South Pacific Regional Fisheries Management Organisation

7th MEETING OF THE SCIENTIFIC COMMITTEE

La Havana, Cuba, 7 to 12 October 2019

SC7-DW09

Candidate Species for Stock Structure Delineation

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Candidate species for stock structure delineation

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Purpose of this paper

This paper discusses the need for stock structure delineation for SPRFMO demersal teleost species and considers a number of potential candidate species for stock structure analysis.

Introduction

The biological structure of most demersal fish stocks in the SPRFMO Convention area is uncertain but there are relatively few species for which we believe stock structure analyses should be prioritised. Importantly, it needs to be established whether there is a pressing need for stock structure delineation in order to manage species and stocks within sustainable limits. With the exception of *Hoplostethus atlanticus* (orange roughy), there are few demersal species for which current levels of catch and effort are likely to be having a measurable influence on stock depletion and where stock assessment and possible implementation of harvest strategies may be warranted. Possible candidate species where this may be the case (based on simple analyses of spatial and temporal characteristics of catches and catch volumes, CPUE, targeting and/or species biology/life history) and where information on stock structuring may be important for their management include *Beryx* spp. (mostly *B. splendens*), *Hyperoglyphe antarctica* (blue-eye trevalla, bluenose), *Polyprion* spp. (hapuku, bass groper, wreckfish etc.), *Nemadactylus macropterus* (tarakihi, jackass morwong), *Seriola lalandi* (yellowtail kingfish, yellowtail amberjack) and Lethrinidae and Etelinae spp. (predominantly *Lethrinus miniatus* (redthroat emperor)). For most stocks, management using catch triggers in conjunction with adequate monitoring may be appropriate management responses in the interim.

The relatively low levels of catch and effort for most demersal species should not preclude work being undertaken now to improve our understanding of their biological stock structure. This knowledge will be important if the characteristics of SPRFMO demersal fisheries change through, for example: increases in catch of certain species; if there are unexpected signals in the data that may indicate depletion; and/or if there are changes in ocean and ecosystem dynamics (e.g. as a result of climate change) influencing species abundance and/or availability. Work that could be undertaken relatively cheaply now—for example, the collection and storage of genetic samples—may become more valuable in future, particularly if the cost of using genetics for stock structure delineation and biomass estimation continues to decrease over time.

Background

In 2013, the first meeting of the SPRFMO Scientific Committee recommended that work be done to identify the existence and distribution boundaries of *Hoplostethus atlanticus* and *Beryx splendens* stocks that straddle Exclusive Economic Zones (EEZs) and the SPRFMO Convention area. Since then, SC has identified that additional work may be required to understand stock structure for a number of key species across the broader bottom fishing areas in SPRFMO.

Under the SPRFMO Convention, straddling stocks are subject to compatible management arrangements within EEZs and on the high seas. There are at least two straddling demersal fish stocks within the SPRFMO area, which may need to be (or are already) subject to compatible management arrangements: alfonsino on northern Lord Howe Rise (which is likely part of the same alfonsino stock in the Australian East Coast Deepwater Zone) and orange roughy on Challenger Plateau and the Westpac Bank (which straddles SPRFMO and New Zealand's EEZ, where it is called ORH7A). A number of alfonsino stocks managed under New Zealand's Quota Management System (e.g. BYX2 and BYX3) may also be straddling stocks. Other potential straddling stocks exploited in Australian and New Zealand bottom fisheries include *Hyperoglyphe antarctica*, *Nemadactylus macropterus* and *Seriola lalandi*.

In accordance with the 'Expanded' multi-annual SC workplan, SC is required to provide a priority list for deepwater stock structure analyses for non-orange roughy stocks. The workplan suggests the use of modelling and observation data to predict stock connectivity, including the use of genetic, microchemistry, morphometric, parasite prevalence and tagging experiments as potential tools. Despite the focus on non-orange roughy species in the SC's workplan, orange roughy has been included for completeness here as it is the main demersal target species and is caught in the largest volumes.

Candidate species

Table 1 includes the top 20 species caught by volume by predominantly Australian and New Zealand vessels from 2014–2018. This table is included because efforts towards stock structure delineation should be commensurate with potential risks and management needs. Many species may be caught in low volumes such that existing data are inadequate for determining the influence of catches on biomass. At very low catch levels, catches for most species are unlikely to have a measurable influence on depletion. Consideration of the spatial and temporal characteristics of catch and effort in conjunction with the biological and life history characteristics of species (e.g. reproductive capacity, site fidelity/potential for localised depletion, migration/spawning patterns etc.) should be taken into consideration when assessing the merits of undertaking stock structure delineation studies. The results of the ecological risk assessment for SPRFMO demersal teleost species (SC7-DW11) may also inform consideration of candidate species.

Table 1. Top 20 species by order of volume taken by predominantly Australia and New Zealand vessels between 2014 and 2018 in SPRFMO. Note that recent 10 year catch (2009-2018) and catch proportion by gears (BLL – bottom longline, TB – demersal trawl, TM – midwater trawl) for the 2014-2018 period is also given. Source: SPRFMO database

3A_CODE	Scientific_name	English_name	Recent 10 yrs 2009-2018 Fishing activity (kg)	Recent 5 yrs 2014-2018 Fishing activity (kg)	Recent 5 BLL (%)	Recent 5 Trawl (TB)	Recent 5 Trawl (TM)
ORY	*Hoplostethus atlanticus*	Orange roughy	11194484	5862492	0%	100%	0%
ALF	*Beryx spp*	Alfonsinos nei	1604757	807154	0%	55%	45%
BWA	*Hyperoglyphe antarctica*	Bluenose warehou	630436	258874.5	92%	5%	2%
HAU	*Polyprion spp*	Hapuka	322391	173552	99%	1%	0%
DWS	*Elasmobranchii*	Deep-water sharks nei	175235	171948	0%	100%	0%
GRV	*Macrourus spp*	Grenadiers nei	187117	169862	0%	100%	0%
YTC	*Seriola lalandi*	Yellowtail amberjack	283475	153737	100%	0%	0%
TAK	*Nemadactylus macropterus*	Tarakihi	277784	124450	100%	0%	0%
ONV	*Neocyttus rhomboidalis*	Spiky oreo	183094	112697	0%	100%	0%
RIB	*Mora moro*	Common mora	156190	100945	10%	90%	0%
LHI	*Lethrinus miniatus*	Trumpet emperor	152064	83734	100%	0%	0%
WRF	*Polyprion americanus*	Wreckfish	87460	76739	100%	0%	0%
EPI	*Epigonus telescopus*	Black cardinal fish	224636	74440	0%	100%	0%
ETC	*Etelis coruscans*	Deepwater longtail red snapper	71471	61528	100%	0%	0%
TOA	*Dissostichus mawsoni*	Antarctic toothfish	57797	57796.67	100%	0%	0%
OVE	*Optivus elongatus*	Slender roughy	62566	56811	0%	100%	0%
EMV	*Pentaceros decacanthus*	Bigspined boarfish	50604	50604	0%	100%	0%
EDR	*Pseudopentaceros richardsoni*	Pelagic armourhead	218565	46060.6	7%	79%	14%
MOW	*Nemadactylus spp*	Morwongs	61,317	45655.5	97%	3%	0%

Note: Fisheries for *Dissostichus* spp. are currently managed in accordance with CMM 13 (Exploratory Fisheries). Fisheries Operations Plans and Data Collection Plans for these exploratory fisheries usually contain reference to efforts to undertake or contribute to stock delineation studies and these species are not considered further herein.

Hoplostethus atlanticus

Stock structure

Research has indicated a high level of genetic structure in global orange roughy populations, but genetic homogeneity between Australian and New Zealand populations (Varela, Ritchie & Smith 2013). Analyses of biological data and various stock assessments have identified separate and geographically distinct fishing areas for orange roughy due to substantial distances or abyssal-depth waters. Based on work by Clark et al. (2016), a series of regional management units have been assumed for orange roughy in SPRFMO and have been used for assessment (e.g. Cordue 2017, Cordue 2019) and management in accordance with CMM 03a-2019. Work to further delineate orange roughy stock structure has been proposed (see 'Next steps').

Successful management of orange roughy in SPRFMO is partly contingent on the stock structure hypotheses used in the accepted assessments (e.g. Cordue 2017, Cordue 2019) being approximately correct. In light of uncertainty, a precautionary approach to their management has been pursued.

Information on catches and status is provided elsewhere and is not included here.

Beryx spp.

Stock structure

It is likely that the majority of catches reported as '*Beryx* spp.' in SPRFMO are *Beryx splendens* although reported catches may also contain small amounts of *Beryx decadactylus*. There have been taxonomic uncertainties within the *Beryx splendens* taxon (e.g. Hoarau and Borsa 2000) and evidence of extremely high intra-specific genetic diversity, even at small scales (Lévy-Hartmann et al. 2011).

Alfonsino is a widely occurring benthopelagic species that aggregates around seamounts and features on the upper continental slope. FAO (2016) reviewed knowledge of alfonsino population structuring in the Pacific and identified a high level of complexity but a general lack of conclusive knowledge of distinct population structuring. Nonetheless, FAO (2016) presents two distinct population hypotheses relevant to the South Pacific; one for a New Caledonian population and another for a New Zealand population.

The first, following the findings of Hoarau and Borsa (2000), found evidence for two reproductively isolated sibling species (A and W) within the *Beryx splendens* taxon based on analysis of the gene composition of 250 alfonsino sampled from seamounts and continental margins in New Caledonia, New Zealand and southeast Australia and from the Northeast Atlantic. Hoarau and Borsa (2000) found no heterogeneity in the distribution of haplotype frequencies within either *Beryx splendens* species A or W at the scale of New Caledonia and noted that three haplotypes from *B. splendens* sp. A in the Northeast Atlantic were also the three most common in the Southwest Pacific populations. This led to a conclusion that *B. splendens* sp. A populations share a recent evolutionary history at the worldwide scale, which in turn implies genetic mixing at an interoceanic scale.

No information is available as to whether alfonsino is a single stock in New Zealand waters. Overseas data on alfonsino stock distributions suggest that New Zealand fish could form part of a widely distributed South Pacific stock (Fisheries New Zealand 2019). Horn & Massey (1989) found substantial differences in length frequency distributions between alfonsino from the Palliser bank compared with those from other locations on the east coast of New Zealand's North Island, suggesting that there may be some age-specific migration occurring. Alekseev et al. (1986) suggested that *Beryx splendens* could comprise widespread populations in large oceanic eddy systems. FAO (2016) also noted that alfonsino might be contained within a large gyre system, or complex of gyres, that reach from the east coast of the North Island to the Louisville Ridge based on the presence of alfonsino on Louisville Ridge seamounts. If New Zealand alfonsino form part of such a system then the east coast North Island may be a non-reproductive zone where fish mature before leaving for a possible reproductive zone further east of the mainland (Horn & Massey 1989).

In summary, genetic studies have suggested a high level of interoceanic mixing but extremely high intra-specific genetic diversity. This may suggest that management units for alfonsino based on prevailing oceanographic currents and gyres, which may act to constrain certain populations to certain areas or influence reproductive connectivity, may be a sensible unit of assessment and management for this species. The evidence also suggests that such oceanographic dynamics may play an important role in the abundance and availability of alfonsino. It should be noted that there is very little new information on alfonsino stock structure in the South Pacific Ocean since 2000, and very limited genetic work. Given the advances in genetics since then, we may draw some very different conclusions about stock structure if more contemporary techniques were applied.

Status and/or catches

Biomass status of alfonsino in SPRFMO is unknown. *Beryx* spp. (code ALF) is listed as the second most caught demersal fish species by volume (approx. 807 t) for the 2014-2018 period (Table 1) and *Beryx* spp. comprised around 16% of the total catch of demersal species over the last 10 years (SPRFMO 2019).

Hyperoglyphe antarctica

Stock structure

A number of studies on population structuring of *Hyperoglyphe antarctica* have been undertaken (e.g. Horn 2003, Hindell et al. 2005, Robinson et al. 2008, Williams et al. 2017) which have relevance to SPRFMO. Earlier studies (e.g. Hindell et al. 2005, Robinson et al. 2008) indicated that genetic variation was not significant among Australian fishery regions; however, Williams et al. (2017) note that genetic homogeneity can be maintained over broad scales even where reproductive exchange and/or movement is limited. In these situations genetically homogenous populations may be comprised of a number of subpopulations that differ in terms of growth rate, reproduction, size at maturity, fecundity, recruitment patterns, etc. (Williams et al. 2017), indicating that regional management at a subpopulation level may be important even despite genetic homogeneity.

Williams et al. (2017) used three lines of evidence—phenotypic variation in age and growth, otolith microchemistry and potential larval dispersal—and identified four geographically distinct subpopulations around southern and eastern Australia (West, South, East and Seamounts-Lord Howe). Three of these subpopulations (South, East and Seamounts-Lord Howe) were found to be interconnected through regional exchange of larvae (Williams et al. 2017). Larval dispersal modelling and other findings of this research suggest that the Seamounts-Lord Howe population is likely to straddle Australia's EEZ and SPRFMO.

Horn (2003) made inferences as to stock structure of *H. antarctica* off the north-east coast of New Zealand based on results of a detachable hook tagging programme and found that *H. antarctica* off the eastern coast of New Zealand between North Cape and Kaikoura probably comprise a single biological stock. Stock boundaries are unknown, but similarity in trends in catch and CPUE across fisheries occurring in each of the five New Zealand *H. antarctica* Quota Management Areas (QMAs) suggests the possibility that there may be a single *H. antarctica* stock across all these areas, or of some close relationship between stocks in these QMAs. Tagging studies have shown that *H. antarctica* are capable of extensive migration, i.e., from the Wairarapa coast to Kaikoura, Bay of Plenty, and North Cape (Horn 2003 in Fisheries New Zealand 2019).

Given knowledge of *H. antarctica* biology (i.e. long-lived, slow growth and late maturity), the characteristics of fishing for them (e.g. on and around seamounts), and the relatively significant catches compared to other SPRFMO demersal species, it may be prudent to prioritize the species for additional stock structure analyses in important SPRFMO fishing areas. There is evidence that targeting *Polyprion* spp. has replaced *H. antarctica* as a key focus of New Zealand line fisheries.

Status and/or catches

Biomass status of *H. antarctica* in SPRFMO is unknown. The species has comprised around 3.5% of total SPRFMO demersal catches over the last 10 years (SPRFMO 2019). It was the third most caught demersal fish species by volume in SPRFMO during the 2014-2018 period (259 t).

The eastern stock of the species is assessed domestically in Australia using standardized CPUE, which indicates biomass has varied over time, but between the relevant limit and target reference points (Haddon 2017). The species is assessed in New Zealand using a full quantitative stock assessment (Cordue & Pomarède 2012). The MPD estimates of stock size in 2016 ranged from 17–27% B_0. Biomass was estimated to have declined continuously from the 1980s to 2011 and then to have either levelled off or increased slightly. Biomass has been below the default 40% B_0 target since around 2000 (Fisheries New Zealand 2018).

Polyprion spp.

Stock structure

Stock structure of *Polyprion oxygeneios* in Australian and New Zealand waters is unknown. The species has similar life history characteristics to *P. americanus* (long-lived, late age-at-maturity), which may suggest a broad population structure (Chick et al. 2018). Paul (2002) reviewed available data for New Zealand *Polyprion* spp. ('groper') and concluded that stock structure could not be described due to an absence of life history data.

Status and/or catches

Catches of *Polyprion* spp. (code HAU) in the SPRFMO database comprise the fourth most caught fish by volume (approx. 174 t) for the most recent five years (2014-2018). Catches of *P. americanus* (WRF) also totaled an additional 77 t during this period.

Biomass status of *Polyprion* spp. in SPRFMO is unknown. In Australian waters, stock status for eastern Australian state-managed stocks of *P. oxygeneios* (New South Wales, Queensland and South Australia) is 'undefined' and the Commonwealth-managed stock is classified as 'depleting' (Chick et al. 2018). No estimates of biomass are available for New Zealand *Polyprion* spp. stocks (Fisheries New Zealand 2018).

Nemadactylus macropterus

Stock structure

Nemadactylus macropterus is a widely distributed species occurring around the southern half of Australia, New Zealand, southern South America, southern Africa and some islands in the Atlantic and Indian oceans. Genetic studies have shown no evidence of separate stocks in Australian waters, but found that Australian and New Zealand stocks are genetically distinct (Elliott and Ward 1994). Otolith microchemistry studies have indicated differences between Tasmanian and New South Wales/Victorian fish (Thresher et al. 1994) and larvae from New South Wales/Victoria have significantly different otolith microstructure to Tasmanian caught larvae (Bruce et al. 2001), but it is unclear if these differences indicate separate stocks. Bruce et al. (2001) found that the dispersal of long-lived larval stages is linked to offshore mesoscale oceanographic processes off south-eastern Australia.

N. macropterus stocks around New Zealand have been identified as having a long pelagic larval phase, large scale movements from tagging (e.g. Annala 1987) and a lack of genetic isolation (Annala et al. 2000). Fisheries New Zealand (2019) identifies considerable connectivity of *N. macropterus* along the east coast of the South and North Islands. The current stock hypothesis is that the Canterbury Bight/Pegasus Bay area represents the main nursery area for the eastern stock unit. At the onset of maturity, a proportion of the fish migrate northwards to recruit to the East Cape area and, subsequently, the Bay of Plenty and east Northland areas. This hypothesis is further supported by the northward movement of tagged fish from the Kaikoura coast to the Wairarapa, East Cape and Bay of Plenty areas.

It is worth noting that the recent advances in genetic approaches has enhanced the ability to evaluate population structure, and may lead us to different conclusions than these previous studies.

Status and/or catches

Nemadactylus spp. (mostly *N. macropterus*) have comprised around 2% of demersal catches in SPRFMO over the last 10 years (SPRFMO 2019). Approximately 125 t has been caught in SPRFMO demersal fisheries during 2014-2018 (Table 1).

There have been some concerns around stock status in both Australia (e.g. Stobutzki et al. 2009) and New Zealand (Fisheries New Zealand 2018). Significant depletion and potential overfishing is evident in some domestically assessed stocks.

Seriola lalandi

Stock structure

Seriola lanandi is a highly mobile pelagic species with a widespread distribution that extends throughout temperate waters of the Atlantic, Pacific and Indian Oceans (Nugroho et al. 2001). Genetic analyses have shown the population in Western Australia to be genetically distinct from the *S. lalandi* found on the eastern and southern Australian coasts or within New Zealand waters (Miller-Ezzy et al. 2011). These findings confirm results from previous analyses that found no evidence of genetic differentiation between New Zealand and New South Wales *S. lalandi* (Smith et al. 1991) and results of tagging studies which show that *S. lalandi* undergo movements between Australia and New Zealand (Gillanders et al. 2001).

For New Zealand *S. lalandi*, a study based on meristic characteristics and parasite loads suggests two stocks of kingfish off the west and east coasts (Fisheries New Zealand 2019). These stocks are contained within the Tasman current on the west coast and the east Auckland current and east Cape current on the east coast, with little mixing between them (Fisheries New Zealand 2019). Tagging results suggest that most adult kingfish do not move outside local areas, with many tag returns close to the release site. However, some tagged kingfish have been found to move very long distances. For example, New Zealand Fisheries (2019) note reports of New Zealand tagged *S. lalandi* being caught in Australian waters and Australian tagged kingfish being recaptured in New Zealand waters.

Status and/or catches

Seriola spp. (mostly *S. lalandi*) have comprised around 1.5% of total SPRFMO demersal catches over the last 10 years (SPRFMO 2019). Catches from 2014-2018 totaled approximately 154 t.

Status of the eastern Australian stock is uncertain (Hughes et al. 2018). Catches in SPRFMO by Australian vessels in 2017 (~35 t) comprised a significant proportion of total mortality (~120 t in 2017) from commercial fishing by Australian vessels for this stock. Various indicators (CPUE, spawning potential ratio, tag recaptures and F/M estimates) suggest that the eastern Australian stock is depleted in at least part of its range (Hughes et al. 2018). For New Zealand stocks, biomass status is unknown but overfishing is assessed to be unlikely (Fisheries New Zealand 2018). In New Zealand waters kingfish is mostly taken as bycatch while fishing for other species (Fisheries New Zealand 2018). Recreational catches in Australia and New Zealand comprise a significant proportion of overall catches.

Next steps for *Hoplostethus atlanticus*

The 2018 SC work plan included the establishment of a sampling plan for *H. atlanticus* to ensure appropriate genetic samples are being collected from deepwater stocks. There were no formal papers submitted on this topic, but it was noted that paper SC6-DW05 included the collection of genetic samples for future analysis. At SC6, Australia summarised discussions to advance this work, which involves applying next generation sequencing and single nucleotide polymorphisms (SNPs) markers to evaluate stock and sub-stock structures. The intention of this work was for genetic samples of *H. atlanticus* to be collected on board New Zealand vessels and sent to the Evolutionary Genetics section, School of Biological Sciences, Victoria University Wellington to undertake SNP analyses. At the time of writing, it is not clear how many SPRFMO samples have been provided.

The work was proposed to be undertaken in collaboration with the Southern Indian Ocean Fisheries Agreement (SIOFA) where there are similar benefits of advancing the delineation of *H. atlanticus* stock structure. A joint analysis will also potentially allow for greater data contrast, which is expected to improve delineation of stocks. The proposed sampling design for the genetic study was to collect 100 random samples per spawning aggregation. Data collection in SIOFA in accordance with the protocol has not progressed as expected.

It is clear that a more structured workplan around *H. atlanticus* stock structure delineation would be beneficial for driving this work.

Future work

The SC is invited to consider candidate species for future stock structure analysis. As noted in the introduction, selection of candidate species should be considered in the context of the management need. If current perceived or actual risks to certain species is low, then management based on effort or catch trigger limits, with the appropriate monitoring and data collection, may be more suitable, cheaper and efficient than stock structure analyses that may inform stock assessment and ultimately development of harvest strategies.

Nonetheless, data collection that could be undertaken relatively cheaply now (e.g. the collection of genetic samples and other biological data) could potentially become more valuable in the future if genetic studies are to be undertaken. Genetics is a rapidly changing field of research and the costs associated with using genetics for stock structure delineation as well as biomass estimation is reducing rapidly.

Recommendations

It is recommended that the SC:

- **Notes** that stock delineation studies would be useful in the short to medium-term for the following species:
    - *Hoplostethus atlanticus* (orange roughy);
    - *Beryx splendens* (splendid alfonsino);

  and **agrees** that a workplan to drive stock structure delineation efforts should be developed for each of these species and presented to SC8 in 2020.
- **Notes** that stock delineation studies could be useful in the medium to longer-term for the following species:
    - *Hyperoglyphe antarctica* (bluenose warehou, bluenose);
    - *Polyprion oxygeneios* and *P. americanus* (hapuku, wreckfish, bass, because these are increasingly targeted instead of bluenose warehou in the New Zealand line fishery);
    - *Nemadactylus macropterus* (tarakihi, jackass morwong);
    - *Seriola lalandi* (yellowtail amberjack, kingfish);
    - Lethrinidae and Etelinae spp. (because these are increasingly targeted in the Australian line fishery);

  and **agrees** that a workplan to drive stock structure delineation efforts for these species should be developed and presented to SC9 in 2021.
- **Agrees** that fish species not included in the above lists are caught in SPRFMO bottom fisheries in such low volumes that stock delineation studies are a very low priority;
- **Agrees** that catches of all species caught in bottom fisheries should be monitored and the priority list should be re-assessed periodically and changed as necessary following any major developments in fishing patterns or knowledge; and
- **Agrees** that the medium-term workplan be modified to reflect any decisions.

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