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A Short Note On The Development Of Biological Sampling Plans For Tuna & Billfish (Projects 117 & 118)

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T. Peatman[1], J Scutt Phillips[2], S. Nicol[2]

[1] Independent consultant for the Oceanic Fisheries Programme, The Pacific Community (SPC)
[2] Oceanic Fisheries Programme, The Pacific Community (SPC), Nouméa, New Caledonia

Development of biological sampling plans for tuna and billfish

The Western and Central Pacific Ocean has accounted for over 50% of the global tuna catch in recent years (Williams & Ruaia, 2023), with tuna fisheries in the region making substantial contributions to the economies of Pacific Island countries and territories (Ruaia et al., 2020). WCPFC supports the collection and storage of biological samples through the WCPFC Pacific Marine Specimen Bank (PMSB), with samples collected from 58,000+ individuals covering more than 160 species ranging from micronekton through to tuna and billfish (SPC-OFP, 2023). However, there is no formal sampling plan for the PMSB, with samples collected on a more opportunistic basis primarily by observers and port samplers, as well as SPC-led tagging cruises. The collection of representative biological samples underpins the effective management of tuna and tuna-like species in the region. Recent assessments of some exploited populations in the WCPO have been hampered by limited or unrepresentative available biological samples which impacts estimation of key biological processes (e.g., Farley et al., 2020; Day et al., 2023). In this context, WCPFC SC19 recommended the development of a biological sampling plan for tuna and billfish species (Anon., 2023). This report briefly summarises the planned methodology that will be used to develop biological sampling plans for tuna and billfish species in the WCPO.

The testing of biological sampling plans will primarily focus on the collection of samples to support estimation of age and growth, i.e., otoliths as well as fin spines for billfish, along with consideration of other areas of work, e.g., reproductive biology. The sampling plan will build on the approach used by Kinney et al. (2023) to develop biological sampling plans of North Pacific billfish species, i.e., a size-stratified approach to maximise efficiency in terms of sampling effort.

A simulation framework will be developed to test the efficacy of different sampling approaches. Available otolith data suggest spatial variation in growth rates (e.g., Farley et al., 2020). The biological sampling plans should be robust to plausible drivers of spatial variation in growth rates, which will require representation in the operating model. Plausible drivers of spatial variation in growth include a) the influence of the local environment on growth rates over the course of individual life history, e.g., habitat quality and local forage availability, and, b) variation in growth among individuals due to genetics coupled with a degree of spatial structure in the underlying population. The individual-based model Ikamoana would be an appropriate choice of operating model (Scutt Phillips et al., 2018), as it allows representation of plausible assumptions of the spatial dynamics of populations in the WCPO, and crucially the origin and path of each individual can be tracked over time. As such, growth rates of individuals can evolve as a function of spatial origin and/or the local environment experienced through time. These individuals can then be sampled in the same way that they would be through a biological sampling programme, permitting an examination of variability and bias in estimated growth rates.

It will not be possible to develop simulation models for all tuna and billfish species. Instead, we propose to develop simulations for a single species and use this to inform the sampling plan for all species. The underlying movement dynamics of the operating model will be parameterised using estimates for tropical tuna species from SEAPODYM (e.g. Senina et al., 2015). Estimates of the distributions of individuals from SEAPODYM will be used, in combination with available length-frequency data, to inform the initial spatial distribution of the underlying population. Length-frequency data will be used to inform the size composition of the underlying population in the operating model.

The estimation model accounts for the assumed sampling plan, and a growth model fitted to the resulting samples obtained from the simulated data. Growth estimates for a given sampling plan can then be compared to the underlying distribution of growth trajectories from the operating model to quantify precision and bias for that plan. A range of sampling plans could be considered, including the opportunistic approach similar to that of sampling effort in recent years, in order to assess the expected benefits to implementing a formal sampling plan.

We invite the Scientific Committee to consider the proposed methodology for development of biological sampling plans for tuna and billfish stocks. Additionally, we invite parties interested in participating in the initiative to contact the authors of this report.

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