

The Life History and Stock Assessment of Anchovy, *Engraulis australis*, in South Australia.

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Abstract

The abundance and distribution of small pelagic fish in coastal upwelling systems fluctuate in response to environmental or biotic factors acting on larval stages. Anchovies (*Engraulis spp.*) have evolved flexible adaptive strategies to maximise recruitment in such environments. Spawning usually occurs throughout coastal and shelf regions, however the relative importance of inshore/offshore waters for spawning and the survival of eggs and larvae is poorly understood.

The objectives of this study were to 1-identify the locations, and season, of anchovy (*Engraulis australis*) spawning in South Australia; 2-determine the oceanographic and biotic characteristics (e.g sea-surface temperature and chlorophyll *a* levels,) of gulf and shelf waters during the spawning season of this species, and 3-determine the relative importance of gulf and shelf waters for anchovy spawning and larval recruitment.

Ichthyoplankton and oceanographic surveys encompassing a total of 128,700 km² were conducted and anchovies were captured at locations throughout this area. Anchovy eggs were found throughout gulf and shelf waters, with highest densities recorded in northern areas of Spencer Gulf and Gulf St Vincent where sea surface temperatures (SST) were 24–26°C. Spawning appeared to peak between 0000 and 0100 hours.

Otolith increment counts were used to age larval, juvenile and adult anchovies from both shelf and gulf waters. In the northern Spencer Gulf only smaller, young fish up to 1 year of age occurred, where there were eggs and young larvae (< 10 mm) at high density. These anchovies spawned relatively small batches of eggs (c. 855 per fish) approximately every 3 days over an area of approximately 4,898 km². The daily egg production method (DEPM), used to estimate an adult biomass for the northern Spencer Gulf gave an estimate of 25,374 tonnes.

The southern gulf area was inhabited by 1, 2 and 3 year old fish, whereas over the continental shelf, where upwelling occurs, 3, 4, and 5 year old fish were found. In these cooler, deeper, shelf waters, where the larger, older, anchovies are found, lower egg densities occurred despite individuals producing much larger batches of eggs (ca.

15,572 per fish) approximately every 7 days. In shelf waters, the highest egg densities were recorded at inshore sampling stations. Spawning by older fish took place over a far greater area of ca. 44,618 km² with an estimated adult biomass of 101,522 tonnes. Unlike in the gulf waters, larvae > 10 mm total length (TL) were mainly found with the largest larvae, > 15 mm TL, being collected from shelf waters near up-welling zones where SSTs were relatively low (< 20°C) and levels of chlorophyll a (chl *a*) relatively high. The high levels of larval abundance in the upwelling zones may reflect higher levels of recruitment to later stages in these areas compared with the gulfs.

Gonosomatic indices, together with egg and larval densities, indicated that the peak spawning season was from January to March. This coincided with the enhanced period of productivity in shelf waters due to up-welling events. However, these highly variable environments can be highly dispersive with resulting high egg and larval mortalities and are generally dominated by sardines (*Sardinops spp.*). In addition to the shelf population young fish are also present in the relatively stable gulf environment. This population may act as a reserve of anchovy in South Australia from which the population may expand under favourable conditions. When the population of dominant sardines (*S. sagax*) are reduced, it appears that the subordinate anchovies, represented by older age-classes, are able to utilise offshore environments which may then provide additional spawning and nursery areas for this species.

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 Wetjens Dimmlich 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. The author acknowledges that copyright of published works contained within this thesis (as listed below) resides with the copyright holder(s) of those works.

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