

**Comparative demography and assemblage structure
of serranid fishes: implications for conservation and
fisheries management**

Thesis submitted by

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Abstract

This thesis examined the biology of some commercially exploited reef fishes with a view to better understanding their life histories and potential vulnerability to fishing or other threats. The focus of this research was comparative age-based demographics of tropical epinepheline serranids (or groupers) from two geographic areas: Australia's Great Barrier Reef (GBR) in the western Pacific; and the Seychelles Islands in the western Indian Ocean. The overall aim was to investigate age-based demographics and assemblage structure of tropical epinepheline serranids at multiple scales.

The epinepheline fauna in the study areas was partitioned for some analyses into three behavioural groupings based on foraging pattern, crypticity and body size. The behavioural groups are *cryptic serranids*, *roving serranids*, and *large mobile serranids* (Chapter 1). Less is known about cryptic and large mobile serranids than roving serranids in the study areas, so candidate species from those two groups were the focus of the detailed age-based demographic analyses.

A comprehensive account of epinepheline assemblages from the GBR and the Seychelles was presented (Chapter 3) using a modified visual survey technique tailored to epinepheline serranids (Chapter 2). I described and compared characteristics of epinepheline serranid faunas at a range of spatial scales from <1 to 1000's km along natural environmental and geographic gradients on the GBR and the Seychelles Islands, and provided abundance estimates for all three behavioural groups and for the almost 40 species they represent. The typical shallow-water, tropical epinepheline assemblages comprised a handful of abundant species from the cryptic or roving serranid behavioural groups, plus numerous species found only in low densities locally (i.e. rare species, less than 1 fish per 1000 m²) from each behavioural group. All five characteristics used to describe assemblage structure (i.e. total density of epinepheline serranids; density of each behavioural group; species richness; size structure; and species distribution and abundance) varied at broad spatial scales (100's to 1000's km) and some at finer spatial scales (1 to 100 km). Three approaches were used to explore possible effects of fishing on densities: 1) incorporating the CRC Reef Research Centre's Effects of Line Fishing Experiment treatments, manipulating fishing level and Marine Park zone status for GBR reefs, into the GBR regional comparison; 2) comparing reefs open and closed to fishing for Lizard outer shelf reefs; and 3) exploring abundance patterns in relation to presumed gradients of historical fishing pressure. Each approach indicated some effects of fishing on epinepheline serranids, but patterns were complex.

Comparative demographic analyses were conducted for three species of cryptic serranids, *E. fasciatus* (blacktip grouper), *E. polyphkadion* (camouflage grouper) and *C. argus* (peacock grouper), from the GBR and the Seychelles based on age estimates derived from thin-sectioned otoliths (Chapter 4). I described size and age characteristics, longevity, and patterns of growth for each species, and explored broad-scale spatial patterns in demography and the nature of size-age-density relationships for each species in the GBR and the Seychelles. Comparative analyses revealed substantial spatial variation in demographics within and among species. Hence, our ability to generalise about the demography of the cryptic serranids appears to be limited. Linking information on abundance and demography revealed that different combinations of processes may influence local populations of the three species, with the possibility of broad-scale compensatory demographic trade-offs dependent on density noted for two of the three species. Further, lifespans tended to be shorter in the Seychelles than the GBR, suggesting higher recruitment levels and predictability of environmental conditions and resources in the Seychelles than the GBR.

I investigated age-specific demographic and reproductive characteristics of *E. fuscoguttatus* from the GBR and examined implications for resource management (Chapters 5 & 6). *Epinephelus fuscoguttatus* (brown-marbled grouper or flowery cod) is an example of a large mobile serranid that is widespread throughout the Indo-Pacific and features strongly in the live reef food fish trade and other reef fisheries. *E. fuscoguttatus* had an extended lifespan (42 yrs) and unusual reproductive ecology, such as large old females with a reproductive lifespan that may exceed 30 yrs and limited spawning in smaller, younger females until about 9 yrs and 566 mm FL. The spawning period of *E. fuscoguttatus* in the GBR was relatively narrow (November, December and January). Combined evidence from histological analyses and age-based demographics suggested monandric protogynous hermaphroditism, although confirmation awaits direct evidence of sex change, such as identification of transitional individuals.

The two biogeographic-scale studies (Chapters 3 & 4) provided support for the idea that there are fundamental differences in the ecology and population dynamics of reef fish assemblages over biogeographic scales. The contribution of fishing to the observed patterns could not, however, be resolved categorically. While the four aged serranids shared some characteristics associated with high vulnerability to fishing, e.g. relatively slow growth and moderate to long lifespans (20 – 40 yrs), differences among them in abundance, demography and body size, and perhaps in population dynamics, suggested vulnerabilities to fishing may vary. We still lack information on many Indo-Pacific species of epinepheline serranids, and this thesis indicates at least some of these, particularly larger bodied species, may be highly vulnerable to over-fishing or other threats.

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Statement of sources

Declaration

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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