The Influence of Uncertainty in Life History Parameters on the Estimation of Status Using Low-data Assessment Methods

La Influencia de la Incertidumbre en los Parámetros de la Historia de la Vida sobre la Estimación de Estado Mediante los Métodos de Evaluación de Baja los Datos

L'influence de L'incertitude dans les Paramètres du Cycle de Vie sur l'estimation de L'état en Utilisant des Méthodes d'évaluation Faible de Données

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EXTENDED ABSTRACT

Many methods for low-data assessment of fishery status require information on life history parameters such as longevity, size at maturity, asymptotic length and growth rate (Cope and Punt 2009, Ehrhardt and Ault 1992, Froese 2004). For reef fish in the Caribbean, these parameters may vary greatly between studies (Figure 1). Generally, when low-data methods are used, life history parameters are taken from the literature, although the reported values may be from locations far from the fishery being assessed. Even within the same country or region of the Caribbean, growth and other parameters may vary depending on habitat characteristics or level of exploitation. Also, correlations between parameters, such as growth rates and mortality rates, may not be considered. Uncertainty in life history parameters is therefore a major source of uncertainty in low-data assessment.

We used a Monte Carlo method to evaluate the implications of parameter uncertainty and correlation between parameter values when using length-based methods to infer status for the spear gun fishery at Glover's Reef, Belize (Babcock et al. 2013). The range of values of the life history values were taken from published studies, or inferred based on relationships between life history parameters (Froese and Binohlan 2000). Indicators such as the fraction of the catch that was above the length at maturity could be quite variable if parameter uncertainty was considered (Figure 2). Nevertheless, despite a large range of parameter uncertainty, the length-based methods were able to infer that black grouper *Mycteroperca bonaci* was overfished, Nassau grouper *Epinephelus striatus*, schoolmaster snapper *Lutjanus apodus* and mutton snapper *Lutjanus analis* were probably overfished, and hogfish *Lachnolaimus maximus*, stoplight parrotfish *Sparisoma viride*, French angelfish *Pomacanthus paru* and gray angelfish *Pomacanthus arcuatus* were probably not overfished. All species except French angelfish were experiencing overfishing across a range of life history parameters. Of the estimated fishery metrics, fishing mortality rate (F) inferred from average length was the most dependent on the life history parameters; F varied from below the natural mortality rate (M) to several times higher depending on the assumed values of M and the growth parameters.

Incorporating parameter uncertainty through Monte Carlo simulation allowed us to quantify the uncertainty in the inferred status of the species. Such methods should be routinely used in low data assessment. For some species such as the angelfishes, the range of possible values of the life history parameters was limited by the small number of available studies. For those species, the true uncertainty in status is probably greater than our estimates. Given that uncertainty in life history parameters is a major source of uncertainty in low-data assessment, studies of basic life history such as growth and length at maturity should be a priority. Such studies are particularly important in the Western Caribbean, where few studies are available.

KEY WORDS: Length-based assessment, Low-data assessment, Monte Carlo simulation, Belize

LITERATURE CITED

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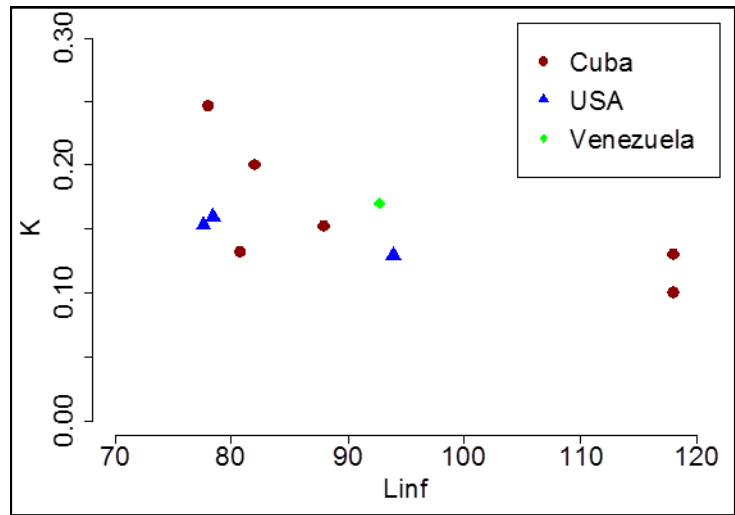Froese, R. and D. Pauly. 2013. *FishBase*. World Wide Web electronic publication.

Figure 1. Estimates of asymptotic length (Linf) and growth rate (K) for mutton snapper (*Lutjanus analis*) vary across the Caribbean (Froese and Pauly 2013).
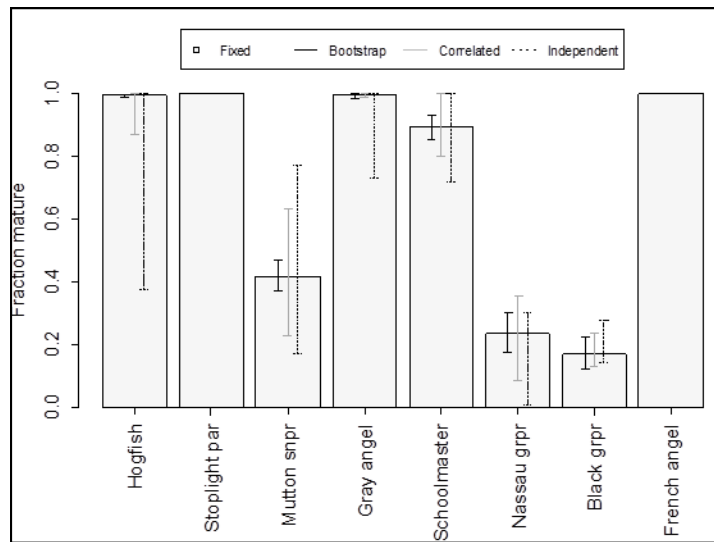

Figure 2. Fraction mature in the catch from the speargun fishery at Glover's Reef Marine Reserve, with alternative treatments of parameter uncertainty (Babcock et al. 2013).