Recovery of Nassau Grouper in the Cayman Islands: Predicting Future Population Levels

Recuperación del Nassau Grouper en las Islas Caimán : La Predicción de los Niveles Futuros de Población

Récupération de Nassau Grouper dans les Îles Caïmans : Prédire les Niveaux Futurs de la Population

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EXTENDED ABSTRACT

Introduction

Species which form aggregations to spawn, such as Nassau Grouper (*Epinephelus striatus*), are easily depleted by harvest during spawning (Sala et al. 2001). As such, many management agencies have adopted management actions to temper over-fishing, including: closures during spawning periods, marine protected areas at aggregation sites, and even complete elimination of harvest (Sadovy and Eklund 1999). In many cases these management actions occur after the population is seriously depleted. The challenge in assessing the effectiveness of such management thus lies largely in the development of accurate estimates of stock size and changes through time, as well as appropriate strategy evaluation.

Nassau Grouper stocks have declined precipitously through most of their range over the last several decades, prompting listing of the species as endangered under the IUCN Red List (Cornish and Eklund 2003). Nassau Grouper form large reproductive aggregations at highly predictable times and locations throughout their range (Colin 1992). In some instances, Nassau Grouper will swim hundreds of kilometers to attend these aggregations on an annual basis (Bolden 2000). Once aggregations of the species are discovered, they are typically fished intensively each winter; many such aggregations have ultimately been fished to the point where fish apparently cease to aggregate (e.g., Sadovy and Colin 2012). In places where management actions have taken place or are proposed, in order to assess the adequacy and effectiveness of these protections, managers require accurate estimates of regional population abundance through time. However, because the species is typically uncommon on home reefs (particularly in areas where over-fishing has occurred), traditional abundance assessment methods such as transect surveys are not effective.

Methods

We use data from a nine year *in situ* visual mark-resight study to estimate the total abundance of spawners at an aggregation site across years and use this to model population growth. This is done using a Bayesian state space model. We investigated a variant of the base model that allows for a surveyor specific effect, i.e., some surveyors see more or less tags than others. Using posterior estimates of the mean population growth rate, this method allows us to assess future population status under various harvest levels. This method also allows us to investigate how long it will take the population to recover to its "original" size at discovery in 2001, prior to fishing. We can use the length distributions from a video laser caliper study (Heppell et al. 2012) and a length-weight relationship ($W = 0.0107L^{3.112}$, Thompson and Munro 1978) to convert numbers to biomass and subsequently model biomass change through time.

Results and Conclusions

Our results show that the Nassau Grouper spawning aggregation population on Little Cayman is increasing through time, but as of 2016, has still not reached the 2001 population size of 8,000 fish (Figure 1). Using the median posterior estimate of the mean population growth rate of 12.33% per year, we estimate it will take an additional 6 years to reach this number (Figure 2). Our results further indicate that the Little Cayman population experiences recruitment pulses, not constant yearly recruitment, suggesting management strategies should investigate the frequency and magnitude of recruitment pulses before assessing the effectiveness of protections.

KEYWORDS: Nassau Grouper, spawning aggregation prediction, population estimation, management strategy evaluation

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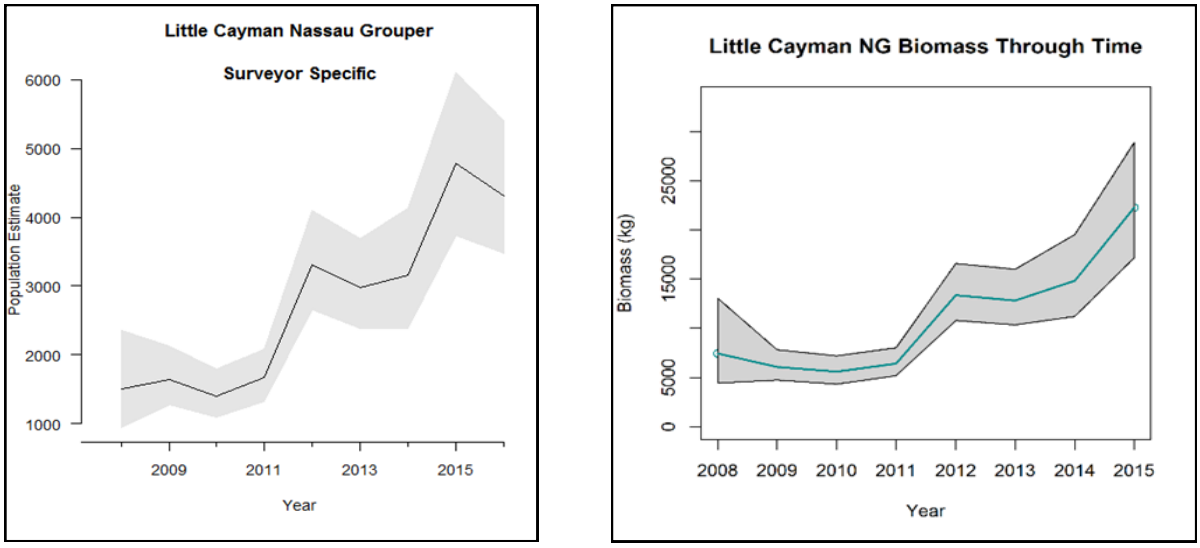

Figure 1. Estimates of population size in terms of numbers (left panel) and biomass (kg; right panel) of adult Nassau Grouper on Little Cayman Island from the mark-resight model with surveyor effect. In both panels the line is the median posterior estimate and the grey shaded area is the 95% Bayesian credible interval.

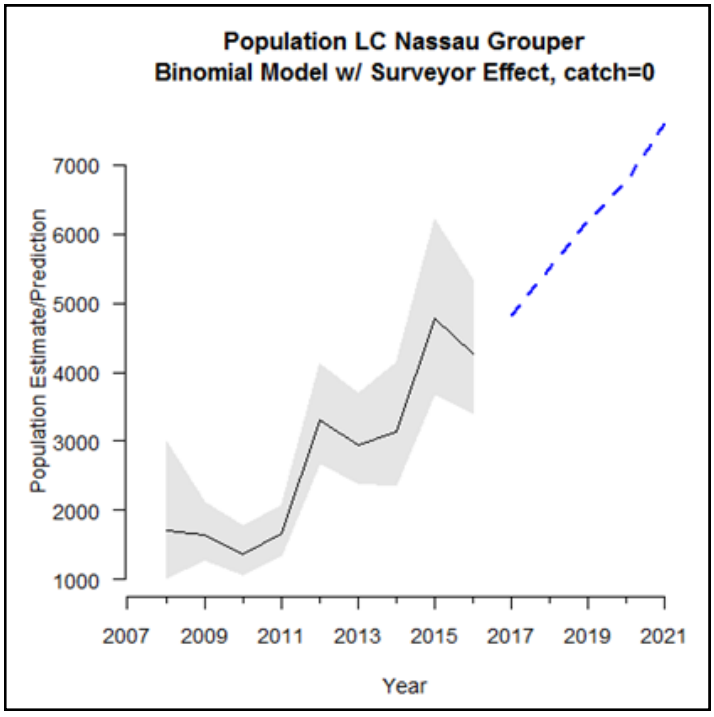

Figure 2. Future predictions of population size of Little Cayman Nassau Grouper, using the median posterior mean growth rate from the state space model.