20th Regular Session of the Scientific Committee
14-21 August 2024, Manila, Philippines

Pacific Community
Communauté du Pacifique

SUMMARY OF BYCATCH IN WCPFC PURSE SEINE FISHERIES AT A REGIONAL SCALE, 2003-2022

WCPFC-SC20-2024/ST-WP-07

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Summary

- Focus on improvements to the estimation approach compared with the previous iteration (Peatman & Nicol, 2021)
  - Catch rate models
  - Estimation groups

Previous catch rate models

- Presence/absence models (Generalised Estimating Equations):

  ~ s(year) + s(SST) + quarter + set type

  splines *categorical variables*

- Catch when present estimated by bootstrapping from observations, stratified by set-type
- Spatial variation in catch rates was not (explicitly) accounted for in presence/absence models
- Inclusion of spatial effects should:
  - Mitigate against bias in estimated catch rates pre-2010 (and post COVID)
    - Lower observer coverage rates, and less representative (spatially & by fleet)
  - Increase utility of catch rate models in monitoring for species requiring more targeted analyses
    - Reduce influence of spatial coverage of observer data on year effects
  - Allow exploration of spatial variation of catch rates (and catches)

Updated catch rate models

- Moved to spatially explicit models, implemented in R package *sdmTMB*
  - Delta-lognormal models for estimation groups with catch rates of tonnes
  - Negative binomial or delta-negative binomial models for estimation groups with catch units of individuals
- Base catch rate model specification:

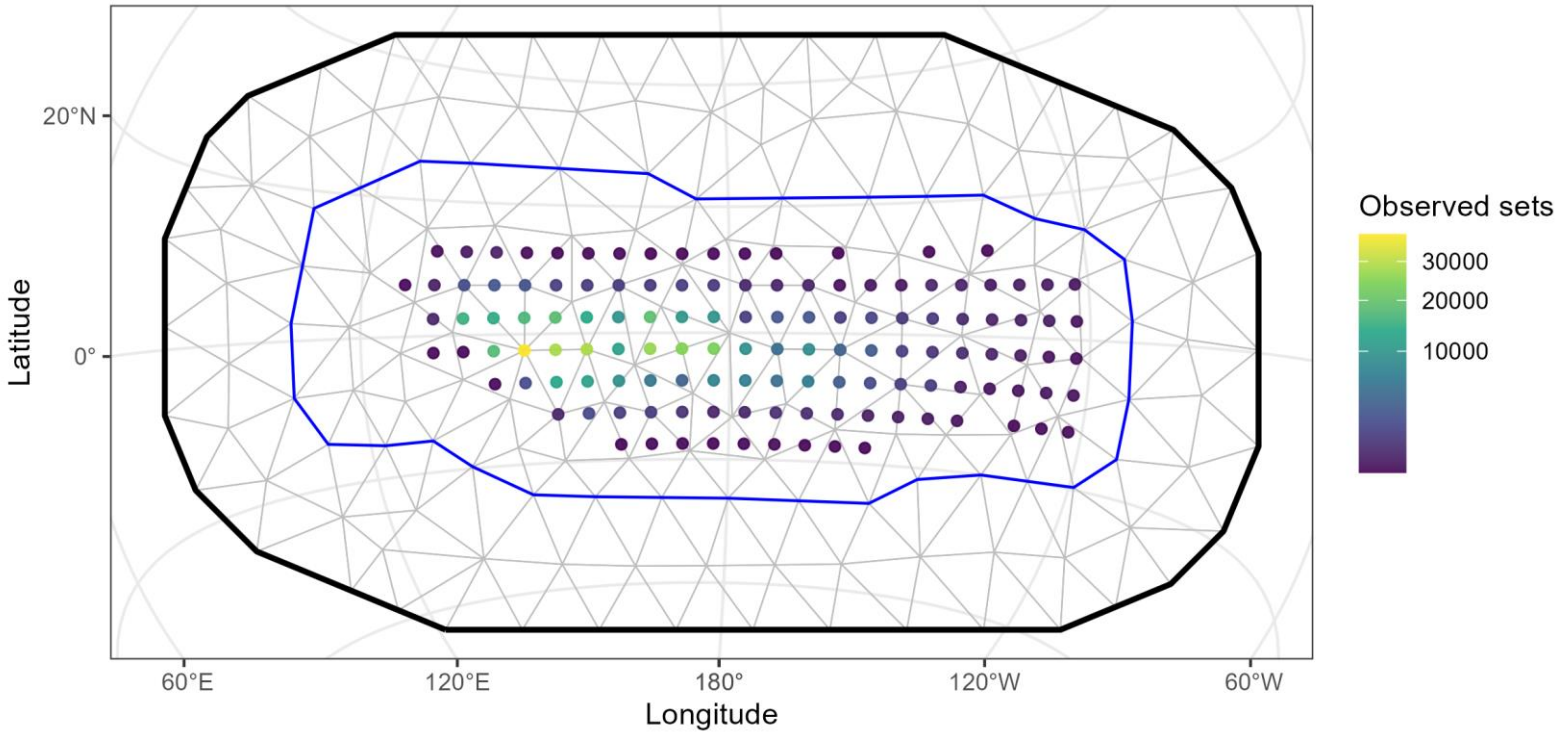
$$\sim (1 \mid \text{year}) + (1 \mid \text{flag}) + s(\text{month}) + s(\text{depth 20°C}) + \text{set type} + \text{ONI class} + \omega_s$$

random intercepts | *splines* | *categorical variables* | *spatial random field*

- For selected estimation groups, also included additional spatial random fields specific to quarter, ONI class or set-type (separately)
  - Prioritised elasmobranchs, sea-turtles and marine mammals, as well as frequently encountered teleosts and billfish
- For these estimation groups, used ensemble model predictions
  - Model weights maximising log-likelihood across the (4) model specifications

Spatial random fields

- Meshes defined using distribution of observed captures for each estimation group
  - Same mesh used for spatial random fields and 'spatiotemporal' random fields
- Example mesh for false killer whale (*Pseudorca crassidens*):

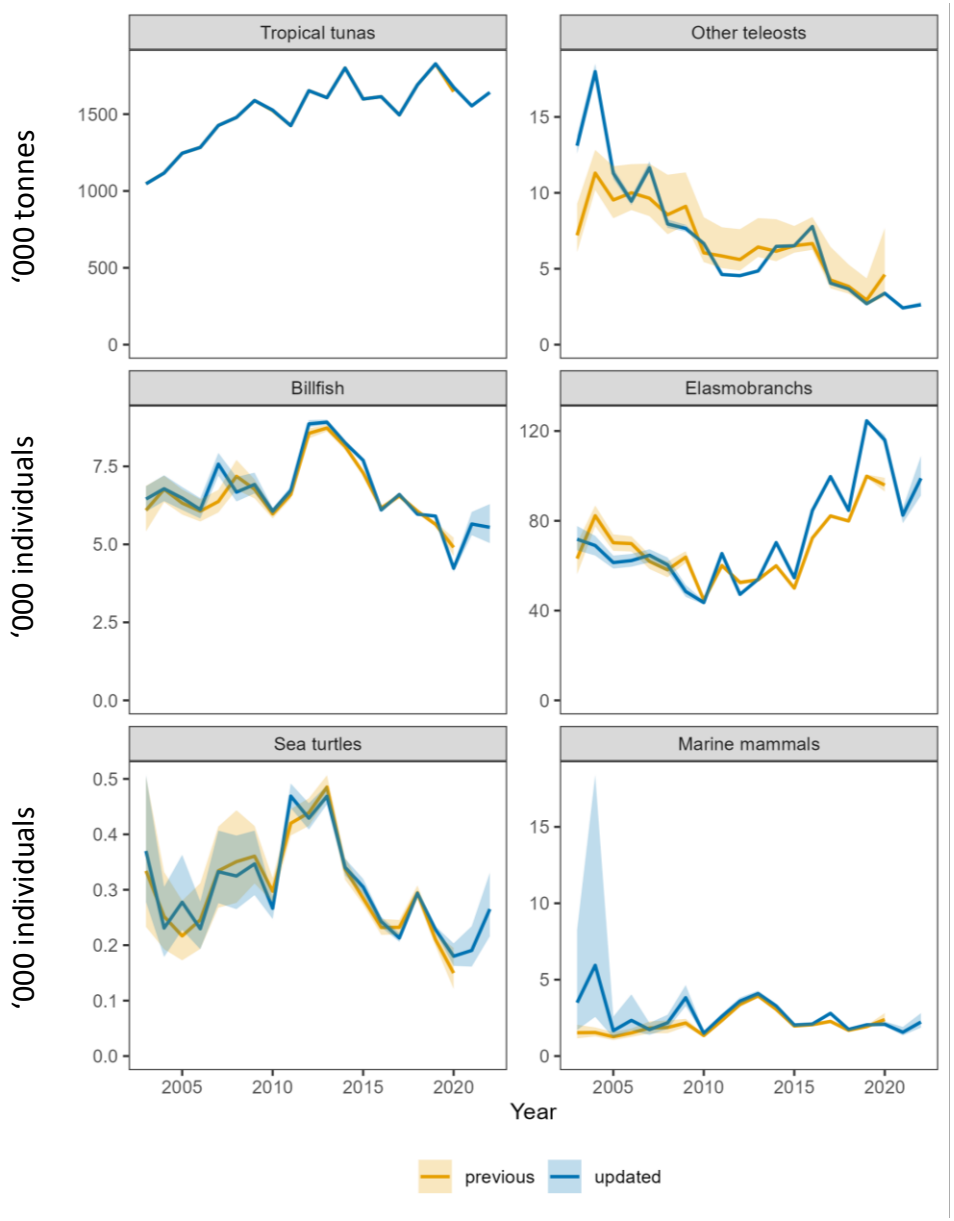


Estimation groups – marine mammals

- Previously a single ‘marine mammals’ estimation group
- Increased taxonomic resolution of estimation groups for marine mammals, informed by recommendations by Miller (2023)

Estimation group	Scientific name
False killer whale	*Pseudorca crassidens*
Short-finned pilot whale	*Globicephala macrorhynchus*
Risso’s dolphin	*Grampus griseus*
‘Blackfish’	‘Blackfish’
Dolphins	Delphinidae
Beaked whales	Ziphiidae
Toothed whales	Odontoceti
Baleen whales	Mysticeti
Marine mammals	Cetacea & pinnipeds

Updated catch estimates



Recommendations

The SC is invited to:

1. Note the estimates of bycatch of the large-scale equatorial purse seine fishery in the WCPFC Convention Area.
2. Note that the bycatch estimates should be interpreted as the bycatch that would have been recorded by observers with 100% coverage of fishing events.
3. Note that other studies suggest that shark bycatch estimates are likely to be underestimates, due to underestimation of captures by observers.
4. Note the refinements to the estimation approach, including the implementation of spatially-explicit catch rate models. This should improve the utility of catch rate models for identification of species that may warrant additional targeted analyses.
5. Note the impacts of recent reductions in observer coverage on the precision of catch rate and catch estimates, and the extent to which they can be used to monitor for temporal trends.
6. Note the refinements to the taxonomic resolution of catch estimates for marine mammals.