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Preliminary analysis for estimating size at sexual maturity of Splendid alfonsino (*Beryx Splendens*) in the Emperor seamounts

by

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Introduction

Splendid alfonsino (*Beryx splendens*) is a commercially important fish species in deep-sea fisheries with the wide global distribution from tropical to temperate regions. In the Emperor seamounts areas, it has been exploited as an alternative target species to North Pacific armorhead (*Pentaceros wheeleri*) since the late 1970s and the catch reached over 10,000 tons in the 1980s (Sawada et al. 2018). Although it is still among the most important resource in bottom fisheries in this area, its biological characteristics and life history remain unclear. For the stock assessment, a previous work attempted to apply surplus production models, but resulted in an unreliable estimation partly due to the biased CPUE (Sawada et al. 2018). One of the options to avoid these issues is to adopt life history-based approaches such as YPR (yield per recruit) or SPR (spawning per recruit) models that do not depend on the historical catch data, which require life history information including spawning seasons and the size at maturity. SWG NPA-SA agreed to conduct those approaches as a collaborative work among Members.

This report presents the analyses on the maturity of splendid alfonsino, to illustrate the type of analyses which will be required as a next step of the collaborative work. We analyzed female samples collected by Japanese fishing and research vessels in 2013~2021 to identify the reproductive season by calculating GSI (Gonadsomatic Intex). To estimate the size at maturity, we further conducted a histological analysis of gonads and calculated FL_{50} (folk length at which 50% of the population reaches sexual maturity). Future work will include the data from each country with the aim for more reliable analysis.

Materials and Methods

We analyzed 5264 female samples collected in the Emperor seamounts areas between 2013 and March 2021. The samples consisted of fish collected by onboard scientific observers and scientists on Japanese commercial and research vessels using either bottom trawl, mid-water trawl or gillnet. Those fish were frozen on board and sent to the laboratory for measurement and dissection. Following the measurement of fork length (to the nearest 0.1 mm) and body weight (0.1 g), gonads were sexed and weighed. Ovary samples for histological examination were fixed in Bouin's solution for ca. 24 hours and then preserved in 70% ethanol.

To identify the spawning season, we analyzed monthly changes in GSI by the following equation:

$$GSI = {}^{WG}/_{WB} \times 100$$

where WG and WB correspond to the wet weight of fish and gonad, respectively.

We also carried out histological analysis using 179 ovaries collected between March 2016 and October 2021. Those ovaries were embedded in paraffin wax, sectioned in 7-8 µm and stained with hematoxylin and eosin. We characterized the gonad development to determine the different maturity stages according to the criteria developed by Lehodey et al. (1997). Maturity stages used in this study are the following seven categories: A; Chromatin nucleolus, B; Peri nucleolus, C; Yolk vesicle, D; Early yolk", E; Late yolk, F; Maturation, G; Spawning. As the monthly GSI change analysis indicated that the spawning season of this species ranges between April and October, only fish collected during the season were included in the following analysis, resulting in a sample size of 151. To examine the relationship between the proportion of matured fish and folk length, we used a logistic regression model and obtained the value of FL_{50} from the model, using R version 4.0.5 (R Core Team 2021). In this analysis, stages D-G were considered as matured.

Results and Discussion

We observed an increase in the variation of GSI in fish over the size at which an individual potentially acquires reproductive activity (Fig. 1) due to the correlation between GSI values and changes in maturity stages. Since no fish smaller than 247.6 mm were in D or more advanced stages, we excluded individuals smaller than this size from the analyses of spawning season.

The analysis of monthly change in GSI indicated the lower values in January and February and an increase in the variation from March with the peak in August (Fig. 2). However, we could not identify the distinct reproductive season because it showed the highest median in March following the decline in May.

For more detailed descriptions of the seasonal change in maturity stages, we examined the monthly development of gonads (Fig. 3). Stages E and F were observed only in April and October, and the proportion of matured individuals (among ones > 247.6 mm) was relatively higher in April and October, too. However, it is worth noting that some fish at stage G (spawning) were found in July and September.

Based on the above result, we estimated that *B. splendens* in the Emperor seamounts has its breeding season from April to October. The indistinct monthly change in GSI and the small sample size for histological analysis of gonads, however, made it difficult to specify accurately. The spawning season of *B. splendens* varies among populations. Lehodey et al. (1997) investigated the monthly change in GSI for the population of *B. Splendens* in New Caledonia and concluded that the population begins to sexually mature in September and spawns between November and February, which corresponds to austral summer. In contrast, the population in Juan Fernandez Archipelago in Chile has its breeding season in winter (Flores et al., 2012). This difference in reproductive strategy can be attributed to different environmental characteristics, and yet the underlying mechanism remains unknown

Our logistic regression model estimated the FL_{50} as 339.7 mm. Although this estimate falls within the range of the previously reported values (Table 1), this estimate is still unreliable given the uncertainty in the GSI analysis and the small sample size for histological analysis of gonads. Therefore, the value cannot be used for management purposes at this point.

In summary, our results currently include a considerable amount of uncertainty, in both spawning seasons and size at maturity. However, this analysis provides a basis for the further work which will be conducted collaboratively. The results will hopefully be improved by the inclusion of data from other Members, as well as additional examinations of alfonsino gonads.

Acknowledgement

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References

Flores, A., Wiff, R., Gálvez, P., Díaz, E., 2012. Reproductive biology of alfonsino *Beryx splendens*. J. Fish Biol. 81, 1375–1390. https://doi.org/10.1111/j.1095-8649.2012.03424.x

Lehodey, P., Grandperrin, R., and Marchal, P., 1997. Reproductive biology and ecology of a deep-demersal fish, alfonsino *Beryx splendens* over the seamounts off New

Caledonia. Mar. Biol.
R Core Team 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.
Shotton, R., 2016. Global review of Alfonsino (*Beryx* spp.) their fisheries, biology, and management. Food Agric. Organ. United Nations 1084, 161.
Sawada, K., Nishida, K., Yonezaki, S. and Kiyota, M. 2018. Review of biology and fisheries of splendid alfonsino *Beryx splendens*, especially in the Emperor seamounts area. NPFC-2018-SSCBF01-WP03. 26 pp.

Table 1. Estimations of *FL50* for *B. Splendens* by previous studies (modified from Shotton, 2016)

Source	Size (mm)	Comment
Azores Pereira & Pinho (2012)	355	Azores
Azores González *et al.* (2003)	230	"Length at maturity"
Canary Islands González *et al.* (2003)	313	"Length at maturity"
Madeira González *et al.* (2003)	346	"Length at maturity"
Lehodey *et al.* (1977) New Caledonia	332	
Guerrero & Arana (2009)	331	October 2001 to May 2003, logistic fit based on macroscopic analysis
Flores *et al.* (2012) Chile	369	January 2006 to October 2009. Logistic fit. Macroscopic analysis.
Flores *et al.* (2012) Chile	437	May to December 2001; logistic fit, histological examination
Gili *et al.* (2002) Chile	404	November; logistic fit; histological examination

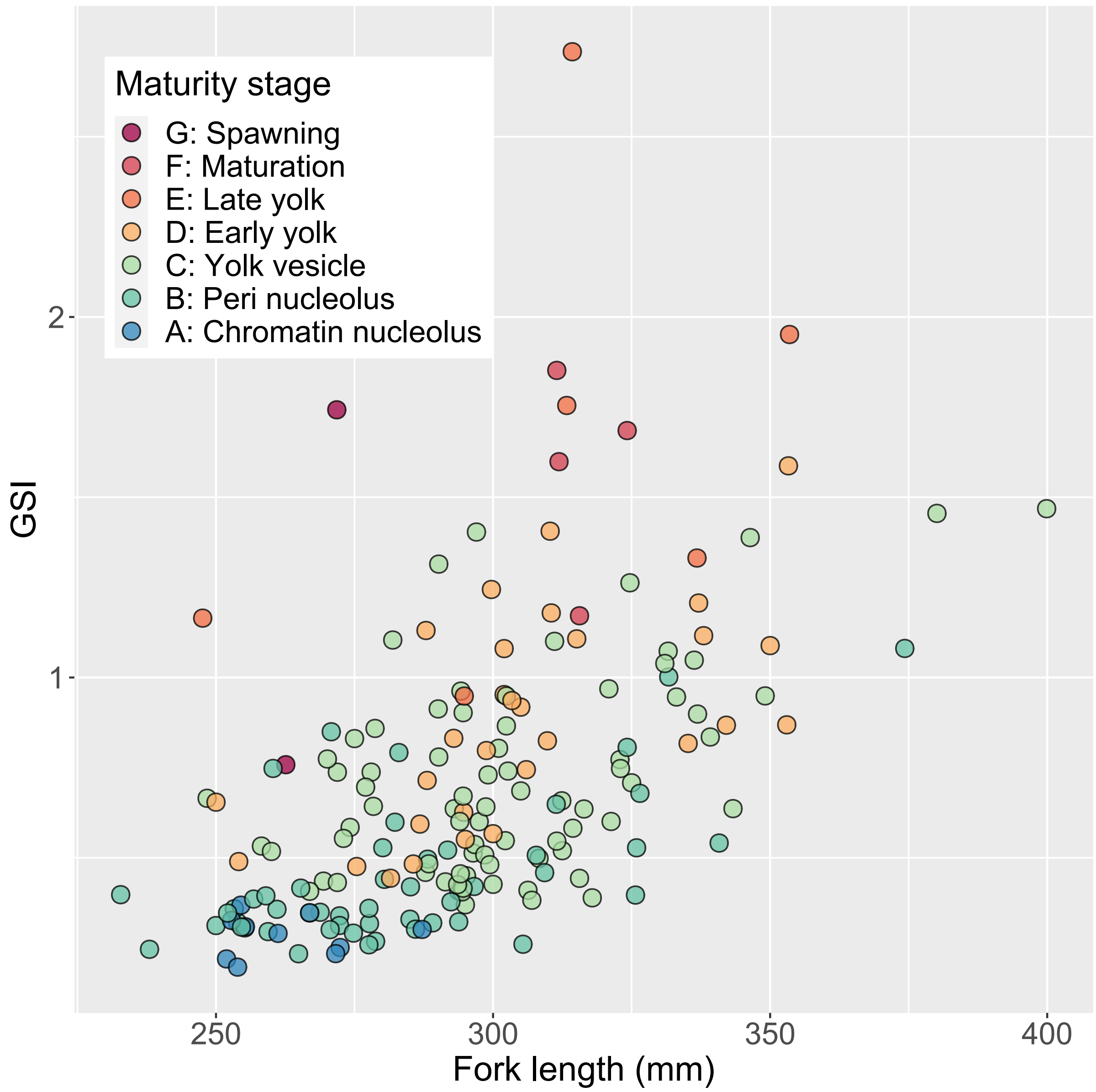

Fig. 1. Relationship between GSI and folk length of *B. splendens* shown by different maturity stages.

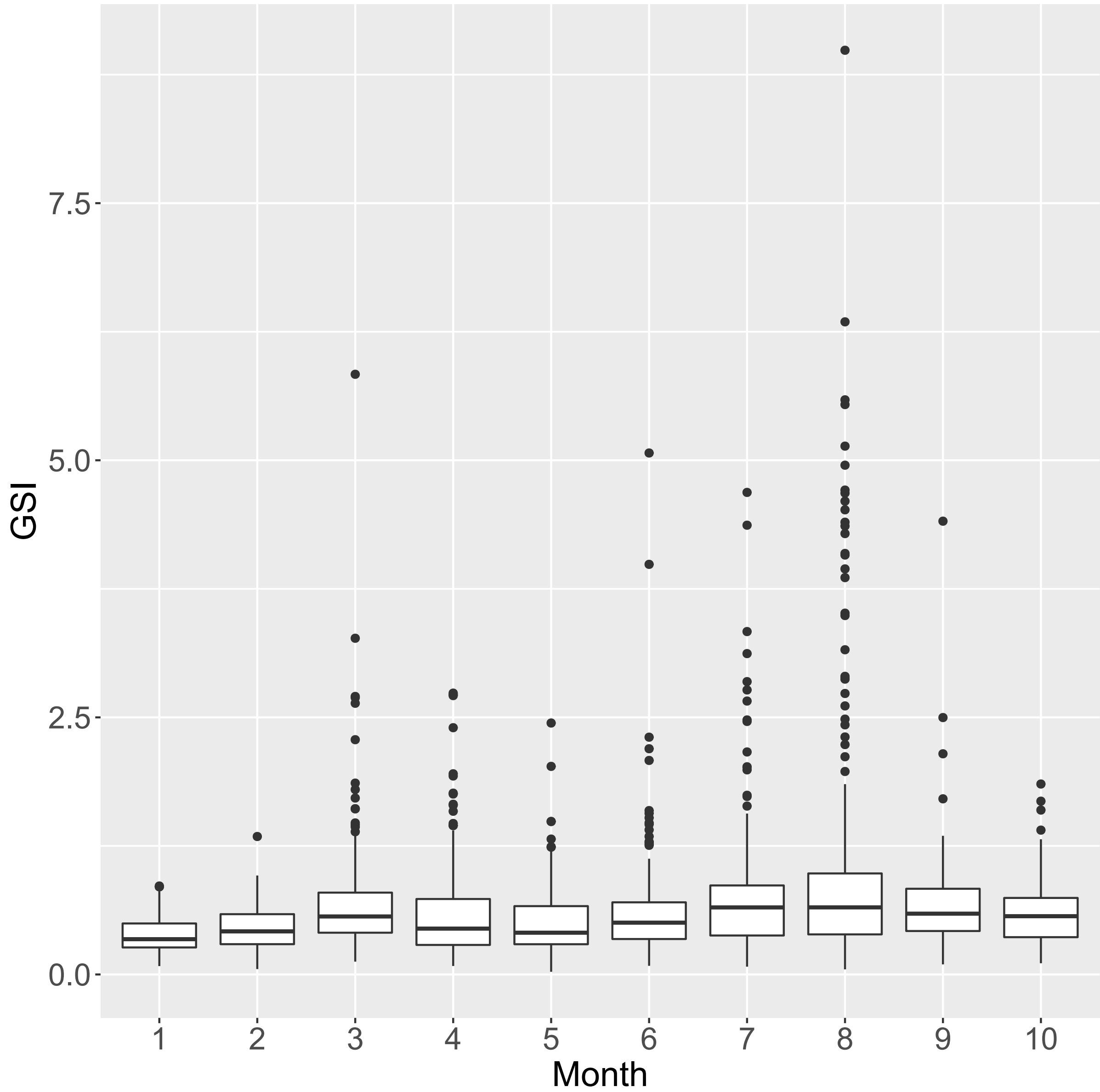

Fig. 2. Monthly change in GSI of *B. splendens*.

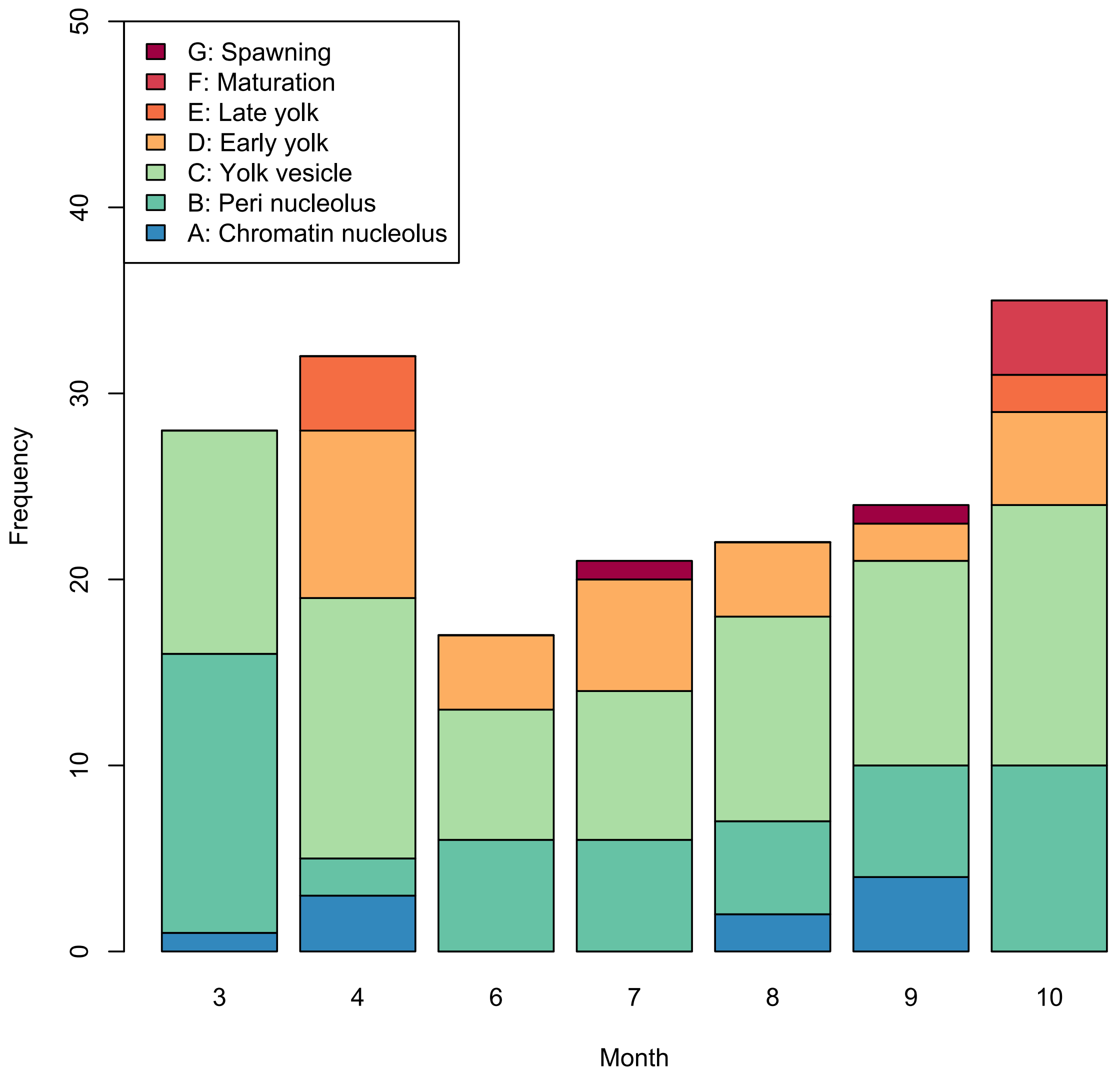

Fig. 3. Monthly gonad development of *B. splendens*.

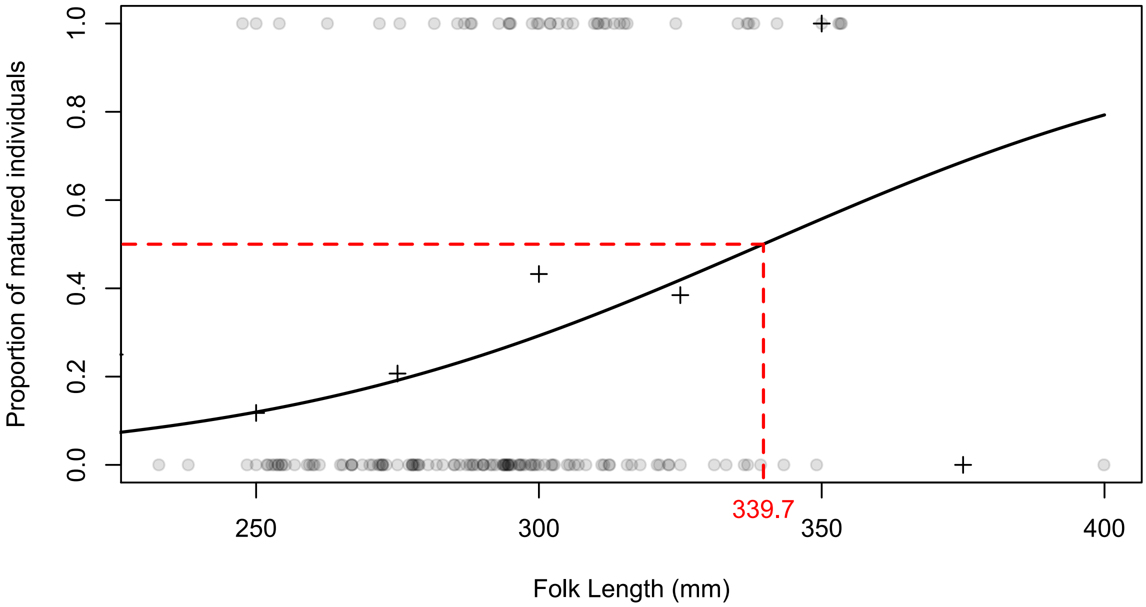

Fig. 4. Fitted logistic regression for the proportion of mature *B. splendens* by folk length. Grey points show the dummy values for maturity that represents “0: Immature” or “1: Mature”. Plus sings represent the proportion mature for each 25-mm length bin. Red dotted line indicates the folk length where 50% of the population reaches sexual maturity (FL_{50}).