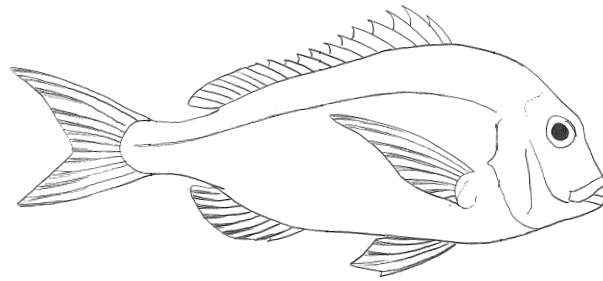


**The reproductive biology and recruitment dynamics of snapper,
*Chrysophrys auratus***



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Table of Contents

<i>Acknowledgements</i>	v
<i>Abstract</i>	vi
<i>Chapter I</i>	1
<i>General Introduction</i>	1
1.1 Recruitment variation in fishes	1
1.2 Thesis	5
1.2.1 Aims and objectives	5
1.2.2 Thesis Structure	6
1.2.3 Notes	7
<i>Chapter II</i>	9
<i>Overview of the study species and region</i>	9
2.1 Snapper (<i>Chrysophrys auratus</i> [Forster 1801])	9
2.1.1 Distribution and Taxonomy	9
2.1.2 General Biology	9
2.1.3 Early-life History	10
2.1.4 Population Structure	10
2.1.5 South Australian Fishery	10
2.2 Study region: northern Spencer Gulf	11
<i>Chapter III</i>	13
<i>Distribution, abundance and early growth of 0+ snapper, <i>Chrysophrys auratus</i>, in northern Spencer Gulf</i>	13
3.1 Introduction	13
3.2 Methods	15
3.2.1 Water Temperature	15
3.2.2 Field Sampling Techniques	15
3.2.3 Laboratory processing techniques	19
3.2.4 Statistical analyses	20
3.3 Results	22
3.3.1 Water temperature	22
3.3.2 Otter Trawls	22
3.3.3 Beam Trawls	29
3.3.4 Growth analysis	31
3.4 Discussion	41
3.4.1 Distribution	41
3.4.3 Growth	44
<i>Chapter IV</i>	47
<i>The spawning dynamics of snapper, <i>Chrysophrys auratus</i>, in northern Spencer Gulf, South Australia: implications for recruitment variability</i>	47
4.1 Introduction	47
4.2 Methods	49
4.2.1 Water temperature	49
4.2.2 Sample collection and processing	49
4.2.3 Laboratory analysis of preserved samples	51
4.2.4 Spawning mode	51

4.2.5 Spawning fraction and spawning frequency	52
4.2.6 Batch fecundity	54
4.3 Results	54
4.3.1 Temperature	54
4.3.2 Microscopic characteristics of ovaries at different stages of development	55
4.3.3 Spawning mode	56
4.3.4 Timing and extent of spawning season	59
4.3.5 Fecundity	67
4.4 Discussion	69
Chapter V	73
<i>The early life history of snapper, <i>Chrysophrys auratus</i>, and the impact of a variable environment on recruitment</i>	73
5.1 Introduction	73
5.2 Methods	76
5.2.1 Water Temperature	76
5.2.2 Field sampling techniques	76
5.2.3 Laboratory processing techniques	76
5.2.4 Otolith preparation	76
5.2.5 Otolith analysis	77
5.2.6 Analyses	77
5.3 Results	79
5.3.1 Water temperature	79
5.3.2 Spawn dates	80
5.3.3 Settlement dates	85
5.3.4 Pre-settlement duration	88
5.4 Discussion	89
5.4.1 Inter-annual recruitment variation	89
5.4.2 Does spawning affect recruitment?	89
5.4.3 Lunar and tidal effects on the timing of spawning and settlement	91
5.4.4 The impact of temperature on recruitment	91
5.4.5 Pre-settlement duration	92
5.4.6 Conclusions	93
Chapter VI	94
<i>The use of food resources by 0+ snapper, <i>Chrysophrys auratus</i>, from northern Spencer Gulf; South Australia</i>	94
6.1 Introduction	94
6.2 Methods	95
6.2.1 Sample collection	95
6.2.2 Laboratory processing	95
6.2.3 Prey identification	96
6.2.4 Data treatment and analysis	96
6.3 Results	98
6.3.1 General information	98
6.3.2 Temporal feeding behaviour	100
6.3.3 Prey assemblage	101
6.4 Discussion	105

Chapter VII	108
<i>The trawl assemblages of northern Spencer Gulf and the associations of 0+ snapper, <i>Chrysophrys auratus</i></i>	108
7.1 Introduction	108
7.2 Methods	110
7.2.1 General	110
7.2.2 Trawl type	110
7.2.3 Species identification and data collection	111
7.2.4 Data treatment and statistical analyses	112
7.3 Results	113
7.3.1 Characteristics of assemblages in northern Spencer Gulf	113
7.3.2 Abundance	113
7.3.3 Biomass	113
7.3.4 Assemblage structure	114
7.4 Discussion	119
7.4.1 Group A and Group B assemblages	119
7.4.2 0+ snapper associations	120
Chapter VIII	122
<i>General Discussion</i>	122
8.1 Rationalisation	122
8.2 Spatial patterns of recruitment	122
8.3 Inter-annual recruitment variation	124
8.3.1 Egg production	124
8.3.2 Mortality in the early life history	125
8.4 Future research	127
8.4.1 Is egg production affected by lunar periodicity?	127
8.4.2 What controls the distribution of 0+ recruits?	128
8.4.3 When is 0+ recruitment strength set?	128
References	130
Appendices	152

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution to Richard James Saunders and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to this copy of my thesis, when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968. I also give permission for the digital version of my thesis to be made available on the web, via the University's digital research repository, the Library catalogue, the Australasian Digital Theses Program (ADTP) and also through web search engines, unless permission has been granted by the University to restrict access for a period of time.

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Abstract

The population dynamics and fishery productivity of snapper, *Chrysophrys auratus*, in South Australia are strongly driven by inter-annual variation in recruitment. This variable recruitment produces the occasional strong year-class which, over a number of years, results in a cycle of increasing and then decreasing biomass. The aim of this study was to develop an understanding of the recruitment dynamics of snapper through a study of the reproductive biology of adults, as well as the biology and ecology of 0+ recruits. Field sampling was done through 2006 to 2008 in northern Spencer Gulf, the region that generally contributes the majority of South Australia's snapper catch.

The recruitment of 0+ snapper was measured from a study of inter- and intra- annual patterns of distribution and abundance. This was done using two independent trawl sampling regimes, one using a beam trawl and the other an otter trawl, at different times in the settlement season. There was considerable inter-annual variation in abundance of 0+ fish of up to two orders of magnitude and, in some years, almost no recruitment was observed. The spatial pattern of dispersion of recruits was clumped and consistent between years; one area, Western Shoal, always produced the highest catches indicating that it is an important nursery.

The effects of the timing of spawning and water temperature on growth patterns of the 0+ snapper collected in the trawl sampling were studied to determine possible impacts on recruitment processes. Growth was studied from age/length regressions and by measuring the widths of micro-increments in the sagittal otoliths. Sub-surface water temperature was also logged in the region. Growth rate varied inter- and intra-annually but was not limited by temperature in the pre-settlement period. However, post-settlement growth rate was significantly correlated with water temperature and fish exhibited a dramatic slowing of growth as temperature declined in autumn. Later spawned fish were considerably smaller than earlier spawned fish of the same age, which may have implications for post-settlement survival.

The reproductive biology of snapper was studied to determine if annual variation in recruitment was related to egg production. Reproductive samples from northern Spencer Gulf were collected over three seasons (2005/06, 2006/07 and 2007/08) and were analysed macro- and microscopically. Spawning activity was determined by calculating estimates of spawning fraction and batch fecundities. The onset of spawning occurred in November but varied between years and corresponded with times when water temperature was between 18 and 20°C. The length of the spawning season also differed between years. In each year the peak spawning activity occurred during December when fish spawned almost daily. Spawning frequency and relative batch size did not differ between the first two spawning seasons but, in the third season, batch size was considerably greater and spawning fraction lower. However, recruitment was considerably more variable than the annual differences in spawning output could explain. This indicates that mortality processes during the planktonic or early post-settlement period are important in the recruitment dynamics of snapper.

The impact of water temperature, lunar cycle and tide on the timing and strength of recruitment was investigated. Pre-settlement duration, spawn dates and settlement dates were determined from the

microstructure of the sagittal otoliths of 0+ snapper. The patterns of successful spawning and settlement were determined by back-calculating to the day on which individual recruits were spawned and settled. The frequency distributions of these dates were compared with water temperature, lunar periodicity and the temporal variation in spawning. There was considerable variation within a season in the timing and magnitude of successful recruitment. Strongest recruitment resulted from spawning during December and January on days when water temperatures were between 21 and 23°C but spawning on days in this range did not necessarily result in recruitment. Pre-settlement duration was unaffected by water temperature. Some evidence of lunar periodicity was detected in both the spawn and settlement date frequencies. Importantly, the spawn date frequency distributions of successful 0+ recruits did not correspond with the measured spawning activity of adults as considerable portions of the spawning season in each year did not produce successful recruits. These results indicated that spawning output and water temperature cannot explain the observed magnitude in recruitment variation.

Food availability for 0+ snapper has been implicated in their patterns of distribution and abundance in New Zealand and Japan. Stomach contents of 0+ snapper were described as an initial step in developing some understanding of the dispersion of 0+ recruits. In spite of their generalist feeding habit, in the area of highest abundance (Western Shoal), snapper took considerably more polychaetes than elsewhere in northern Spencer Gulf. If polychaetes are more abundant at Western Shoal, this could explain the higher density of 0+ snapper there but insufficient information was available on these animals for northern Spencer Gulf to address this hypothesis. Food availability and/or quality may influence the distribution of 0+ recruits.

The multi-species collections from the beam trawls were described to develop an understanding of the spatial dispersion of recruits and their habitat associations. 0+ snapper co-occurred with an assemblage that was characterised by fish and invertebrate species that are associated with mud/soft bottom, but they never occurred with the assemblage of species associated with seagrass, even when recruitment was strongest. This association partly explains the observed distribution pattern, but not all areas of mud/soft bottom had 0+ recruits, even in strong recruitment years. In northern Spencer Gulf, seagrass areas could be excluded from future snapper recruitment surveys.

The recruitment dynamics of snapper in northern Spencer Gulf were characterised by dramatic inter-annual variation but a consistent pattern of dispersion. 0+ snapper were concentrated in a few small areas in northern part of the study region. One of these areas, Western Shoal, appears to be very important as a nursery for snapper. Furthermore, the pattern of 0+ snapper dispersion was independent of recruitment strength. The potential magnitude of 0+ snapper recruitment, set by egg production, was altered by mortality during the early life history. Some of this mortality was related to temperature regimes at the time of spawning but this did not explain all the variation in the magnitude and timing of recruitment. Snapper spawning occurred at times with suitable temperature conditions but recruitment did not always result. This indicates the presence of other factor(s) that have substantial influences on mortality in the early life history.