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Population biology, dynamics and their
implications for management of red bass:

a large, long-lived reef fish.

Thesis submitted by

Ross James MARRIOTT B.Sc. (Masters Qual.)
in March 2005

for the degree of Doctor of Philosophy
in Marine Biology
within the School of Marine Biology and Aquaculture
James Cook University
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Abstract

The red bass, *Lutjanus bohar* (Forsskal 1775), is a large tropical reef fish that has a widespread circum-tropical distribution (Allen 1985). Preliminary research (Marriott 2002) done prior to this thesis identified that this species was potentially long-lived and slow-growing. Knowing this, the harvest of *L. bohar* by commercial fisheries is a cause for concern because populations of long-lived, slow growing species are typically more vulnerable to overfishing (e.g. Adams 1980; Musick 1999). This issue was investigated by addressing the following research objectives: (i) to investigate aspects of the population biology of *L. bohar*; (ii) to explore potential impacts of fishing on growth, size, and age structure of an exploited *L. bohar* population; and (iii) to explore the vulnerability of *L. bohar* populations to overfishing using an age-structured model and simulations.

Detailed studies of the population biology of *L. bohar* on the Great Barrier Reef provided support for the accuracy of initial estimates of age, and statistically justified a method of accepting estimates of age from repeated readings of otolith sections. The initial indication of relatively slow growth for this species was supported and the fit of the von Bertalanffy growth function (fork length-at-age) to samples from Lizard Island Region was: \[ L_t = 649.8 (1 - \exp\{-0.093[t+2.500]\}) \], with no detectable difference in growth between sexes. Sexual maturity was found to be reached relatively late in life, compared to other reef fish, with the length at 50% maturity (*L*50) for females observed at 428.96 mm and the age at 50% maturity (*a*50) at 9.39 years. The *L*50 and *a*50 for males could not be resolved but were indicated to be at a much smaller size and younger age than those observed for females. Oocyte development was asynchronous and ripe.
females were sampled in 8 months of the year, indicating that *L. bohar* spawned multiple times over a protracted period during each year, over a long reproductive life. Estimates of batch fecundity were also relatively high, ranging from $1.02 \times 10^3$ to $3.13 \times 10^6$ eggs, and an exponential relationship with fish weight was indicated. All of these characteristics are consistent with a theoretical $K$-selected life history strategy, and one which is typically vulnerable to overfishing.

Comparisons of size and age structures sampled from regions of different historical fishing pressure in the Seychelles, where *L. bohar* is a major component of the fishery, indicated a top-down size-selective fishing impact in the historically harvested region. Interestingly, a larger length-at-age for older age groups was also observed for this region, which was atypical of a fishing impact. Predictions made using an age-structured stock assessment model and data of its historical harvest indicated that these differences in growth were not likely due to historical differences in fishing but to other region-specific factors. The age-structured modelling also facilitated the exploration of the fished population’s vulnerability to overfishing and identified the potential importance of an inferred reduced availability to harvest of older age groups to its persistence, at least in the short term.

Results from this thesis have important implications for fisheries management. My results are applicable to managing the harvest of *L. bohar* in the Seychelles and the by-catch of *L. bohar* on the Great Barrier Reef where it has recently become a “no take” species. Issues identified for *L. bohar* could also be transferred to the harvest of other exploited species with similar life history characteristics, such as the red emperor (*Lutjanus sebae*) and mangrove jack (*L. argentimaculatus*), which are targeted by
commercial and recreational line fishers on the Great Barrier Reef. This thesis also builds on developing theory concerning the impacts of fishing on species with different life history characteristics because *L. bohar* is an exploited species that is at one end of a theoretical continuum of life history strategies.

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Table of Contents

Abstract ........................................................................................................................................ 3
Acknowledgements ...................................................................................................................... 5
List of illustrations and diagrams .............................................................................................. 10
Statement on Sources/Electronic Copy Declaration ................................................................. 13

Chapter 1: General Introduction ............................................................................................. 14
  1.1. The issue ....................................................................................................................... 14
  1.2. Fish biology, population dynamics, and life history theory ......................................... 15
  1.3. The impacts of fishing ................................................................................................ 17
  1.4. The Study Species ....................................................................................................... 21
  1.5. Thesis Objectives ......................................................................................................... 23
  1.6. Rationale ...................................................................................................................... 24

Chapter 2: General sampling methods .................................................................................... 25
  2.1. Study Sites .................................................................................................................. 25
      2.1.1. Great Barrier Reef ............................................................................................... 25
      2.1.2. Seychelles ........................................................................................................ 27
  2.2. General sampling methods ......................................................................................... 29
      2.2.1. CRC Reef ELF Experiment catch surveys ....................................................... 29
      2.2.2. Catch samples from the CRFFF ....................................................................... 33
      2.2.3. Catch samples from the Seychelles ................................................................. 34
      2.2.4. Supplementary spear-fishing ........................................................................... 35

Chapter 3: Criteria for age estimation ...................................................................................... 37
  3.1. Introduction .................................................................................................................. 37
  3.2. Theoretical Framework ............................................................................................... 39
  3.3. Methods ...................................................................................................................... 43
      3.3.1. Sample collection .............................................................................................. 43
      3.3.2. Sample processing and age estimation ............................................................. 43
      3.3.3. Accuracy of Age Estimates – Increment Periodicity ....................................... 45
      3.3.4. Agreement and Precision of Repeated Age Estimates .................................... 50
      3.3.5. Trends in inter-read discrepancy with nominal age ....................................... 53
  3.4. Results ......................................................................................................................... 54
      3.4.1. Accuracy of age estimates ............................................................................... 54
      3.4.2. Precision: Influence of Geographic Area and Preparation Method ............... 61
      3.4.3. Trends in the proportion of agreement with nominal age ............................... 63
      3.4.4. Trends in inter-read discrepancy with nominal age ....................................... 66
  3.5. Discussion .................................................................................................................... 70
      3.5.1. Accuracy of age estimates ............................................................................... 70
      3.5.2. Percentage of Disagreements with Putative age ............................................. 71
Chapter 4: Age-growth characteristics and within-Region effects. 79
4.1. Introduction.......................... 79
4.2. Methods. .............................. 81
  4.2.1. Sample and data collection. 81
  4.2.2. Analyses: age and size of *L. bohar*. 84
  4.2.3. Analyses: Growth. 87
  4.2.4. Analyses: Mortality estimation. 91
4.3 Results.................................. 92
  4.3.1. Samples collected by different methods. 92
  4.3.2. Age.................................. 94
  4.3.3. Fork length........................ 103
  4.3.3. Growth............................. 112
  4.3.4. Mortality. .......................... 122
4.4 Discussion.............................. 123
  4.4.1. Within-Region effects. 124
  4.4.2. Age-growth characteristics of *L. bohar*. 130
  4.4.3. Conclusion......................... 134

Chapter 5: Geographic, regional, and temporal variation in age-growth characteristics. 136
5.1. Introduction.......................... 136
5.2 Methods. ................................ 139
  5.2.1. Sample and data collection. 139
  5.2.2. General analysis framework. 141
  5.2.3. Analyses: Comparing sampled age and length data. 145
  5.2.4. Analyses: Comparing growth. 147
5.3 Results.................................. 148
  5.3.1. Age and length.................... 148
  5.3.2. Growth............................. 164
5.4. Discussion.............................. 176
  5.4.1. Spatiotemporal variability and implications for the “mensurative experiment.” 177
  5.4.2. Inferred fishing impacts........ 182
  5.4.3. Conclusions......................... 185

Chapter 6: Reproductive parameters of GBR populations. 187
6.1. Introduction.......................... 187
6.2 Methods ................................ 189
  6.2.1 Preparations for age and maturity estimation. 189
  6.2.2. Batch fecundity estimation 194
  6.2.3. Analyses............................. 197
6.3 Results.................................. 199
List of illustrations and diagrams

Figure 1.1. Global distribution of Lutjanus bohar.................................................................21
Figure 2.1. The Great Barrier Reef.......................................................................................26
Figure 2.2. The Seychelles Exclusive Economic Zone........................................................28
Figure 2.3. Geographic Areas and Study Regions sampled..................................................28
Figure 2.4. Reefs sampled in GBR regions..........................................................................30
Figure 2.5. Sampling locations in the Seychelles...................................................................36
Figure 3.1. (a) Expected patterns in inter-read discrepancy with increasing fish age for 3 alternative hypotheses.................................................................40
Figure 3.2. Whole otolith with reading axis and opaque increments counted for age estimation....................................................................................................................43
Figure 3.3. Transverse section of otolith with reading axis and opaque increments (annuli) counted for age estimation.................................................................43
Figure 3.4. Temperature readings from aquarium used for OTC experiment......................45
Figure 3.5. Penultimate cycle width (solid arrow) and marginal increment width (transparent arrow) as measured on otolith sections for the marginal increment analysis.................49
Figure 3.6. Penultimate increment widths as measured along the ventral sulcus.................50
Figure 3.7. Position of opaque increments (a) and oxytetracycline (OTC) band (b) of a 447 mm FL individual estimated to be nominally 5 years of age........................................56
Figure 3.8. Position of oxytetracycline (OTC) band on the otolith section of a 650 mm FL individual estimated to be nominally 29 years of age..................................................57
Figure 3.9. Marginal Increment Analyses...........................................................................58
Figure 3.10. Edge analysis of otoliths from the GBR and Seychelles....................................59
Figure 3.11. Model II regression of otolith weight on age for L. bohar from different areas.........................................................................................................................60
Figure 3.12. Age bias plot comparing nominal age estimates derived from whole and sectioned otoliths.................................................................................................................61
Figure 3.13. Transverse sections from each area prepared by each method.........................62
Figure 3.14. Fit of the "p constant" model to observed percentage of disagreed ages (PD) per nominal age (t)..............................................................................................................65
Figure 3.15. Estimated marginal means of mean inter-read discrepancies observed per nominal age bin from main effects model ANCOVA.................................................................67
Figure 3.16. Fit of the linear model to observed mean inter-read discrepancy (IRD) with nominal fish age (t).................................................................................................................68
Figure 3.17. Standard error of inter-read discrepancies (IRD), indicating the precision of calculated mean IRD for each nominal age group (t)..................................................69
Figure 3.18. Mean of observed variances of age estimates among readings for nominal age groups.................................................................................................................................70
Figure 4.1. Microincrement structure of the transverse section of a sagittal L. bohar otolith.................................................................................................................................83
Figure 4.2. Length frequency distributions from using different sampling methods. ...............93
Figure 4.3. Mean age.............................................................................................................95
Figure 4.4. Age frequencies sampled from each zone............................................................98
Figure 4.5. Age frequencies sampled each year.....................................................................99
Figure 4.6. Sex-specific age frequency distributions.............................................................101
Figure 4.7. Comparison of sampled age frequency distributions of L. bohar between zones in 2003.......................................................................................................................103
Figure 4.8. Mean fork length............................................................................................104
Figure 7.2  Intervals between expected lengths from the von Bertalanffy function used to convert catch-at-length categories to catch-at-age. ................................................................. 227

Figure 7.3  Assumed functional relationship between depletion in population density of *L. bohar* due to fishing and increase in as a density-dependent growth response. ............. 234

Figure 7.4  Catch-curve analysis of observed catch-at-age, 1994. ............................................. 243

Figure 7.5.  Selectivity function fitted to selectivity calculated from observed catch-at-age (1994). .................................................................................................................... 244

Figure 7.6  Residual plots of lognormal errors of catch-at-age (*Ca*, 1994) from fit of the model (a) without and (b) with an availability parameter for age groups 22 to 25yr and the 26+ group ........................................................................................................................................ 245

Figure 7.7.  Frequency distribution of bootstrapped estimates of Relative Depletion for different model scenarios. ........................................................................................................ 249

Figure 7.8.  Frequency distribution of bootstrapped estimates of Relative Depletion for different model scenarios, *P* constrained. .......................................................................................... 252

Figure 7.9.  Percent depletion in numbers at age to 2003 ................................................................ 253

Figure 7.10. Percent depletion in numbers at age in 2003; *P* constrained. ................................. 254

Figure 7.11. Sensitivity analysis: effects of perturbations of all parameters on *B*0. ................. 258

Figure 7.12. Sensitivity analysis: effects of parameter perturbations, excluding *b* _wt_. ......................................................................................................................................................... 259

Figure 7.13. Projected recovery of *L. bohar* population if fishing were stopped for different model scenarios ........................................................................................................... 260

Figure 7.14. Projected Spawning Stock Biomass each year (SSB_y) with different management strategies. ...................................................................................................................... 261

Figure 8.1.  Relationship of maximum asymptotic length () with maximum estimated age (*t* max). ............................................................................................................................ 276

Figure 8.2. Relationship of Brody growth coefficient (*K*) with maximum estimated age (*t* max) ......................................................................................................................................... 277

Figure 8.3. Relationship of maximum asymptotic length () with estimated age at maturity (*t* _mat_ ) from post-1986 studies of lutjanids. ................................................................. 279

Figure 8.4. Relationship of Brody growth coefficient (*K*) with estimated age at maturity (*t* _mat_ ) from post-1986 studies of lutjanids. ................................................................. 280
STATEMENT ON SOURCES

DECLARATION

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