISLAND FISHERY

Pacific tuna and climate change

Tuna experiences normal shifts in distribution and abundance:

- La Nina = tuna populations are found more in the western pacific
- El Nino = more in the central and east pacific

Variability will increase (including severity and frequency of severe ENSO events)

Tuna can move to more favourable conditions, so impacts will have limited effects on overall abundance until about 2050-60

Fishing will continue to have a greater effect on populations than climate change

Pacific tuna and climate change

Distributional change

- SKJ and YFT will move eastwards, BET to a lesser degree
- Some southerly movement of ALB, density will decrease in west WCPO and increase in east.
- More catch expected in international waters
- Catch rates of surface dwelling SKJ and YFT may increase where SST still suitable, due to less oxygen in deeper water. More ALB may be found in surface waters.

Productivity change

- After 2050 decreases will become more evident in SKJ, YFT and BET
- ALB may benefit …

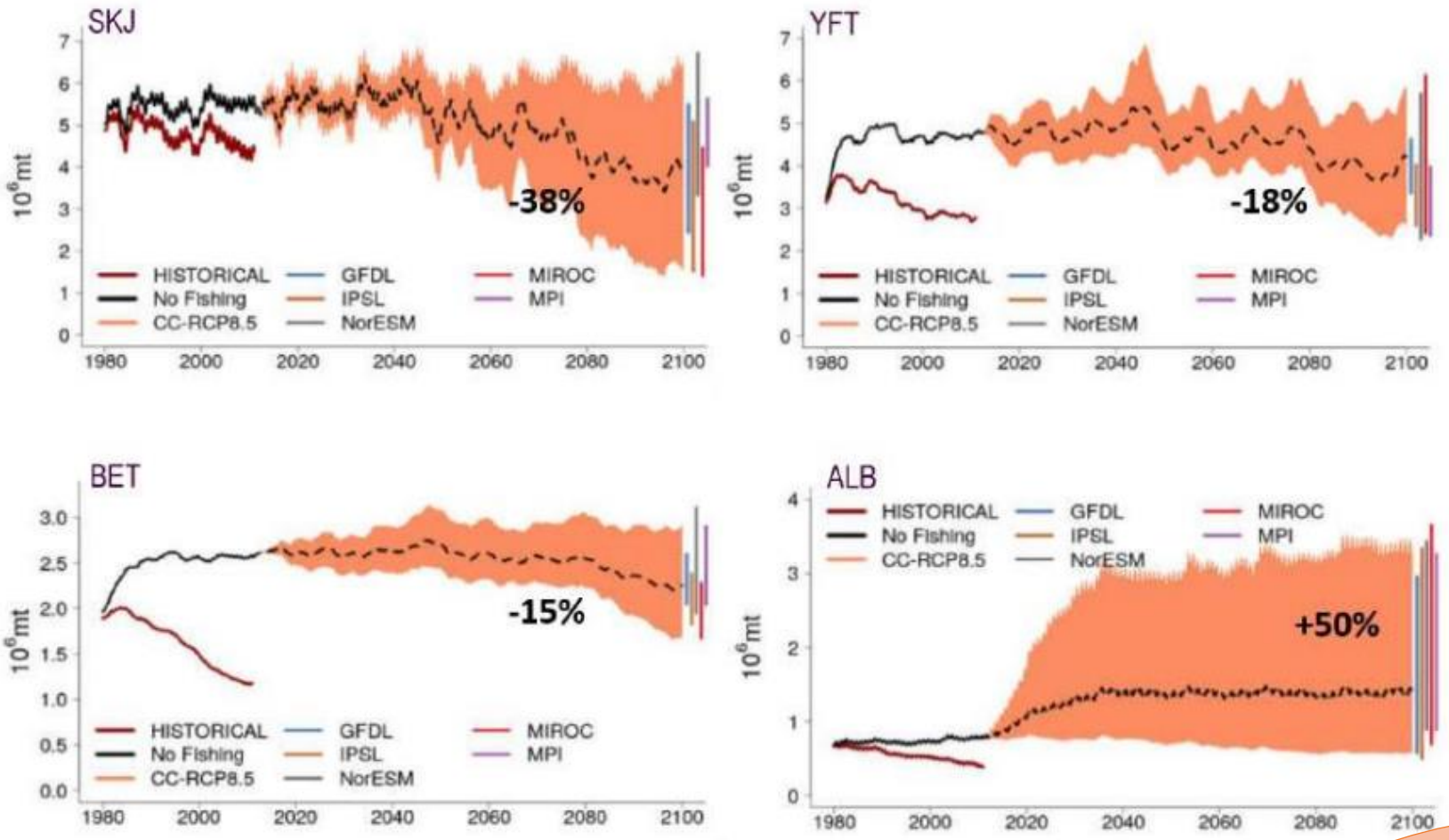
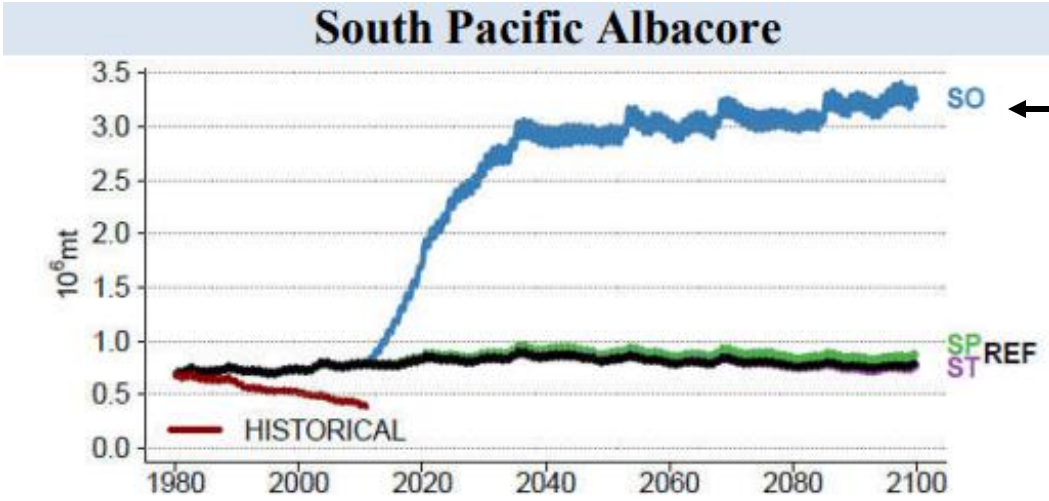


Figure 28: Envelope of predictions computed from simulation ensembles under IPCC RCP8.5 WCPO for skipjack (SKJ), yellowfin (YFT), bigeye (BET) and albacore (ALB) tuna. T biomass is presented with the average (dotted line) and its envelope bounded by the 5% a of the simulation ensembles. The percentage values represent the change in the mean the 1990–2010 time window compared with 2090–2100. The bars on the right hand ar corresponding to the four RCP scenarios defined in Figure 27. Modified from Senina et al.

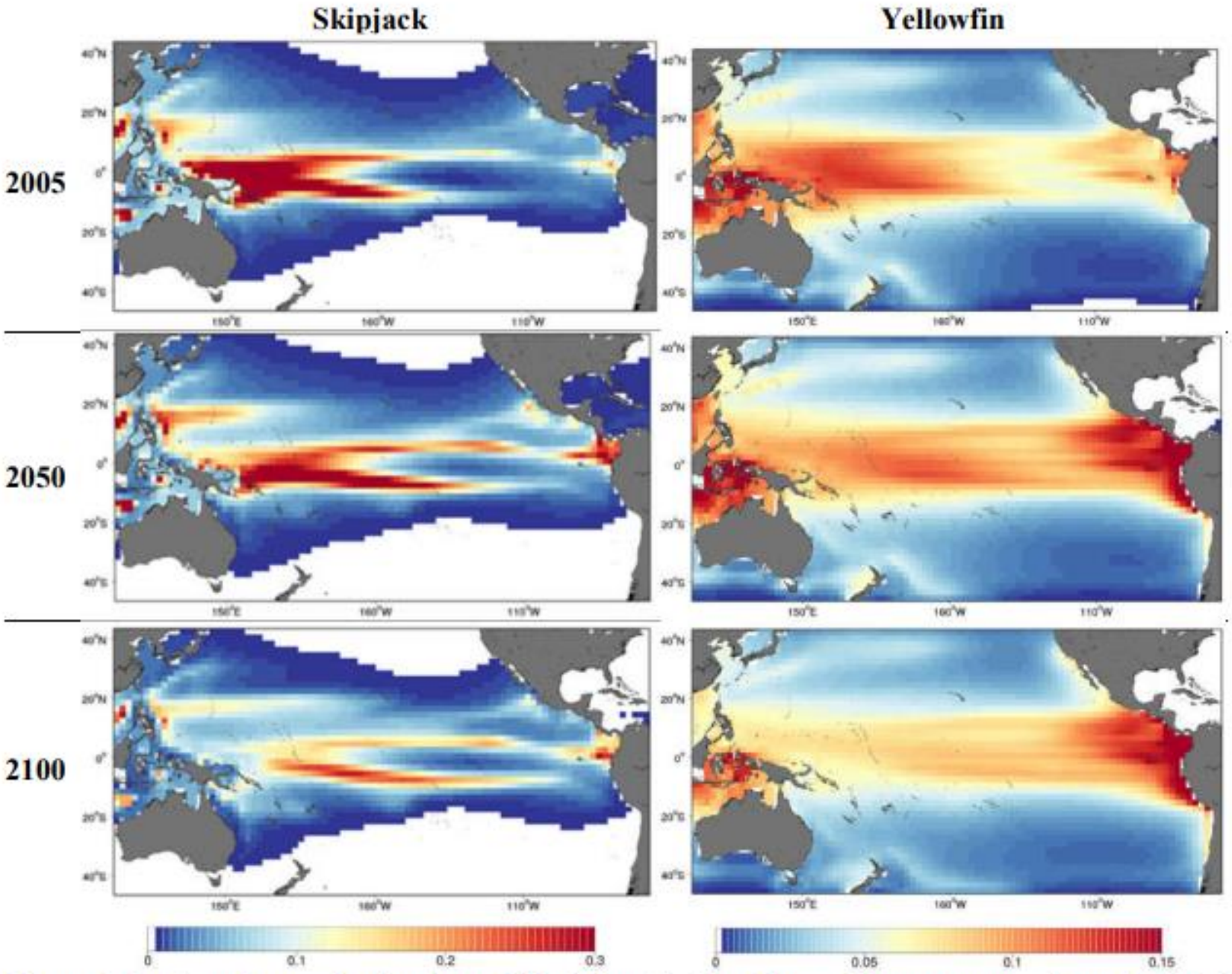
NB: Projections done on the "no fishing" scenario

From: Hare S.R., Williams P.G., Castillo Jord´an C., Hamer P.A., Hampton W.J., Lehodey, P., Macdonald, J., Scutt Phillips, J., Scott R.D., Senina, I., Pilling G.M. 2022. The western and central Pacific tuna fishery: 2021 overview and status of stocks. Tuna Fisheries Assessment Report no. 22. Noumea, New Caledonia: Pacific Community. 63 p. *(Modified from WCPFC-SC14-2018/EB-WP-01)*

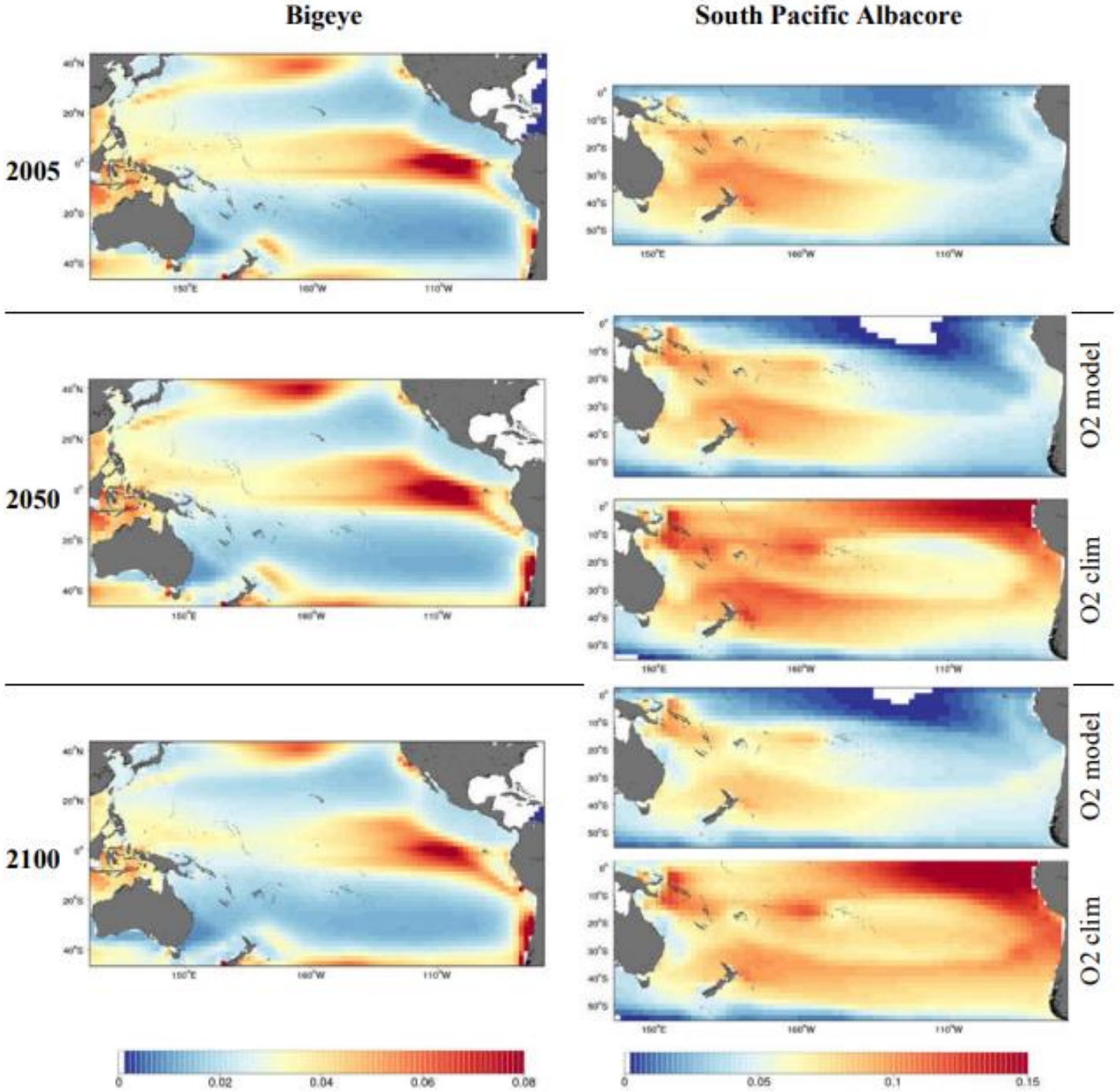


If no change in dissolved oxygen concentration occurs

If predicted decrease in dissolved oxygen concentration occurs as water temperature increases



Taken from WCPFC-SC14-2018/EB-WP-01
"The impact of climate change on tropical Pacific tuna and their fisheries in Pacific Islands waters and high seas areas"


Bigeye
South Pacific Albacore
2005
2050
2100
O2 model
O2 clim
O2 model
O2 clim
0
0.02
0.04
0.06
0.08
0
0.05
0.1
0.15

Climate change at WCPFC

WCPFC Resolution 2019-01 resolves to:

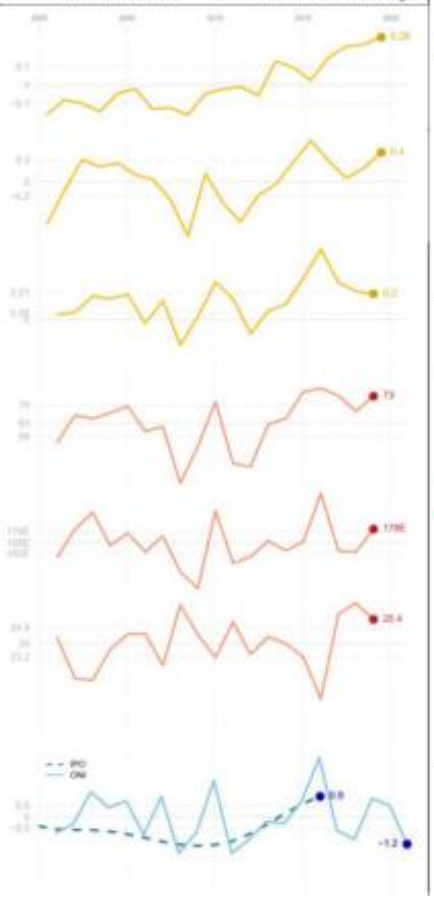
- Consider potential impacts
- Support development of science
- Take science into account in deliberations
- Address any potential impacts
- Consider options to reduce impacts of Commission headquarters and meetings

WCPFC SC are developing ecosystem and climate indicators

Could form the basis of a report card on WCPFC ecosystem and climate status, or development of triggers for management response

Annex 2 Candidate Ecosystem and Climate Indicators presented to SC17 (see SC17-EB-IP-09)

Report Card 1. Environment and Fishing Effort Indicators

Indicator	Description	Notes	Time-series
Sea Surface Temperature Anomalies (ANNEX 1 - A.1)			Mean/Reference Value — Central 50% of data range
Annual SST Anomaly	Mean annual SST anomaly (°C) across **WCPO area**	• Derived from ocean models • WCPO area western limit of 130°E • Anomaly from mean temperature 2000-2019	
	Mean annual SST anomaly (°C) across **WCPO equatorial zone**	• Derived from ocean models • Equatorial zone 5°S-5°N • Anomaly from mean temperature 2000-2019	
Nov-Apr Warm-pool SST Anomaly	Mean annual SST anomaly (°C) within warm-pool extent	• Derived from ocean models • Warm-pool defined by mean Nov-Apr temperature > 29°C	
Warm-pool Indices (ANNEX 1 - A.2)			
Mean Size of Warm-pool	Approximate size of warm-pool in millions of km^2	• Derived from ocean models • Warm-pool defined by mean Nov-Apr temperature > 29°C	
Eastern Limit of Warm-pool Boundary	Longitude of strongest sea surface salinity boundary	• Derived from ocean models • Boundary defined as largest change over 10° distance	
Mean Warm-pool Mixed Layer Depth	Mean depth (m) of the mixed layer within warm-pool	• Derived from ocean models • Layer over which water temperature is homogenous	
Climate Indices (ANNEX 1 - A.3)			
Oceanic Niño (ONI) and Interdecadal Pacific Oscillation (IPO) Index	ONI indicates SST anomalies in the Niño 3.4 region during Nov-Jan each year IPO represents long-term oscillation between El Niño favourable and La Niña favourable phases	• ONI values > 0.5 indicative of El Niño events, values < -0.5 indicative of La Niña • IPO values > 0 indicative of more El Niño events, < 0 indicative of more La Niña events • Long-term IPO changes only calculable to 2016	

Indicator	Description	Notes	Time-series
Target Species Condition (ANNEX 1 - A.7)			Mean/Reference Val
Mean Length of Target Species	Mean fork length (cm) of **Skipjack** tuna caught by WCPO purse seine and longline fisheries	• Length data sourced from purse seine and longline • Length measurements recorded at sea and in port	
	Mean fork length (cm) of **Yellowfin** and **Bigeye** tuna caught by WCPO longline fisheries	• Length data sourced from longline only • Length measurements recorded at sea and in port	
Mean Condition Factor from Longline Catch	Mean observed individual tuna weight divided by predicted weight at length	• A measure of relative tuna 'fatness' • Predicted weight modelled from longline records spanning 2000 to 2019, for each species separately	
Mean Fat Content of Sampled Tuna	Mean fat content (%) as measured by fatmeter during annual PTTP research cruises informing on tuna condition: fatter fish being considered in better condition	• Yellowfin tuna measuring 40 to 60 cm fork length • Years available: 2007-2009, 2011-2013, 2019-2020 • Sample size varies considerably by year (range n = 9-264, mean n = 110)	
Bycatch Species (ANNEX 1 - A.8)			
Annual Finfish Bycatch	Estimated **Unassociated Purse Seine** catch in 1000s of metric tonnes	• Excluding billfish and tuna • Catch estimates based on observer data, excluding small-scale domestic fisheries of Indonesia, Vietnam, the Philippines, and temperate water purse seiners	
	Estimated **Associated Purse Seine** catch in 1000s of metric tonnes	• Excluding billfish and tuna • Catch estimates based on observer data, excluding small-scale domestic fisheries of Indonesia, Vietnam, the Philippines, and temperate water purse seiners	
	Estimated **Longline** catch of finfish bycatch species in millions of individuals	• Catch estimates based on observer data, excluding domestic fisheries of Indonesia, Vietnam and the Philippines, and former shark-targeted fisheries in Papua-New Guinea and Solomon Islands	
Annual Billfish Bycatch	Estimated **Purse Seine** catch in 1000s of individuals, separated between associated and un-associated purse seine.	• Catch estimates based on observer data, excluding small-scale domestic fisheries of Indonesia, Vietnam, the Philippines, and temperate water purse seiners	
	Estimated **Longline** catch of billfish in millions of individuals	• Catch estimates based on observer data, excluding domestic fisheries of Indonesia, Vietnam and the Philippines, and former shark-targeted fisheries in Papua-New Guinea and Solomon Islands	

Recommended resources

OFMP 2 Climate Change fact sheet_0.pdf (ffa.int)

Impact of climate change on tropical Pacific tuna and their fisheries in Pacific Islands waters and high seas areas | WCPFC Meetings

Latest update to WCPFC SC on Ecosystem and Climate Indicators: WCPFC-SC18-2022/EB-WP-01

The western and central Pacific tuna fishery: 2021 overview and status of stocks. Tuna Fisheries Assessment Report no. 22. SPC

Southern Bluefin Tuna

Current information suggests species has a low sensitivity to climate change.

However, depending on change in primary productivity , upwelling and spawning thermal tolerances, impacts could include:

- Southerly shift of species
- Change in location of tuna and sardines in the GAB
- Increases in abundance of juveniles
- Juveniles found deeper
- Finding SBT may be harder

AFMA's Climate Adaptation Program

Integrating climate adaptation into the management of Commonwealth fisheries

- **Information and research on existing and predicted climate impacts are incorporated into decision-making processes**
  - Info / research already available and being used in some fisheries
  - More strategic / explicit approach to consideration of CC information in RAGs, MACs, Commission
  - Build our understanding and that of stakeholders
  - Identify critical gaps in knowledge
- **Fisheries management arrangements are adaptive**
  - Climate change impacts are considered in decisions
  - Developing adaptation options and management responses
  - Feeding into policy and legislative reviews (e.g. harvest strategy, rebuilding strategies, OCS)

Building climate change information into AFMA's decision-making processes

Actions being implemented in AFMA fisheries:

1. Standing agenda item "Climate and ecosystem update" for RAG and MAC meetings where TACs (or RBCs or TAEs) are being considered
2. Climate and Ecosystem Status Reports
3. Include climate sensitivity information and consideration of climate impacts into advice to the Commission
4. Qualitative assessment and incorporation of climate change information into decision-making

Rolling out across AFMA fisheries

Is this something that would be useful for ETBF and/or WTBF?

If so, what sort of indicators should be included? Or could we draw from the WCPFC indicators?

Integrating climate adaptation into the management of Commonwealth fisheries

- **Information and research on existing and predicted climate impacts are incorporated into decision-making processes**
  - Info / research already available and being used in some fisheries
  - More strategic / explicit approach to consideration of CC information in RAGs, MACs, Commission
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  - Identify critical gaps in knowledge
- **Fisheries management arrangements are adaptive**
  - Climate change impacts are considered in decisions
  - Developing adaptation options and management responses
  - Feeding into policy and legislative reviews (e.g. harvest strategy, rebuilding strategies, OCS)

Climate Adaptation Workshops

AFMA planning stakeholder workshops for priority fisheries utilising the [Climate Adaptation Handbook](#).

The

Would TT fishery and stakeholders benefit from an adaptation workshop?
If so, what would that look like?

of

Method: Engage a range of experts and stakeholders in the process

Output: Better understanding of the climate risks to a fishery and guidance on how to respond.

Next steps for tropical tuna?

- Significant scientific work underway, although regional focus
- Inclusion of climate on the agenda at TTRAG and TTMAC
- Climate adaptation work will look different for tropical tuna

- ➢ Would a domestic 'Climate and Ecosystem Status Report' be useful for this fishery?
- ➢ What changes are operators seeing on the water?
- ➢ Would a climate adaptation stakeholder workshop that looks at current science, and potential management and industry adaptation options be beneficial?

Coral Sea Zone Hook Trial Annual Review
Discussion Paper
Small Working Group meeting # 4

15 February 2023

Meeting Objectives

1. For the Working Group to **consider**:
    a. an update to be provided by members in-session on recreational and commercial fishing effort trends in the Coral Sea Zone (CSZ); and
    b. results of the two-year CSZ Hook Trial compared to the baseline period (2015-2019) as detailed in this paper.
2. Having considered (1) above, for the Working Group to **provide advice** on the key outcomes of the two-year CSZ Hook Trial.
3. For the Working Group to **provide advice** on whether the CSZ Hook Trial should continue in its current form (retain working group and trial arrangements) for the next two seasons (2023 and 2024) whilst the Tropical Tuna RAG and Tropical Tuna MAC evaluate the trial outcomes and consider any next steps in assessing the industry proposal and developing future management options if applicable.

Trial overview

Need

In March 2020 AFMA received an industry request to vary the current longline boat SFR conditions in the CSZ of the ETBF to remove the hook limit per longline shot except between September to February west of longitude 148^0E. The current maximum limit is 500 hooks (h) per shot, at all times. Industry advise that these changes would improve the cost effectiveness and efficiency of their operations whilst maintaining measures to minimise interactions with blue and black marlin (the industry proposal is at **Attachment A**).

Industry advised that under the proposed changes they would be able to optimise the timing of effort when fish are feeding rather than setting two shots per day. Industry expects these changes should also minimise interactions with marlin. Depending on the moon phase, the changes include:

- setting all their effort at night when targeting bigeye, yellowfin and broadbill. Through their experience industry advise marlin do not feed at night and are therefore less susceptible to being caught; or
- deep setting (>200m) for albacore, yellowfin and bigeye. In their submission industry highlighted that research has shown that less marlin interactions occur when setting deeper than 75 meters.

Objective of current 500 maximum hook limit

The ETBF contains a specific management zone, the Coral Sea Zone (CSZ – historically referred to as "Area E" until 2005) that was first set up in the mid-1980s (and extended in area in 1991) to reduce longline fishing impacts on marlin availability to the Queensland game fishery in that area. This was implemented alongside a ban on retaining black and blue marlin in the ETBF, for the same purpose. The maximum 500 hook limit per shot condition was implemented in the mid 1990's to reduce soak time and increase black and blue marlin survivability at haul and post release.

Purpose

In considering the industry proposal TTRAG and TTMAC[1] considered whether the proposal would, if implemented, impact on black and/or blue marlin stock sustainability and potential impact/risks to non-target species, including protected species, given available Ecological Risk Assessment, stock status and catch per unit effort and protected species interactions (**Attachment B**).

TTRAG advised at its meeting on 12-13 October 2020 (meeting 30) that a trial of the proposal would be the best way to assess the gather additional information to help better assess the potential implications of the proposal were it to be implemented on a more permanent basis in future. TTRAG also noted that there is temporal variability in fishing conditions in the area and therefore any trial should be for at least two years and designed with appropriate parameters that are both precautionary and allow for the collection of key data that is needed.

At its meeting in October 2020 (meeting 24), TTMAC recommended that a two-year trial, with sufficient safeguards to ensure Blue and Black Marlin interactions are managed be implemented from early 2021.

Trial arrangements

In line with recommendations from TTMAC (meeting 24) the current working group was formed to determine the exact specifications of the trial. The WG has met three times[2] to both agree the trial arrangements and monitor progress. To date the WG has annually reviewed data trends in marlin interaction rates, marlin discard fates, total shots and total hooks set during the trial. The WG has compared results from the trial against an agreed baseline period of 2015-2019. The trial arrangements are:

1. Hook limit per longline shot.
    - a maximum of 1200 hooks per day may be set in the area of the CSZ east of longitude 148^0E, regardless of the number of longline sets undertaken.
    - a maximum 1200 hooks[3] per day may be set between the period of 1 March and 31 August in the area of the CSZ west of longitude 148^0E, regardless of the number of longline sets undertaken.
    - no more than 500 hooks per longline may be set in the area of the CSZ west of longitude 148^0E between September to February.

[1] TTAMC 22, TTMAC 24, TTMAC 25, TTRAG 27, TTRAG 30

[2] 19 November 2020, 23 June 2021, 3 February 2022

[3] The agreed hook limit has been recorded as 1,200 and 1,250 in different WG meeting outcomes. The WG agreed at its first meeting (19 November 2020) that the limit of 1,200 hooks, with an additional 50 hook buffer, would be appropriate given the boats intending to fish during the trial are currently equipped to set a maximum of 1,200 hooks. Please note that the trial conditions imposed to the Coral Sea Boat Statutory Fishing Rights conditions have applied a 1,200 hook limit.

2. Number of sets per day.

   In year one of the trial a maximum of one set per day was applied if shooting more than 500 hooks. In year two of the trial this restriction was removed[4].

3. Two-tier marlin catch trigger for fishing in the area west of longitude 148^0E during the period 1 March to 31 August.

   Rules

   Within a trial year, if the number of marlin interactions recorded in the area west of longitude 148^0E reach the:

   - first tier, AFMA will convene the working group (within two weeks of the trigger being reached) to review available data.
   - second tier, the trial is to be terminated and the conditions in the fishery be reverted to standard arrangements (ie reinstate the maximum 500 hook limit per longline shot).

   Tier levels

	Year one of trial (2021)		Year two of trial (2022)
	Blue Marlin	Black Marlin	Marlin (blue and black combined)
First Tier	34	65	99
Second Tier	45	86	131

   Note the tier levels were calculated based on the seasonal average of marlin interactions recorded from March to August between 2016-2019 west of longitude 1480E. Tier one is twice the four-year (2015-2019) average whilst Tier 2 is 75 % of the average.

4. All boats operating in the trial must comply with the ETBF e-monitoring requirements. AFMA will continue to monitor e-monitoring audit rates for reporting accuracy.

5. Life status and size data (less than or greater than 20kg) will be collected during the trial, facilitated through the new e-log software and verified through e-monitoring.

[4] Working Group meeting # 3, 3 February 2022

Trial Results

Effort reported during the trial compared to the baseline period

In total, three vessels fished in the CSZ in 2022 compared with only two in 2021. During the baseline period an average of three vessels fished in the CSZ (**Table 1**). Total sets and hooks deployed during trial period were significantly lower than the baseline period average (**Table 1**). Consistent with the baseline period most sets were deployed west of 148^{0}E during the trial (**Table 1**).

Two vessels set longlines with >500h during year one of the trial (2021) with only one vessel doing so in year two (2022) (**Table 1**). The total number of longline sets with > 500h varied from 91 in 2021 to 36 in 2022 (**Table 1**). This represents 39.4% and 22.5% percent of all shots set in the CSZ in 2021 and 2022 respectively (**Table 1**).

Of the total number of sets with >500h, 89 were set in the area west of longitude 148°E and 34 were set east of longitude 148°E (**Table 1**). In year one of the trial (2021) most >500h shots, had 1200 or more hooks (no more than 1250). In contrast, in year two (2022) most >500h shots had no more than 700h (**Table 2).**

The monthly distribution of total hooks set west 148^{0}E during the trial is shown in **Figure 1.** In year one of the trial, all hooks set between April and August were on longlines with greater than 500h. In contrast hooks set per shot varied from less than 500h to greater than 500h during those months in year 2 of the trial **(Figure 1).**

Table 1. Vessel numbers, hooks, total sets and sets with greater than 500h recorded during the baseline (2015-2019) and trial periods (2021 and 2022) in the CSZ.

	Baseline period annual average	2021 (total n)	2022 (total n)
Vessels fished	3	2	3
Hooks	427703	221160	102947
Total sets	867	322	200
# of sets west of 148^{0}E	796	319	197
# of sets east of 148^{0}E	71	3	3
# of vessels that set shots with >500h	Not applicable	2	1
Total # sets with >500h	Not applicable	91	36
% of sets >500h	Not applicable	39.4%	22.5%
# of >500h sets west of 148^{0}E	Not applicable	89	34
# of >500h sets east of 148^{0}E	Not applicable	2	2

Table 2. Comparison of number of hooks per set recorded in the CSZ during the trial period (2021 and 2022).

	≤500	600	700	800	850	900	1000	1050	1100	1175	1200	1210	1250	**Total**
2021	231	-	1	1	1	4	3	1	8	6	26	1	39	**322**
2022	164	11	23	-	-	-	-	-	-	-	2	-	-	**200**

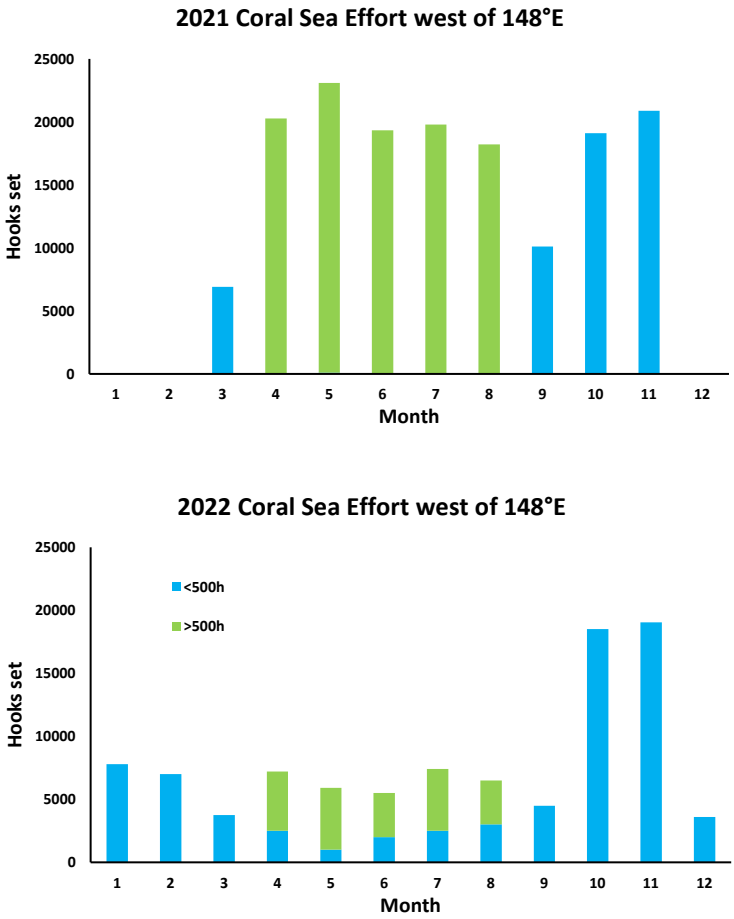


Figure 1. Total monthly hooks set west 148^0E each month during the trial years (2021 and 2022). Shots less than (blue bars) and greater than 500h (green bars) are shown.

Total marlin interactions reported during the trial compared to the baseline period.

The total number marlin interactions (blue and black marlin combined) recorded during the trial was 641 for 2021 and 168 for 2022. During the baseline period the average annual number of interactions recorded in the CSZ was 955.5 (**Table 3**). The number of marlin interactions recorded on sets with greater than 500h during the trial period, was 55 for 2021 and 5 for 2022 (**Table 3**). This represents 8.6% and 2.9% percent of all interactions for 2021 and 2022 respectively (**Table 3**).

Of the total interactions that occurred when fishing west of 148^0E (March to August), 54 were recorded during 2021 and 5 during 2022 (**Table 4**). This means that the tier one trigger (99 marlin for fishing in the area west of longitude 148 degrees east during the period 1 March to 31 August was not reached in either of the trial years.

Table 3. Marlin interactions recorded during the baseline (2015-2019) and trial periods (2021 and 2022) in the CSZ.

	Baseline period annual average	2021 (total n)	2022 (total n)
Total interactions	955.5	641	168
Interactions <500h	Not applicable	585	163
% interactions on sets <500h	100%	91%	97%
Interactions on sets >500h	Not applicable	55	5
% Interactions on sets >500h	Not applicable	8.6%	2.9%

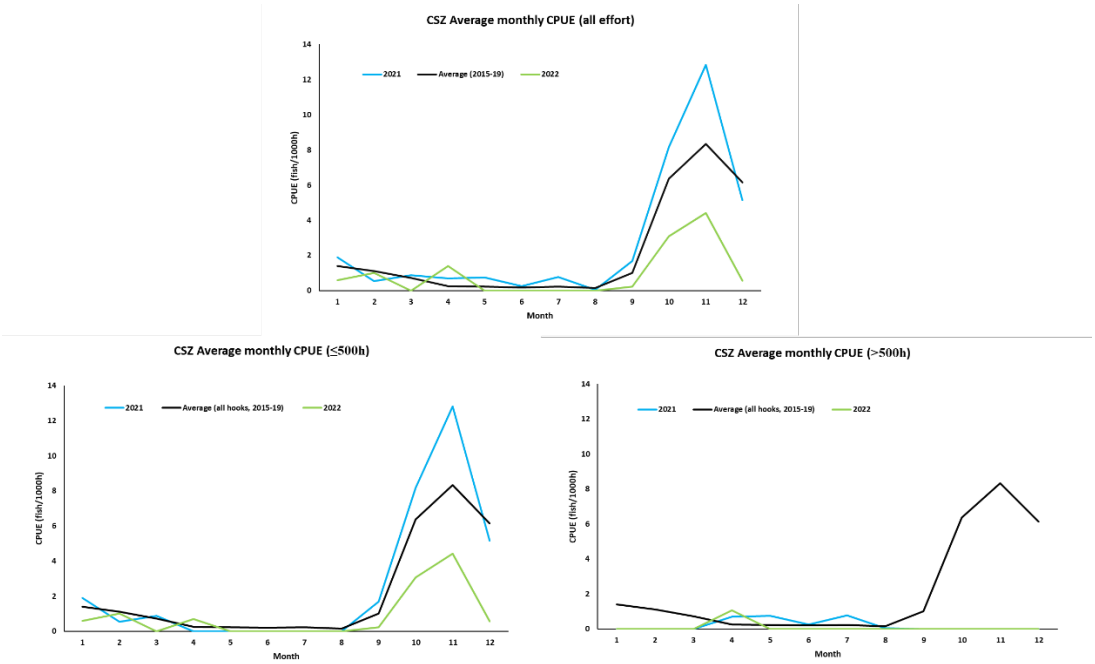
Table 4. Combined marlin interactions recorded on sets with less than or greater 500h, east and west of 148^0E annually during the CSZ trial.

	2021		**Total**	2022		**Total**
	Sets with <500h	Sets with >500h		Sets with <500h	Sets with >500h	
West of 148^0E	585	54	639	163	5	168
East of 148^0E	0	1	1	0	0	
Total	**640**			**168**		**168**

Marlin interaction rates reported during the trial compared to the baseline period (marlin interactions per 1000h)

The average monthly marlin interactions recorded per 1 000h (blue and black marlin combined) remained around the baseline average between January and August during the trial (**Figure 1**). During the trial yeas the average monthly marlin interactions were higher than baseline between October to December in 2021 but lower than baseline for the same months in 2022 (**Figure 1**).

Figure 2. Average nominal marlin CPUE (marlin interaction per 1000h) for the CSZ during the baseline period (2015-2019) compared to the averages for trial period (2021 and 2022) for: a) all shots; b) shots with hooks less than 500h; c) shots with more than 500h.



Marlin discards fates reported during the trial compared to the baseline period

The recorded discard fates for all marlin interactions reported in the CSZ during the baseline and trial periods are shown in **Table 5**. During the baseline period on average, 54.4% of marlin discarded were reportedly alive. Compared to the baseline period, the relative proportion of marlin discards reported alive was higher with 80.6% and 61.9% of total marlin discards being record as alive in 2021 and 2022 respectively. Further during the trial years, the relative proportion of marlin discards reported alive was higher on sets with greater than 500h compared with sets with less than 500h (**Table 5**). The proportion of unknown fates for marlin discards were significantly lower during the trial compared to the baseline period (**Table 5**).

Table 5. Discard fates of blue marlin, black marlin, and combined marlin (blue and black marlin) caught in the CSZ during the baseline (2015-2019) and trial periods (2021 and 2022). Unk = Unknown.

	Blue Marlin			Black Marlin			Combined Marlin			
	Alive	Dead	UnK	Alive	Dead	UnK	Alive	Dead	UnK	Total
Baseline average	157	42.2	89.75	363.4	116.4	186.75	520.4 (54.4%)	158.6	276.5	955.5
Mar-Dec[5] '21	43	15	0	473	109	0	516 (80.6%)	124	0	640
2022	32	37	1	72	26	0	104 (61.9%)	63	1	168

Table 6. Discard fates of blue marlin, black marlin, and combined marlin (blue and black marlin) caught on sets with less than and greater than 500h during trial period (2021 and 2022). Totals (n) are without brackets and proportions are given within bracket.

	2021		2022	
	Sets with <500h	Sets with >500h	Sets with <500h	Sets with >500h
Alive	516 (82%)	43 (95.5%)	100 (61.3%)	4 (80%)
Dead	112 (18%)	2 (4.4%)	62 (38%)	1 (20%)
Unknown	0	0	1 (0.6%)	0
Total	628	45	163	5

Size class information

At the first meeting of this WG, it was agreed that in addition to life status, size data would also be recorded to aid the WG to explore impact levels on juvenile fish. Whilst fishers have provided comments on other observations such as depredation by sharks and whales, size data is yet to be provided[6]. In addition to working with fishers to encourage size reporting, AFMA will investigate options to amend the e-log pro-forma to assist fishers report size information. Amending an e-log however can take up to 6 months.

[5] Trial commenced 1 March 2021

[6] At the CSZ Hook Trial Working Group meeting #4, AFMA advised that size class data, used to measure interactions with either juvenile or adult marlin, had been submitted by fishers during the trial however in error, AFMA had not extracted the data in its latest data query. AFMA advised that a summary of the size class data would be provided to Working Group members out of session.

Next steps

The intended two-year trial period has concluded. It is necessary for the Tropical Tuna RAG and MAC to consider the outcomes of the trial. This will be undertaken throughout 2023 and possibly into 2024 (if appropriate, two years allows time to develop and consult on any management options). Subject to advice from the WG, AFMA recommends that the trial continue in its current form (retain working group and arrangements) during this time (2023 and 2024) on the basis that:

- extending the trial, it will allow ongoing data collection; and
- the trial has safeguards in place to minimise impacts on marlin (catch based management triggers, together with an annual stakeholder review process).

A key aspect of the trial review will be to assess whether the data collected further informs us on the likely risks with changing the hook limit (noting the original purpose of the hook limit) and whether the information now available is sufficient to support a management decision to change or retain arrangements and/or collect more data. As part of the review, the following should be examined:

a) the potential for the management arrangements adopted in the trial which combined input and output measures, to achieve the same objective as the current hook limit; and

b) as far as possible, risks associated with changing the hook limit compared with those that might be associated with a general increase in overall effort. This will assist in identifying management needs once the efficacy of existing management arrangements in the fishery including the AFMA's Ecological Risk Assessment/Ecological Risk Management framework, and bycatch/TEP arrangements are taken into account.

Attachment A

Trial Proposal letter from operators

Seeter PTY LTD

T/A Great Barrier Reef Tuna

37-39 Aumuller Street, Portsmith, QLD 4870

T: (07) 4035 2633

E:rowan@gbrt.com.au

Dear President of Cairns Professional Game Fishing Association,

RE: Management conditions for Historic Area E of the Coral Sea

I am writing you this letter seeking your support to amend the management conditions outside the dates for the Far North Queensland black marlin heavy tackle season within the Historic Area E of theCoral Seas within the Eastern Tuna and Billfish Fishery.

During the mid 1990's a fishing condition was placed on longline fishing vessels restricting the maximum allowable hooks to 500 per set. This condition was implemented to maximise Blue and Black Marlin survival should they become hooked, especially when they aggregate near the ribbonreefs north of Cairns to spawn.

We have been fishing this area since 1991, and currently have 3 vessels that are restricted to using 500 hooks per shot. However, the fishery has changed significantly since this condition was introduced. Our access to fishing areas has been reduced, and costs are ever increasing. To maintaineconomic viability and achieve greater efficiency, while maintaining ecological sustainability for the marlin fishery we wish to review the 500 hook condition.

To review the 500-hook condition we examined our logbook catch data verified by AFMA for the past 5-years. The data demonstrated that the majority of our marlin catches occurs to the west oflongitude 148°, with peak catches during the months from September to December (Black marlin 87.4%, Blue marlin 72.5%)

Our Proposal

We propose to have the 500-hook condition amended to reflect that

A maximum of 500 hooks per shot be maintained west of longitude 148° in Historic Area E from 1 September to 31 December. Outside of this temporal and spatial condition there will be no specification of the number of hooks than can be used in this area of the ETBF.

We also recommend that any ETBF vessel fishing Area E must have a permit in keeping with the current regulations of a limited entry fishery with no new issuing of permits.

This will ensure the intent of the 500-hook condition to maintain ecological sustainability is

maintained, while improving the economic efficiency of our fishing operations

We request that with your knowledge and time spent in the Marlin Fishery that you can support usto amend the 500-hook condition.

This issue will be considered at the next Tropical Tuna Management Committee meeting scheduledfor late March, 2020, and I would sincerely appreciate it if you could send them a letter of support by 14 March 2020 (Draft letter template attached)I am also more than happy to discuss this proposal at your convenience.

Any questions please don't hesitate to ask

Kind regards,

Rowan Lamason

Attachment B

TTRAG27 (June 2020) CSZ Outcomes

AFMA requested that TTRAG members provide written responses/advice on the following questions:

1. Do you consider the proposal would, if implemented:
    a. significantly impact on Black and/or blue marlin stock sustainability, or
    b. have implications for populations of other non-target species including protected species.
2. For both, why or why not? If yes, what variations to the proposal could be considered to mitigate those impacts?
3. Is there further scientific/research information or data that you can identify that might further assist AFMA and TTMACs consideration of the proposal.

Written response submissions were received from four scientific members, the AFMA member, the economic member, and two industry invited participants. Submissions were not received from TTRAG industry members. Substantive discussion was not held on this agenda item due to time constraints.

The following summarises key issues and points raised by TTRAG member and invited participants written submissions.

Potential implications for black and blue marlin and protected species

In relation to **question 1a** on the implications of the proposal for black and blue marlin stock sustainability, TTRAG members noted the information provided in the cover paper including the following:

- **For blue marlin** - The blue marlin stock is considered to be pan-Pacific and stock status is considered to be healthy on the latest assessment, noting the data assessed was to 2014. The ETBF ERA (using data to 2015) indicated the stock to be at low risk from the ETBF, while NSW tournament data suggests a relatively stable if not recently higher local abundance. There is relatively little relevant (i.e. longline study based) post release survival information.
- **For black marlin** - There are likely two stocks in the Pacific, however the stock status for the stock which the ETBF interacts with is unknown. The ETBF ERA (using data to 2015) indicated the stock to be at low risk from the ETBF, while NSW tournament data suggests a relatively stable if not recently higher local abundance.

Significant further information pertaining to black and blue marlin catches and catch rates and life status in the CSZ were provided by two scientific members in their submissions, including drawing on scientific longline surveys in the 1990s. In particularly they noted:

- Historically under the 500 hook per shot limit, some vessels have set multiple shots per day (e.g. 2 or 3) and in recent times the average hooks per day per boat is ~800.
- Evidence for increasing mortality of black marlin upon hauling as sets (i.e. soak time) become longer. For example - increasing from 10% to 44% mortality with set times increasing from less than 200 minutes to 1000 minutes.

More generally, the following points were raised by one or more TTRAG members:

- It is difficult to predict potential impacts without having explored a range of scenarios of possible effort and catch changes and their impacts on total mortality of both species. Mortality estimates should potentially include consideration of at haul mortality and condition (including set time

impacts on this), during set cryptic mortality (e.g. depredation by false killer whales potentially increasing with increased set times), and post release mortality. They should also account for spatial and temporal differences in catches and catch rates from historic data and different effort scenarios from increasing effort by current active CSZ vessels (3) to all CSZ licenses (11) being actively used in the CSZ. It was noted CPUE for black marlin is highest in the CSZ so effort increases would have larger impacts on total ETBF black marlin catches, than relative to blue marlin impacts.

- Scenarios could consider impacts of variations on the current proposal – for example, expanding the hook limit period to include January and February, which have similar CPUE to already proposed month of September.
- Consideration of whether the ERA should be rerun for these species under the above scenarios.
- The proportional change of increased effort could be higher for black marlin as CSZ CPUEs and proportion ETBF catches in CSZ are higher for this species.
- Localised depletions may be a concern that requires consideration, including with respect to charter/recreational strike rates.
- It is important to consider annual variability in monthly catch proportions not just the average over multiple years (e.g. up to 50% of blue marlin catch is outside proposal area/months in some years).
- Any amended arrangement should be upon agreement of both sectors and implementation should potentially be done in a stepwise manner with monitoring/assessment of impacts (on commercial catch/mortality levels and potentially charter strike rates) pre and post implementation.

One scientific member felt future RAG consideration should include a history of the current arrangements for context (as provided to TTMAC), examine the uncertainty and potential overestimation of post release survival estimates associated with the one study of longline released blue marlin (Kerstetter et al 2003) and raised two questions:

- Will the southeast CSZ still be subject to year round 500 hook limit?
- Will the arrangement be 500 hooks/day or per shot?

An industry invited participant raised concerns over the use of input and output controls in the CSZ and the negative economic impacts upon industry of the current arrangements, stating that this should be considered in the Commonwealth Resource Sharing arrangements.

For Protected species, members noted a range of issues to consider including:

- **Seabirds** – The AFMA paper noted that the area of the proposal is north of the main seabird interaction area and it is therefore unlikely that there would be significant increase in seabird interactions as a result of fishing effort increasing by vessels already fishing in the area. It is possible that if fishing effort shifted from further south to the CSZ, a lowering of total interactions with seabirds in the ETBF could result. However, proper examination of relevant data and information should be undertaken to examine these assumptions. A scientific member noted scientific surveys in the mid-1990s that supported the very low level of seabird interaction in that region.
- **Sea turtles** – The AFMA paper noted it is uncertain if an increase in fishing effort by current CSZ vessels or from shifting of effort by other vessels into the CSZ could lead to an increase in turtle interactions, and therefore increased the risk to local sea turtle populations. As such, this could be considered further through examination of spatial and seasonal trends in interactions rates of sea turtles (where possible by species) through the ETBF relative to the CSZ, and considerations of implications for interaction levels

under different plausible CSZ future fishing effort levels. A scientific member noted that leatherback hotspots are further south than the CSZ but areas of relatively high green turtle interaction do occur in the CSZ and that longline fishing method factors (e.g. lightsticks and fishing depth) may be influential.

- **Marine mammals** – The AFMA paper noted that by comparison to seabirds and sea turtles, marine mammal interactions are relatively rare throughout the ETBF, so AFMA does not expect the proposal to impact on marine mammal populations. However, this should be examined through available data summaries and presentation to TTRAG/TTMAC regarding relative interaction rates inside and outside the CSZ, as per the sea turtles analysis recommended above.

An industry invited participant submitted that non-target species sustainability implications are already addressed through the combination of Seabird TAP, bycatch strategy, ecological risk assessment, trip limits, trigger limits, bycatch mitigation strategies, by-catch handling policy, EM and e-log books. He stated that the proposal is consistent with the intent of the 500 hook limit, would introduce cost efficiency for industry and effort may decrease in future as operations are optimised.

In general, through written submissions, industry invited participants were supportive of the proposal, and two scientific members provided some additional useful information to inform consideration of the key questions, but a number of members also raised concerns that other information would be required to be considered by TTRAG before final advice could be provided to TTMAC. In addition, a member asked if the questions needed to be broadened to consider the implications of the proposal upon recreational fishery catch rates (a separate question to that of stock sustainability). This latter question might be best considered by TTMAC.

Further information, data or scientific research needed

The specific data and information that was identified by TTRAG members to further consider this issue at the next TTRAG meeting TTRAG was:

1. For black and blue marlin and protected species (particularly sea turtles), an analysis of the range of potential changes in likely catches and mortalities that might occur as a result of a range of potential and likely changes in fishing effort in the CSZ. This should take into account the most up to date and relevant information on:
    - at haul life status (condition and mortality),
    - post release mortality,
    - potential cryptic mortality (e.g. depredation impacts, if possible),
    - the potential implications of extended soak time (due to more hooks per set) on both of the above,
    - a range of effort change scenarios, from no change, to current active CSZ vessel increases, to increased numbers of CSZ licensed vessels operating (up to 11), and
    - consideration of both potential individual season and average season effects.
2. Extension of the above analyses to provide information on how estimates might change under a range of modified proposals/arrangements – for example – extending the hook limitation period to include January and February. TTMAC could assist in identifying the scenarios to explore. Extension could potentially include analysis of potential ecological risk under the proposal via ERA Level 2 tools.
3. For black and blue marlin – consideration of the need for information pre- and post- implementation of any new arrangements to assess the impacts of the arrangements on charter vessel strike rates in the CSZ (including potential localised depletions).

4. Further information from industry on how the proposal might improve economic efficiency for ETBF fishing operations in the CSZ.
5. TTRAG should also consider what monitoring would be required to assess the impacts of any revised arrangements upon marlin and protected species.

In conclusion TTRAG agreed that this information should be compiled through collaboration between AFMA and relevant TTRAG members where required, as a priority in time for the next TTRAG meeting in July, with that meeting to develop and provide its advice on the above questions to TTMAC.

TTRAG 30 October 2020 CSZ Outcomes

Coral Sea proposal - indicators and data review

Under this item, the RAG discussed the industry proposal to restrict the 500 hook limit condition on longline fishing in the Coral Sea Zone (CSZ) to the area west of 148^{o}E during the period of 1 September to 31 December each year.

The RAG noted the background to the proposal where:

- Currently, AFMA requires operators must only fish 500 hooks or less per shot. This condition was implemented to reduce soak time and increase Black and Blue marlin survivability at haul and post release.
- At TTRAG 27, AFMA provided maps of the area of the CSZ and the distribution of where Black and Blue Marlin have previously been caught, as well as catch by month for each of the species that showed the bulk for both species is between October and December.
- TTRAG 27 information provided to the RAG also showed that the CSZ catch of Blue Marlinis a relative low proportion of the total ETBF where as CSZ Black Marlin is a relatively high proportion of the total ETBF catch. It was further noted in the AFMA summary that the ERA outcomes for both species resulted in them being low risk.
- In TTRAG's analysis of the proposal, the RAG suggested that for Black and Blue marlin and protected species (particularly sea turtles), an analysis of the range of potential changes in likely catches and mortalities that might occur from potential changes in fishingeffort in the CSZ under the proposal should be done. The RAG suggested a number of factors (such as life status of interactions, post release mortality, and a range of effort scenarios) be included in the analysis.
- TTMAC22 supported the TTRAG27 proposal for further analysis to support development of advice on this matter, with that advice to be then provided to TTMAC to support its further consideration of the industry proposal.

The RAG was asked to consider and discuss a subsequent analysis (provided at Agenda item 4.1a) on how varying fishing effort scenarios may impact the level of interactions with Black and Blue marlin in the CSZ. The RAG noted that not all the factors they suggested be considered at TTRAG27 were able to be included in the analyses.

For the purposes of the analyses presented, the level of future potential fishing effort in the CSZ, under the industry proposal (and variations upon that) was considered to be a product of:

- The number of boats
- The number of months in which 500 hook rule does not apply
- The number of hooks set per shot (in months when the 500 hook limit does not apply)
- The number of sets per day
- The number of days fished per month

The analysis examined three potential variations in each of three of these factors only, being:

- Number of boats fishing:
    - 3 (status quo),
    - 7 (mid-range) and
    - 11 (all CSZ Boat SFRs utilised)
- Number of months (in which the 500 hooks limit does not apply):
    - 4 months (May-Aug)
    - 6 months (Mar-Aug)
    - 8 months (Jan-Aug)

Note –the industry proposal is for 8 month application when the 500 hook limit does not apply, TTRAG noted that variations (extensions) on this should be explored to cover extended periods of high CPUE for blue marlin in particular. Hence consideration of 4 and 6 months.

- Number of hooks per set:
    - 1200 (intended hooks/set by industry proponent)
    - 1500 (mid-range)
    - 1800 (ETBF average – Campbell 2020)

The key results and conclusions include the following:

- Overall, the key drivers of significant change in the relative levels of likely longline interactions with black and blue marlin is increasing the number of vessels and increasing numbers of hooks per set. Increasing the number of months of application of the 500 hookrule has a lesser impact on minimising increases in interactions that might occur under theproposal. This is particularly so for black marlin, due to the months of high CPUE for that species occurring mainly within the core 4 month period in which the 500 hook limit is proposed to apply. This is somewhat less the case for blue marlin.

- If the core industry proposal (8 months with no hook limit, fishing 1200 hooks per set1 or per day) is applied, for only three vessels that have historically fished the area, the analysis estimates a potential increase by 8% in annual black marlin interactions and by 18% for blue marlin interactions, relative to the baseline. The increase is due predominantly to the higher estimated fishing effort per day fished per vessel (1200 hooks versus ~750 hooks/day previously on average). For blue marlin, the increase is higher due to relatively higher CPUEs outside the September-December period in which the 500 hook limit applies. These estimated increases drop to 1% (black marlin) and 5% (blue marlin), if the 500 hook limit is removed for only 4 months (May-August).

- If the above scenario is modified to include all 11 vessels fishing at the same monthly effort levels (1200 hooks/set and 8 months with no hook limit) then the estimated interactions increase by 63% (black marlin) and 136% (blue marlin).

- These increases are by 100% (black marlin) and 218% (blue marlin) if hooks per set increased to the ETBF average of 1800hooks (and 11 vessels). This is effectively the "worst case" scenario of those examined.

- However, for that scenario (11 vessels and 1800 hooks/set) the increase is only by 11% (~84 fish) for black marlin, and 59% (186 fish) for blue marlin, if the period without 500 hooklimit is restricted to four months.

In considering the outcomes of the analysis, the key points discussed by the TTRAG were that:

- Scaling each of the factors (number of boats, hooks set and months fished) gives a varying result in the percentage increase of interactions for both blue and black marlin.
- There is interannual variability in the average catch rates in blue and black marlin however the analysis has used the average CPUE per month (across 5 years for each month) so the resulting figures should be interpreted within that context.

- While the analysis focuses on the CSZ, changes to spatial effort (e.g. translocation of effort) generally may influence the number of interactions in the ETBF as a whole (i.e. effort shifting to the CSZ may reduce interactions elsewhere in the fishery).

- It is difficult to predict whether all 11 boats that are licensed to fish in the CSZ would increase their effort if current restrictions were to change, and overall, there is not enough information to predict what the likely impact would be if the 500 hook restriction is lifted on apermanent basis.

In addition, the recreational member noted that the recreational fishery may see value in quantifying their current strike rate as a baseline if they choose to explore whether there are effects on recreational catches resulting from the proposal in the future (assuming the proposal is endorsed).

TTRAG Recommendation:

The RAG agreed that a trial of the proposal would be the best way to assess the gather additional information to help better assess the potential implications of the proposal were it to be implemented on a more permanent basis in future. The trial should aim to collect key data on factors that remain uncertain, and the trial should be designed by considering:

- The specific circumstances that would result in the cessation of the trial (e.g. if interactionlevels were considered to have significantly increased beyond was is deemed acceptable).
- The number of boats that would be permitted to participate in the trial (e.g. all boatslicensed to fish in the CSZ or a subset of those)
- Whether there is an upper limit for the number of hooks that can be set during the trial andwhich months the current 500 hook limit would continue to apply.
- The type of data collection and monitoring that would accompany the trial (e.g. increasedreview of electronic monitoring, observer coverage, additional data fields collected etc.)
- The length of the trial (where the RAG noted too short time frame may not result

inenough information to assess the outcomes).

- What is achievable under a trial, and what a successful trial looks like.

It was agreed that the RAG's recommendation of proceeding with a trial be presented to TTMAC, and if endorsed, a sub-group be formed to design the trial with appropriate parameters that are both precautionary and allow for the collection of key data that is needed to look at some of the uncertain factors that have been identified.

TTMAC 24 – October 2020 CSZ Outcomes

1. Under this agenda item, TTMAC discussed the industry proposal to restrict the 500 hook limit condition on longline fishing in the Coral Sea Zone (CSZ) to the area west of 148^{o}E during the period of 1 September to 31 December each year.

2. TTMAC noted that it had previously considered the proposal at TTMAC 22, where it was agreed to seek additional advice from TTRAG. AFMA and TTRAG have since provided additional analysis and advice on the potential implications of the proposal to the MAC.

3. The AFMA member explained all fishing effort in the Coral Sea Zone in recent years has been conducted by the three boats owned by the Lamason's, a company which maintains very good relations with local game fishers and charter owners.

4. TTRAG advice concluded that a trial of the proposal would be the best way to assess the gather additional information to help better assess the potential implications of the proposal were it to be implemented on a more permanent basis in future. TTRAG also noted that there is temporal variability in fishing conditions in the area and therefore any trial should be for at least two years and designed with appropriate parameters that are both precautionary and allow for the collection of key data that is needed.

5. Subsequent to the TTRAG meeting, AFMA arranged a meeting between Rowan Lamason, David Ellis, Grahame Williams and Ian Bladin to consider the options. This meeting also supported a two year trial with suitable hook limits of around 1,200 to 1,500 per shot), time limits (the trial west of 148 could only use more hooks between either January-August or April- August) and interaction limits with blue and black marlin (which will depend on the time period chosen).

6. Participants at the meeting reported to the MAC that a high degree of co-operation characterised the meeting and also made suggestions regarding suitable candidates for scientific members to sit on the proposed Small Working Group for the Coral Sea Zone hook trial. Suggestions included: Dr Julian Pepperrell, Dr Rob Campbell or other CSIRO scientist.

7. TTMAC agreed that a two-year trial, with sufficient safeguards to ensure Blue and Black Marlin interactions are managed be implemented from early 2021; and

8. To form a small working group to determine the exact specifications of the trial.

Action item 2: Coral Sea Zone hook proposal

2.1 TTMAC agreed that a two-year trial, with sufficient safeguards to ensure Blue and Black Marlin interactions are managed be implemented from early 2021; and

2.2 To form a small working group to determine the exact specifications of the trial.

WG Meeting #1 Outcomes

Issue	Discussion	Decision
Hook Size Limits	The group noted that 7 of the total 12 CSZ Statutory Fishing Rights (SFRs) belong to company that has requested the trial with other operators unlikely to participate. In good faith, the company will only operator 3 boats, and not utilise their remaining 4 SFRs during the trial. A limit of 1250 hooks per day (including a 50 hook buffer) would be appropriate given the 3 boats are currently equipped to set a maximum of 1,200 hooks	It was agreed to limit the trial to a maximum of **1,250 hooks** set and one set per day
Time Period	The group noted that there would be a 2 year trial period with the above hook limit. Fishing west of 148^{o}E will be restricted to certain months within the trial. Given the high numbers of marlin are present in the CSZ during October to December, and the migration of marlin during September, these months were excluded from the trial. The recreational sector noted significant concerns in allowing the trial to occur during January and February. A cautioned approach commencing the first of the trail in March 2021 and running through to August 2021 was adopted to allow for a review of data prior to deciding the time period for the second year of the trial.	It was agreed the first year of the two year trial would occur between the months of March to August in 2021, with a review of the data arising from year one to inform the time period for year two.
Marlin Limits to cease the trial	It was agreed there would be benefit in adopting a two tier marlin catch limit; with a mid-point that triggers a review of the trial but does not cease trial, and an upper limit that ceases the trial if reached. The two tier limit would apply to cumulative marlin catch for the duration of the trial. The two tier marlin catch limit should be based on the average marlin catch over the last four years. The upper threshold (second tier) being twice the four year average, and the lower (first tier) being 75% of the upper threshold.	A two-tier marlin catch limit will apply during the trial. If the first tier is reached, this would trigger AFMA convening this small working group (within two weeks of the limit being reached) to review available data. If the second tier is reached, the trial would be suspended and boats would revert to setting 500 hooks.
Additional data requirements	The group noted that operators would be required to provide life status information on a fish by fish basis through the e-log software for all fishing activity. It was recommended that size categories should capture juvenile fish that are “less than 20kg” or adult fish “over 20kg”, to gain a better understanding on interactions.	All boats operating in the trial must comply with the ETBF e-monitoring requirements. AFMA will continue to monitor e-monitoring audit rates for reporting accuracy. It was agreed that **life status and size data** would be collected during the trial, facilitated through the new e-log software and verified through e-monitoring.

WG Meeting #2 Outcomes

1. If requested, further marlin ID resources will be provided to Industry.
2. Tier 1 and 2 Marlin interaction which were originally broken down into Black and Blue Marlin species, are to be combined as follows:

	Marlin (Blue and Black)
First Tier	99
Second Tier	131

Table 1 (revised 23/06/21) two-tier marlin catch limit to apply during CSZ hook trial

3. The operator must still attempt to identify marlin by species. That is, all requirements regarding identification and recording of species, as in the original trial outline, still apply. This will continue to include recording of all interactions with protected species and the recording of species, life status and weight estimation for each individual interaction with marlin.
4. With regard to the counting of marlin interactions when fishing with 500 hooks, group members affirmed their understanding that these should be included in the trigger number. Noting some concerns from industry around the validity of this in the trial, the committee agreed that each marlin interaction within the trial period would be counted but additional information would be included, such as number of hooks for the shot.
5. AFMA will provide data on: catch rate of marlin (combined blue and black) per 1000 hooks, by month, to establish a nominal catch rate (2015 to now) as part of analysis of the trial. This is to be provided for the next meeting of the group.
6. AFMA is to provide further breakdown of life status of individual marlin interactions, including historical data (data supplied appeared to have multiple fish against a single life status and it wasn't clear how this was grouped) for next meeting of the group.
7. The trial will continue, with the combined trigger and AFMA will continue to monitor marlin interactions.
8. AFMA will convene another meeting of this group if the combined 99 marlin interaction trigger is reached before August. If this does not occur, the next meeting of the group will be at the end of 2021 leg of the CSZ hook trial in August 2021.

WG Meeting #3 Outcomes

1. The trial is to continue in 2022 and AFMA will continue to monitor marlin interactions.
2. The trial period for fishing west of 148°E will remain between 1 March and August 31 2022, with shots limited to a maximum of 500h outside of these months.
3. Amend permit condition to allow a cumulative maximum of 1250h per day regardless of number of longline sets undertaken east of 148°E year round, and west of 148 between 1 March and 31 August.
4. Tier 1 and 2 Marlin interaction triggers will remain as the combined limits set on 23 June 2021 as follows:

	Marlin (Blue and Black)
First Tier	99
Second Tier	131

Table 1. Two-tier marlin catch limit to apply during CSZ hook trial

5. Operators must continue to attempt to identify marlin by species. That is, all requirements regarding identification and recording of species, as in the original trial outline, still apply. This will continue to include recording of all interactions with protected species and the recording of species, life status and weight estimation for each individual interaction with marlin.
6. As discussed in June 2021, all marlin interactions across the CSZ during 2022 will be included in the trigger number.
7. AFMA will provide data on whole fishery shot characteristics and marlin fates by shot type (≤500h or greater than 500h) as described in **Attachment A**.
8. AFMA provided supplementary requested data **Attachment B.**
9. AFMA will convene another meeting of this group if the combined 99 marlin interaction trigger is reached.

Following discussion and agreement on the trial, the group heard from J Pepperell on his efforts seeking funding for a project aiming to update a prior study on black marlin catch rates in the Great Barrier Reef (GBR) area, which he had completed with Rob Campbell in the early 2000s. The group heard that an application to the GBR Foundation, which had already received partial funding from the Cairns Professional Game Fishing Association and the Queensland Game Fishing Association ($25k of $71k sought), was unsuccessful. The group agreed that updating this study with another 20 years of data would be valuable and noted that while AFMA is not well placed to provide funding due the nature of the research and AFMA research funding focus, an application to the FRDC is worth pursuing.

Fiona Hill thanked the Small Working Group for its continued commitment to working through the trial, and the meeting concluded at 12:54pm

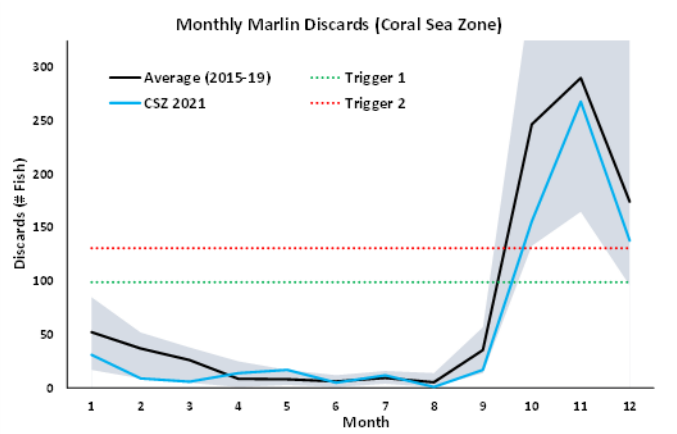
Attachment A: REQUEST FOR FURTHER INFORMATION

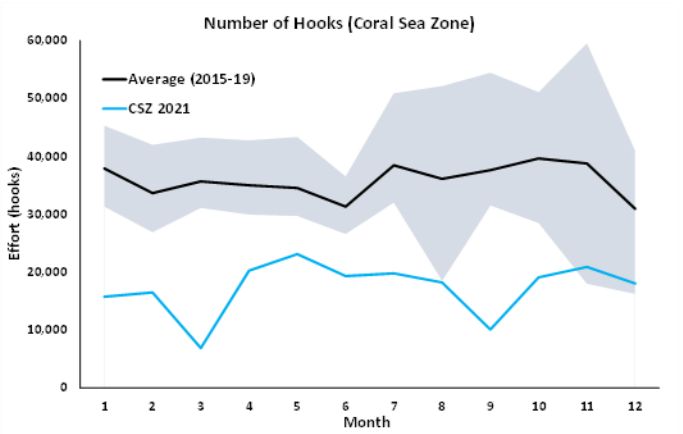
1. As there were two vessels operating during the year, it would be good to provide details for both vessels in a table such as that shown below. Providing the number of days that each type of shot was deployed allows one to the calculate the mean number of hooks deployed per day (based on previous analyses this was around 800 hooks, as often more than one set of up to 500 hooks were deployed on any day). Also, providing the data for the extra months would also indicate whether effort has changed during the 'out-of-trial' period.

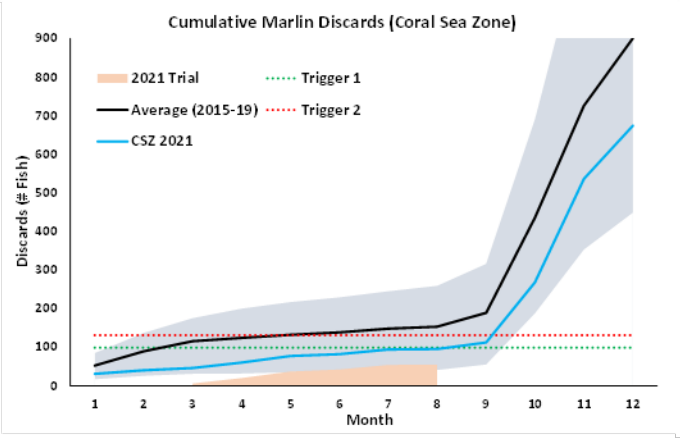
Vessel #	Shots with <=500 Hooks			Shots with >500 Hooks			All shots	
Month	N. Days	N. Shots	Total Hooks	N. Days	N. Shots	Total Hooks	N. Shots	Total Hooks
March								
April								
May								
June								
July								
August								
September								
October								
November								
December								

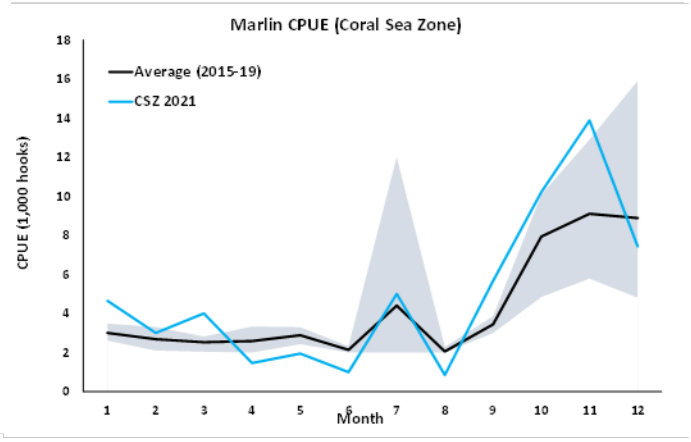
2. In Figure 1, the blue lines in both graphs represent average CPUE in the Coral Sea Zone for combined black and blue marlin discards, by month, during 2021. We understood that this average was for calculated over all vessels. In the figure on the right, the average CPUE is also shown just for the trial vessel – brown line. It was queried as to why the blue line (both vessels) and the brown line (trial vessel only) were the same for all months except the last two. It would seem highly unlikely that both vessels had exactly the same average CPUE for most months. Seems that some understanding is missing here.

3. In Figure 2 (labelled Figure 3) we understand that these data are for all (both) vessels that fished in the CSZ in 2021 (i.e. not just the trial vessel) – is that correct? It would be useful to show figures similar to this figure but for the data i) east of 148E and ii) west of 148E (as the 1250 hook limit applies to all months in the eastern sector and based on some data reviewed by the working group last June it appeared that most marlin were caught west of 148E).









4. In Table 3 and Figure 3 again we understand these data are for all (both) vessels that fished in the CSZ in 2021 (i.e. not just the trial vessel) – is that correct? As a main focus is on billfish survivability, it would be useful to compare life-status for shots using <=500hooks and those using >500 hooks. As such, could you provide tables and figures similar to Table 3 and Figure 3 but stratified by shots deploying <=500hooks and those deploying >500 hooks.

Meeting participants were reminded that the data, and all documents provided for discussion are commercial-in-confidence and must not be shared outside the meeting under any circumstances.

Attachment B: SUPPLEMENTARY DATA

1. 2021 vessel level effort summary

Table 1. Vessel effort for the two active vessels in the CSZF in 2021, from the commencement of the hook trial on 1 March 2021.

Vessel 1	Shots with ≤500 hooks			Shots with >500 hooks			All shots		
Month	N. days	N. shots	Total hooks	N. days	N. shots	Total hooks	N. shots	Total hooks	μ daily hooks
March	5	6	3,000				6	3,000	600
April				17	17	20,260	17	20,260	1,191
May	1	1	100	19	19	23,000	20	23,100	1,155
June				16	16	19,325	16	19,325	1207
July				17	17	19,800	17	19,800	1,165
August				16	16	18,225	16	18,225	1139
September	13	21	10,100				21	10,100	778
October	23	41	19,100				41	19,100	830
November	20	34	16,940				34	16,940	847
December	20	30	14,800				30	14,800	740
Annual	**82**	**133**	**64,040**	**85**	**85**	**100,610**	**218**	**164,650**	**985**

Vessel 2	Shots with ≤500 hooks			Shots with >500 hooks			All shots		
Month	N. days	N. shots	Total hooks	N. days	N. shots	Total hooks	N. shots	Total hooks	μ daily hooks
March	5	8	3,900				8	3,900	780
April									
May									
June									
July									
August									
September									
October									
November	5	8	3,950				8	3,950	790
December	13	25	12,000				25	12,000	923
Annual	**23**	**41**	**19,850**				**41**	**19,850**	**863**

2. *In **Figure 1**, the blue lines in both graphs represent average CPUE in the Coral Sea Zone for combined black and blue marlin discards, by month, during 2021. We understood that this average was for calculated over all vessels. In the figure on the right, the average CPUE is also shown just for the trial vessel – brown line. It was queried as to why the blue line (both vessels) and the brown line (trial vessel only) were the same for all months except the last two. It would seem highly unlikely that both vessels had exactly the same average CPUE for most months. Seems that some understanding is missing here.*

AFMA response: (Table 1) above illustrates that the second vessel active in the fishery only fished during March (56% of total fishery effort), November (19% of total fishery effort) and December (45% of total fishery effort). For this reason, the CPUE for the coral sea fishery, and the CPUE for the trial vessel are virtually identical until later in the year, though some divergence between the lines can also be seen in January. Nominal CPUE has also been recalculated in **(Table 2)** below.

Figure 1. Average CPUE in the Coral Sea Zone for combined black and blue marlin discards, by month, for the period 2015-2021, and 2021, showing the trial vessel, trail period relative to the 2021 CSZ CPUE.

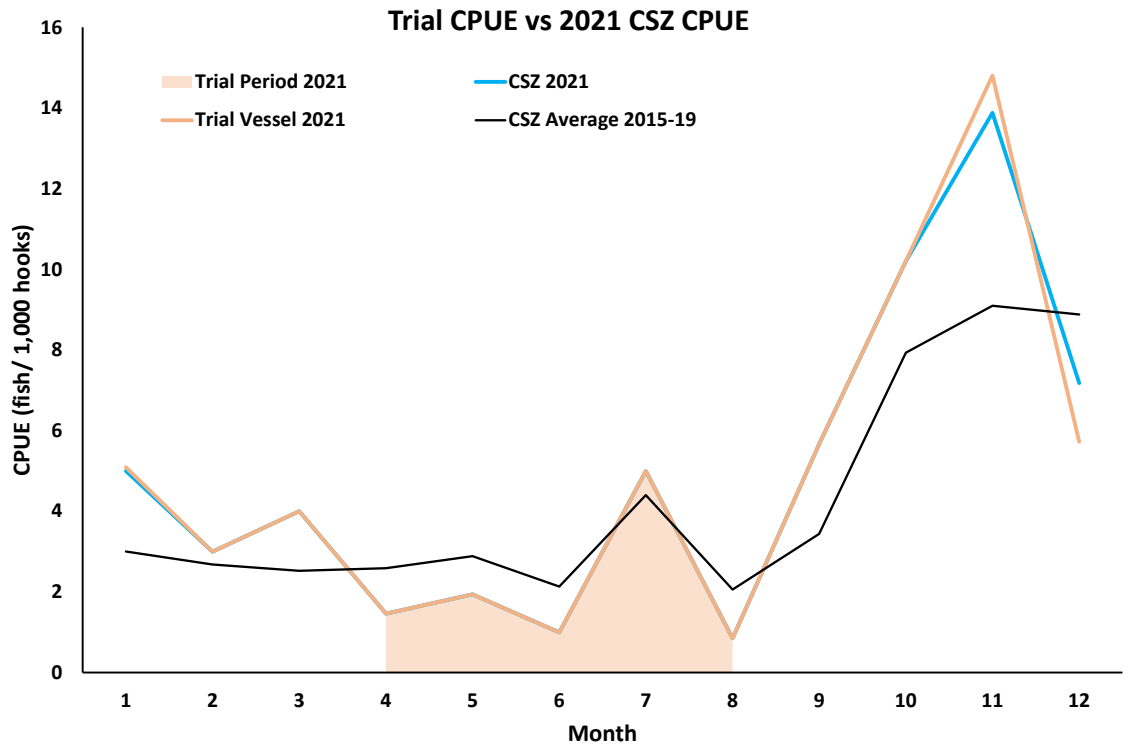
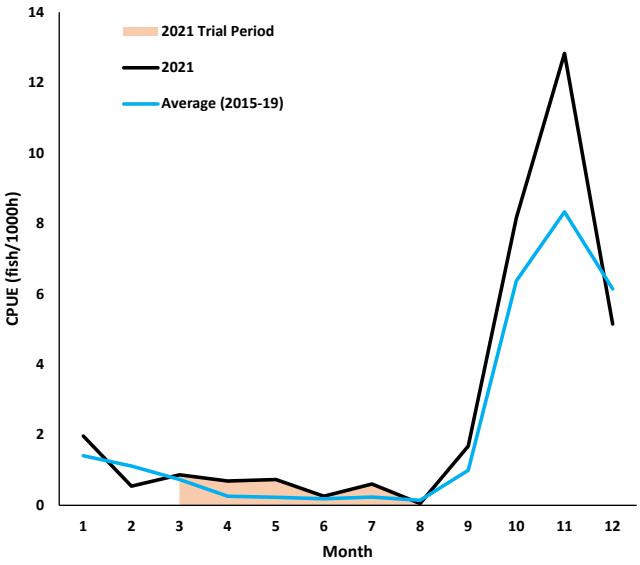
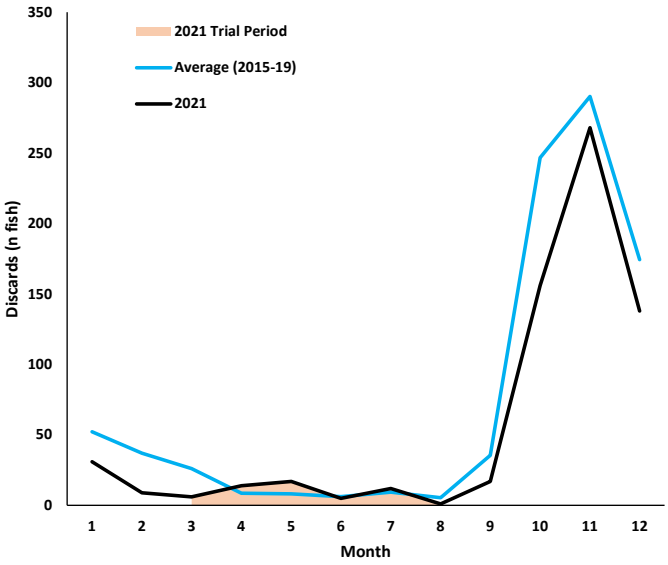


Figure 2. Recalculation of combined marlin CPUE incorporating all effort in the CSZF (not just those hooks from shots that saw interactions) results in slightly lower CPUE for marlin than previously shown, and flattens the peak previously seen in July.

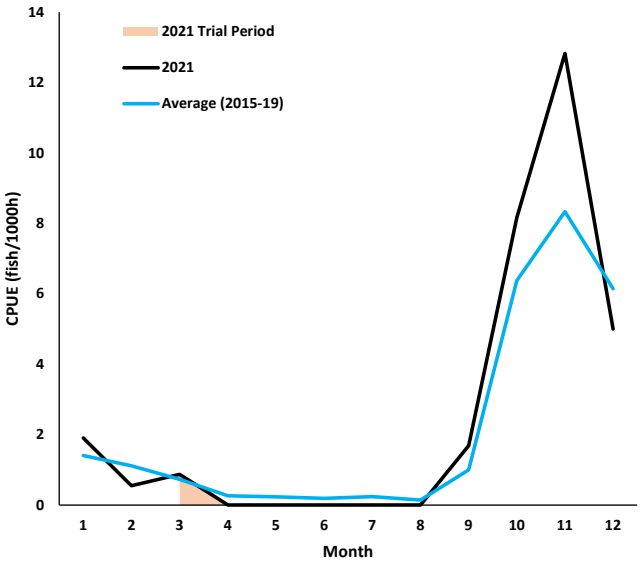
Average CSZ CPUE vs 2021 CSZ CPUE (all vessels)



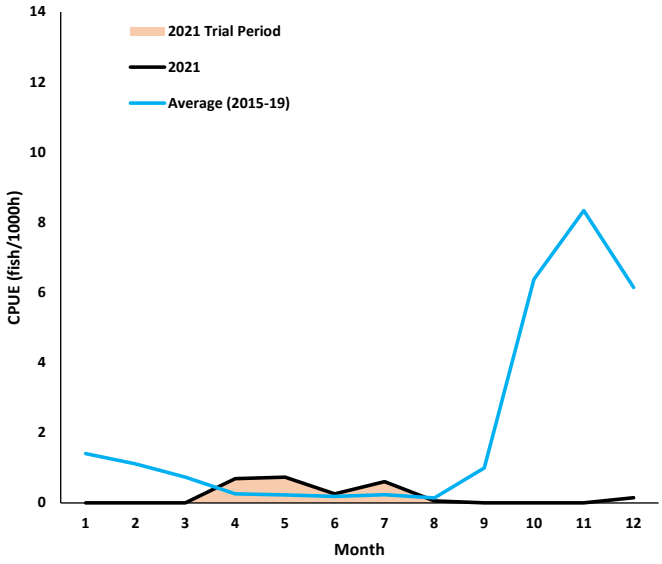
Average CSZ discards vs 2021 CSZ discards (all vessels)



Average CSZ CPUE vs 2021 CSZ CPUE (≤500h)



Average CSZ CPUE vs 2021 CSZ CPUE (>500h)



Interaction rates increase at the end of the year, with a peak CPUE of 12.83 seen in November 2021 **(Table 2)**, which falls within the historical range for this month (max of 14.34 in 2018). This peak is associated with shots of <500h, and a fishery average of 818.5 hooks per day in that month.

Table 2. Recalculated monthly combined marlin CPUE in the CSZ from 2015-2021, and an indicated mean annual nominal catch rate for the period.

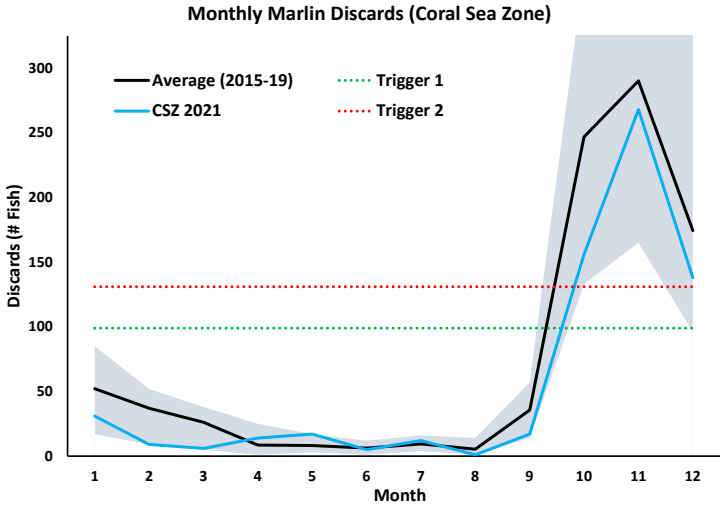
	2015	2016	2017	2018	2019	2021	Mean
Jan	0.54	0.84	1.14	1.92	2.60	1.97	**1.50**
Feb	0.38	0.90	1.05	1.71	1.55	0.55	**1.02**
Mar	0.15	0.88	1.19	0.64	0.81	0.87	**0.76**
Apr	0.12	0.82	0.18	0.03	0.15	0.69	**0.33**
May	0.22	0.45	0.18	0.20	0.10	0.74	**0.32**
Jun	0.29	0.33	0.14	0.15	0.04	0.26	**0.20**
Jul	0.23	0.24	0.31	0.18	0.22	0.61	**0.30**
Aug	0.09	0.10	0.30	0.07	0.16	0.05	**0.13**
Sep	1.54	0.42	1.48	0.44	1.11	1.68	**1.11**
Oct	9.06	3.33	7.34	3.76	8.39	8.17	**6.67**
Nov	9.09	2.77	6.31	9.17	14.34	12.83	**9.08**
Dec	11.46	2.34	3.05	7.82	6.06	5.15	**5.98**
Mean	**2.76**	**1.12**	**1.89**	**2.17**	**2.96**	**2.80**	**2.28**

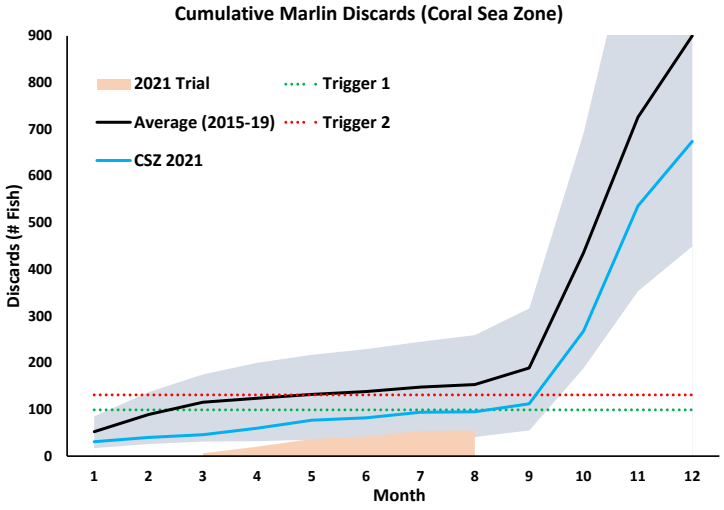
3. **Effort, monthly & cumulative discards**

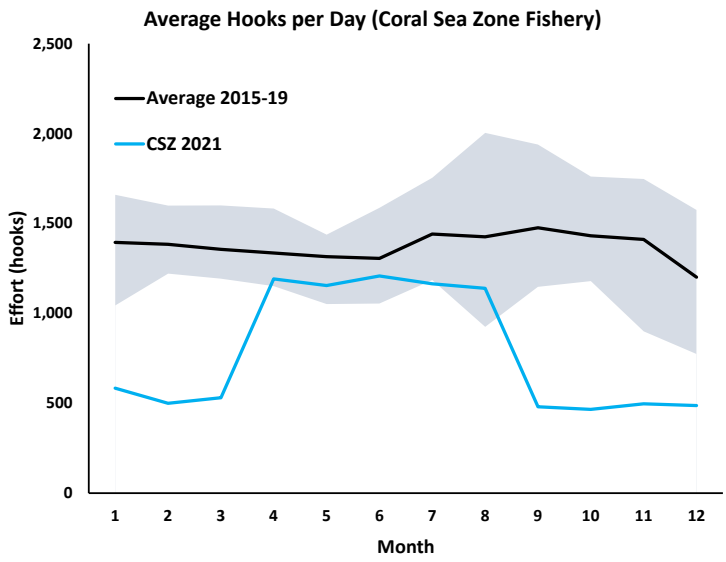
East of 148°E. 2 shots of 1200h each were undertaken in April east of 148°E.
No discards (no interactions, reflected in industry's report that trips were generally short to meet supply chain limitations).

West of 148°E. **Figure 3 below.** 2021 total discards by month (black and blue marlin), monthly effort (total hooks), cumulative discards (including discrete 2021 trial period values), and CPUE (black and blue marlin, fish/1,000h) shown in comparison to 2015-19 averages (black line). Also shown are the values bounded by the minimum and maximum values recorded between 2015-19 (shaded area).

Figure 3. Effort, monthly and cumulative discards.







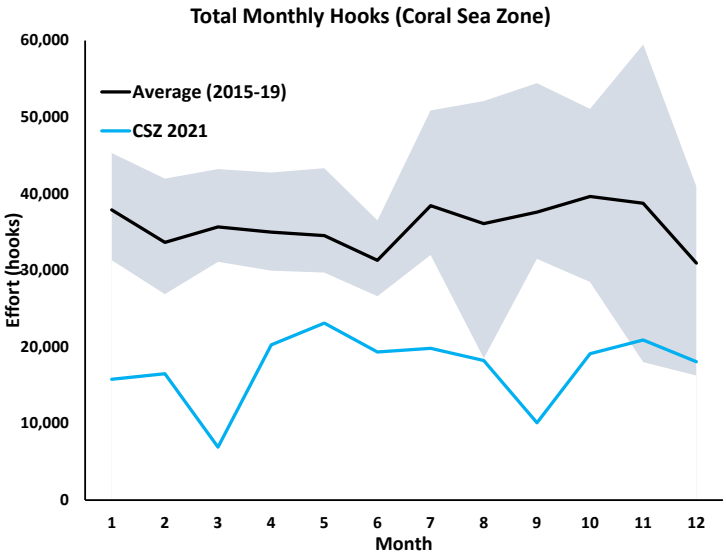
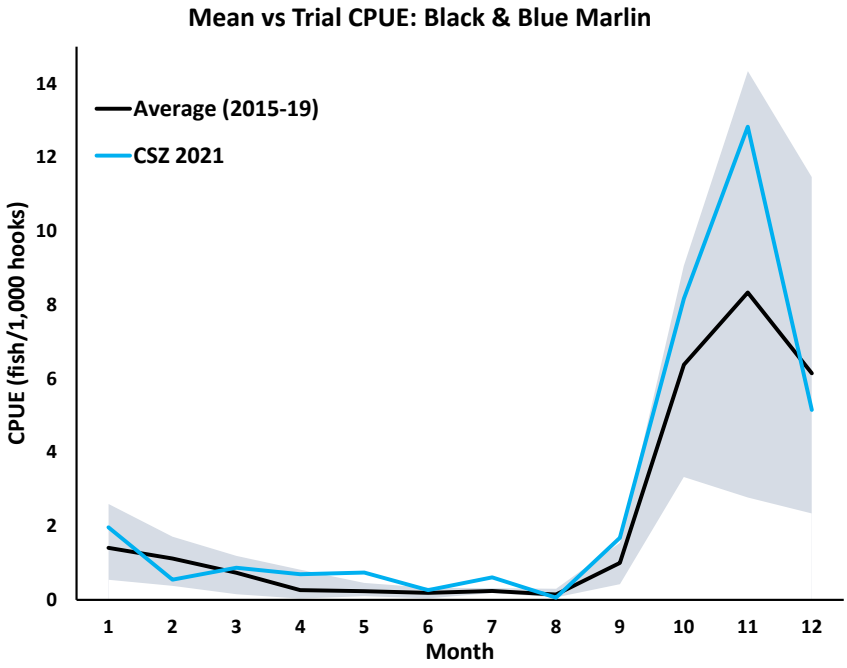


Figure 3. Effort, monthly and cumulative discards.



4. *In Table 3 and Figure 3 again we understand these data are for all (both) vessels that fished in the CSZ in 2021 (i.e. not just the trial vessel) – is that correct? As a main focus is on billfish survivability, it would be useful to compare life-status for shots using <=500hooks and those using >500 hooks. As such, could you provide tables and figures similar to Table 3 and Figure 3 but stratified by shots deploying <=500hooks and those deploying >500 hooks.*

AFMA Response: Figure 4 and **Tables 3 & 4** below illustrate discard fates of blue, black and blue and black marlin caught on sets with ≤500 h and >500h to explore differences in life status outcomes. While shots of >500h had proportionally greater dead discards, the number of marlin interactions on these shots was low. The greater incidence of dead discards seen in shots of ≤500h likely correlates with increasing CPUE seen in November.

Figure 4. Discard fates of blue, black and blue and black marlin caught on sets with ≤500 h and >500h to explore differences in life status outcomes 2021.

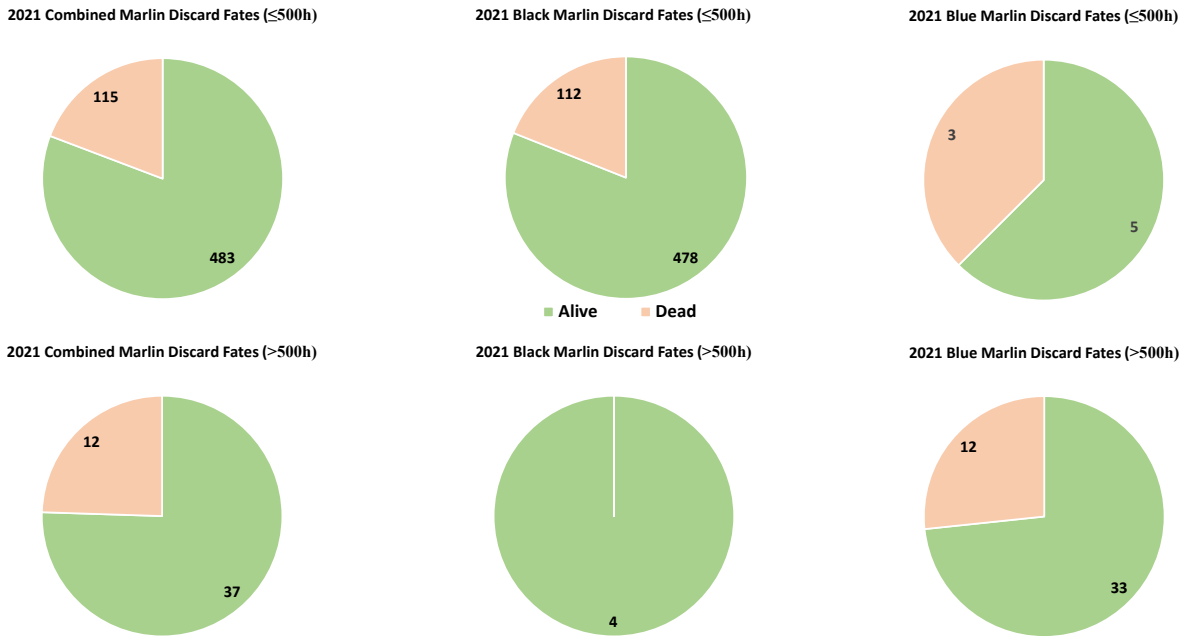


Table 3. Discard fates of blue, black, and combined blue and black marlin in the Coral Sea Zone. For 2021, the figures provided are available for trial – present, and whole year (in parentheses).

	Blue Marlin			**Black Marlin**			**Combined Marlin**			
	Alive	**Dead**	**UnK**	**Alive**	**Dead**	**UnK**	**Alive**	**Dead**	**UnK**	**Total**
Mar-Dec '21	37 (49)	15 (16)		473 (493)	109 (112)		510	124		634 (674)
-										
2019	105	26	13	768	244	14	873	270	27	1170
2018	25	29	31	344	85	85	369	114	116	599
2017	107	26	180	200	83	365	307	109	545	961
2016	111	30	135	47	10	283	158	40	418	616
2015	437	100		458	160		895	260		1155
μ 2015-19	157	42.2	89.75	363.4	116.4	186.75	520.4	158.6	276.5	955.5

Table 4. Discard fates of blue, black and combined blue and black marlin in the Coral Sea Zone in 2021. Note that figures vary slightly from that provided in Table 3, indicating an update to submitted logbook data since February 2022.

2021	**Blue Marlin**	**Black Marlin**	**Combined Marlin**
≤ 500h			
Alive	5	478	483
Dead	3	112	115
>500h			
Alive	33	4	37
Dead	12	0	12
All hooks			
Alive	38	482	520
Dead	15	112	127

Australian Government
Australian Fisheries Management Authority

Coral Sea Zone Hook Trial Annual Review

FINAL meeting record

Small Working Group meeting # 4

15 February 2022

11:00am – 12:00pm Online

Chair: Selina Stoute
Participants:

Name	Position
Selina Stoute,	AFMA
Dr Ashley Williams	Scientific Member TTRAG and TTMAC
Bob Lamason	Industry Representative, Coral Sea Zone Boat SFR Owner
Rowan Lamason	Industry Representative
Kyle Lamason	Industry Representative
Paul Zolezzi	Industry Representative
Dr Julian Pepperell	Recreational/Charter Fishing Member TTRAG
Ian Bladin	Recreational/Charter Fishing Invited Participant TTMAC
Grahame Williams	Recreational/Charter Fishing Member TTMAC
David Ellis	Tuna Australia, CEO. TTMAC Member
Phil Ravanello	Tuna Australia, Program Manager
Kate Martin	AFMA
Lachlan Farquhar	AFMA

Apologies: Dr Ian Knuckey, Scientific Member, TTRAG

Meeting Objectives

The meeting was convened to review the results to date of the trial and compare the results with the 2015-2019 baseline data. The Working Group was asked to consider both whether the trial should continue, and if so, if any changes to trial parameters are needed.

Updates

Recreational Fishing Sector

Recreational fishing sector members provided an update on the 2022/23 season and noted it had been a good season yielding variable results. Currently there are high catches of juvenile Black Marlin both in the

Coral Sea and off the New South Wales coast. Relationships between the charter fishing and longline sectors were reported to be strong with the charter groups off Cairns increasing effort following slow years due to COVID-19.

Dr Pepperell advised the Working Group that funding has been secured from the Ocean Health Foundation, to conduct an analysis of historic black marlin catch-effort data. The project will receive contributions from Game Fishing Association of Australia, Queensland Game Fishing Association and the Cairns Professional Game Fishing Association (charter boat operators). This will provide an additional 25 years of catch-effort data and will aim to recognise variability of catch rates over time. It is anticipated the project will take approximately 2 years to complete.

Commercial Fishing Sector

Industry members provided an update on the 2022 season and noted high target species catch rates during the winter months (notably Bigeye Tuna), and very low interactions with marlin. Setting up to 1250 hooks in single sets in the late afternoon increased target species catch rates and reduced marlin interactions due to avoiding setting during marlin bite times. Industry members noted that setting up to 1250 hooks on a single shot was highly beneficial as it reduced running costs, shortened trips and allowed them to fish more efficiently. Members advised that one vessel was diversifying their fishing practices by targeting lobster in the Queensland East Coast Crayfish and Rocklobster Fishery during new moon and then longlining during the full moon phases. This, coupled with poor weather conditions, led to low fishing effort in the Coral Sea Zone (CSZ). Industry members advised that winch capacity and line thickness varied between vessels which limits some vessels ability to set greater than ~800 hooks. Sets using varied amounts of hooks were seen during the 2021 season in the CSZ, however the variability in hooks/set reduced in 2022. Industry members advised they may set fewer hooks/set due to poor weather or during periods of high catch rates to ensure they can retain the quality of their catch. Industry members noted that while they deployed sets with greater than 500 hooks, they did not utilize deep setting options in the CSZ during 2022 due to the setting preferences of their skippers. It was also noted by the Working Group that the data showed reduced marlin mortality when setting shots with greater than 500 hooks.

Trial results

Participants noted the summary of results of the two-year CSZ Hook Trial compared to the baseline period (2015-2019) as detailed in the discussion paper for the meeting (**Attachment A**). AFMA noted:

- there was reduction in effort in the 2022 season compared to the 2021 season as well as the baseline average (2015-2019). In total, three vessels fished in the CSZ in 2022 compared with only two in 2021. Total sets and hooks deployed during trial period were significantly lower than the baseline period average.
- marlin interactions recorded during the baseline period and trial period were: ~955 in the baseline period (average); 641 in 2021; and 168 in 2022. The combined marlin interactions recorded on sets with greater than 500 hooks West of 148°E in 2021 was 54, and in 2022 was five; and
- trigger limits were not reached West of 148°E between March and August in either 2021 or 2022.

A recreational fishing sector member raised vessel numbers within the CSZ and queried that if the trial continued, whether it would be restricted to three vessels. The Working Group discussed concession latency and the safeguards in place such as the trigger limits, and it was recommended that if the trial continued, a vessel cap in the CSZ would not be required. Industry members advised there was possibly one other vessel likely to fish the CSZ.

Size Class information

AFMA advised that size class data, used to measure interactions with either juvenile or adult marlin, had been submitted by fishers during the trial however in error, AFMA had not extracted the data in its latest data query. AFMA advised that it would correct the discussion paper to reflect this and provide a summary of the size class data to Working Group members out of session.

Action Item 1. AFMA to update CSZ WG 3 Discussion Paper to acknowledge that fishers have correctly reported size class data through e-logs. COMPLETE.

Action Item 2. AFMA to provide a summary of size class data collected during the trial to the Working Group out of session. INCOMPLETE.

Next Steps

The Working Group:

1. supported AFMAs recommendation to continue the trial in its current form (retain working group and arrangements) for the next two fishing seasons during which time the Tropical Tuna Resource Assessment Group (TTRAG) and Tropical Tuna Management Advisory Committee (TTMAC) will consider the outcomes of the trial to date;

2. agreed that the intended maximum hook limit for the trial was 1250 hooks and not 1200 hooks; and

3. agreed, noting industry's support at the meeting, for the meeting discussion paper to be made public.