LARVAL FISH ASSEMBLAGES IN THE LOWER RIVER MURRAY, AUSTRALIA: EXAMINING THE INFLUENCE OF HYDROLOGY, HABITAT AND FOOD.

KATHERINE JANE-MAREE CHESHIRE B.Sc (Hons)

Presented for the degree of Doctor of Philosophy.

School of Earth and Environmental Sciences,

University of Adelaide

and

South Australian Research and Development Institute (SARDI),

Aquatic Sciences

June 2010

Frontispiece: The Lower River Murray, Plush's bend boat ramp at sunset (photo courtesy of Matt Pellizzari)

TABLE OF CONTENTS

DECLARATION OF AUTHORSHIP

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 Katherine Jane-Maree Cheshire 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.

KATHERINE JANE-MAREE CHESHIRE

9th June 2010

The Lower River Murray, South Australia (photo courtesy of Kelly Marsland).

ACKNOWLEDGEMENTS

Scholarships were provided through the University of Adelaide and the CSIRO Water for a Healthy Country Flagship. Financial support was provided through SARDI, Aquatic Sciences and the DWLBC, from the CNRM, the MDBC/MDBA, The Living Murray Program, and the SA MDB NRM board. The research was approved by the Animal Ethics Committee of University of Adelaide (RM code: 0000007145).

I would like to extend my most heartfelt thanks to my supervisors Bronwyn Gillanders, Alison King and Qifeng Ye, three of the most incredible people I have had the pleasure of working with. To say thankyou, for all of your dedication, guidance, support, understanding, tolerance, the endless well of enthusiasm and belief in me (even when mine ran out), and for pushing me when I needed it (and I did), seems to be understating it… but, THANK YOU!

There is, as always, a never-ending cast of thousands to thank… so here it goes…

I am indebted to Qifeng and the entire Inland Waters and Catchment Ecology program at SARDI, for the support both financial and emotional. Especially, to Luciana Bucater, Phillipa Wilson, Lesley Alton, Michael Guderian and Matt Pellizzari for their extensive help throughout various stages of the project. Similarly, my gratitude to Neil Wellman, David Short, Simon Westergaard, Michelle Braley, Ruan Gannon and David Fleer for assistance with field work and sorting samples. These people braved searing heat, freezing nights, the occasional storm, kangaroos, flies, bugs, moths, spiders and snakes all the while dealing with thousands of larvae and a pedantic student. Thank you to: Brenton Zampatti and the "Chowilla Crew" for letting me crash at their pad, Russ Shiel for identifying my fish food in the basement of the University of Adelaide, Maylene Loo and Jason Nicol for their advice on various statistical analyses, Suzanne Bennett for her enthusiasm in finding those references I desperately needed yesterday, and to everyone who let me borrow their beautiful photographs.

To "my work friends", who were always so much more than that, (Kelly Marsland, Suse Gehrig, Dale McNeil, Sandra Leigh, Leigh Thwaites, Luciana Bucater and my fellow sufferer Anthony Conallin a.k.a Rex), thanks for being there, and for your friendship, support, experience, willingness to help, question answering, lunch outings and the random moments of laughter and craziness!

To my beautiful ladies (Alys Stevens, Kelly Marsland, Lesley Alton and Suse Gehrig) who crossed the boundaries of "work" and "not work" for the dinners and drinks, for the deep and meaningfuls and existential discussions about science, work, life, love and saving the world. You inspired me to believe that not only could I save the world, but that I could do it with style and sass!

Thankyou to my "not work friends" and "adopted families" (Airlie Holberton, Briony Schadegg, Cathryn Weymouth, Damien Weymouth, Helen & Laurie Schofield, Kim Burton and Steve Arnold) who supported and encouraged me, said nice things, and believed that I could do it. Thanks also to everyone (and there are too many of you to name) who listened to me whinge asked me how it was going and just generally cared about my well being. A special thanks to: Kim, for the consistent support, the chats and boogies, and for always making sure that I had the most spectacular nails the science community has ever seen! and Steve, for the constant stream of support, for ensuring I knew I was not an island and it was an achievement worth making, for recognising how hard it was and for not telling me it'd be alright because I was clever! Big hugs to my little "not work friends" Faith MacKenzie and Katala Arnold – who made me to stop sometimes and smell the roses, watch the clouds float by, eat too many grapes and for asking me to read 'Jane and the Dragon' cause you know it is my favourite…

To the sister of my heart, Cathryn Weymouth, you get an extra special thankyou! So for tolerating my crazy moods, inability to function in the morning and random house wandering in the middle of the night, for turning on the coffee machine every morning, and for your absolute, unconditional, unwavering support, belief, friendship and always being there - I say thank you! And to our furry little friends, Cooper, Delilah and Dougz, for the companionship, unconditional love and making us laugh with their crazy antics every day.

To my family, I cannot thank you enough for everything you have done and continue to do. To David, for volunteering on field trips and sorting the odd sample. To Mum, for proof reading and removing those pesky commas that just seemed to want to be everywhere. To Dad, for giving me the opportunity to discuss any, and all, aspects of my project; and for all your help with everything, from databases and stats, to master documents and formatting. Thanks also to Mum and Dad, for putting me back on my feet, for a house to call my own, for making sure I never doubted I could do this, for calming me down and helping me make it through to the end, and for helping me to get excited and love it again.

~

This thesis is dedicated to my Mum and Dad…

For choosing a life dedicated to science, for inspiring and encouraging my love of science and the environment from a very early age and for the unconditional love and support that is given every day…

~

Chowilla (photo courtesy of Lesley Alton).

ABSTRACT

The major assumption of currently accepted fish recruitment hypotheses (e.g. *flood pulse concept* and *flood recruitment model*) is that in the absence of overbank flows the main river channel does not provide adequate food and habitat for larvae and juveniles. However, periods of low flows are common throughout floodplain rivers, and there are a wide diversity of life history strategies exhibited by riverine fish. Therefore, the broad applicability of these assumptions to the management of all fish species and floodplains rivers has been questioned. The *low flow recruitment hypothesis* pioneered the concept that some fishes can successfully spawn and recruit during low flows by utilising main channel habitats. Characteristics of the river channel, flow regime and level of regulation are often distinctly different both within and between rivers, and many of the recruitment models and indeed the life history strategies of fishes, remain untested in alternative floodplain river systems.

River regulation has resulted in altered flow regimes in river systems throughout the world, and in turn, has a range of negative impacts on the fish populations. The Murray-Darling Basin is Australia's largest river catchment and has been severely affected by river regulation. To test some of the assumptions of the previously described recruitment models larval fish and zooplankton sampling was conducted in the main channel environments of the Lower River Murray, South Australia. In comparison to the rest of the Murray-Darling Basin, the Lower River Murray is unique due to the combination of four distinct geomorphologic regions, the absence of significant tributaries, and the high degree of regulation. Extensive river regulation has drastically reduced the natural flow variability of the Lower River Murray. Furthermore, there has been little work on the spawning and larval assemblages within this region.

Larval fish sampling is often used for studying the early life history of fishes, but sampling gear and diel timing of sampling can bias results. Pelagic plankton tows were the single most effective method for collection of most species. Diel variation was identified for many species; with most exhibiting higher abundances during the night, although one species occurred in higher abundances during the day. Given these results the sampling regime for this project utilised both day and night pelagic plankton tows.

Annual differences in the larval assemblages in relation to variations in hydrology and environmental variables were investigated across four years, including a year of increased flow and a water level raising, and three years of low regulated flow with stable water levels.

The main channel environment of the Lower Murray supported larvae from all life history strategies. The larval assemblage differed between years; the flow pulse year was consistently different from the subsequent three low flow years. Three responses to varying hydrology were identified in the larval assemblage: larvae that were 1) positively correlated to increased flow, 2) negatively correlated to the increased flow and 3) correlated to temperature. The low flow recruitment hypothesis was supported, with a number of small-medium bodied native species spawning under low flow conditions in the river channel. However, golden perch and silver perch (flow cued spawners), were only present during the flow pulse year. Environmental flows are therefore vitally important for the management and restoration of some native fish species.

Strong within year variability was inherent in the data due to the seasonal variation in spawning time of fishes. The timing of peak spawning in the Lower River Murray was compared to other studies throughout the Basin. The broad spawning patterns identified for individual species were similar to seasonal spawning guilds identified for Australian species in previous studies. These spawning guilds were spring/summer and summer spawners. Understanding the timing of spawning of key species within a region will ensure that management actions can be targeted at providing benefits for species of interest.

The key assumption of many recruitment models is that the main river channel is an area of low productivity, and therefore it does not provide adequate food for developing larvae, which is particularly pronounced in years of low flow. Zooplankton sampling was conducted during the spring/summer of 2006 in the pelagic zone of the main river channel in a typical low flow year. Although temporally and spatially restricted, results indicated that during a low flow year an abundant prey source does exist in the main river channel in the Lower River Murray. Furthermore the prey was abundant in the pelagic zone of the open water, where traditionally pelagic zooplankton abundances have been documented to be relatively low. This suggests that in the absence of floodplain inundation developing larvae have adequate access to food in this lowland temperate system.

The inundated floodplain is generally recognised as important habitat for developing, larvae, consequently the importance of the main channel environment is frequently overlooked despite many studies highlighting the importance of shallow, still littoral zones. Larval fish were sampled in three main channel habitats: backwaters, open water and still littoral zones. Larvae of key species successfully spawned and utilised these main channel habitats during a low flow year. Specifically, still littoral zones and backwaters were important main channel habitats for developing fish larvae, providing support for the applicability of the low flow recruitment hypothesis to the Lower River Murray.

Some species (namely the small – medium bodied natives were able to spawn and recruit in the Lower River Murray under low flow conditions, but these were also able to spawn under the higher flow conditions. However, during the low flow years there were no larvae golden perch or silver perch collected, suggesting that these species were not spawning under the low flow conditions. This study has highlighted that a number of species will spawn and develop as larvae in the heavily regulated weir pool environment. In addition, adequate food and habitat were available for developing fish larvae in the absence of floodplain inundation in the Lower River Murray. However, for species with specific flow requirements (such as golden perch and silver perch, and potentially Murray cod and freshwater catfish) continued low flow conditions may pose a significant threat. In heavily regulated systems, environmental water allocations should be considered to manage and potentially restore declining fish populations, and the benefit of within channel flow pulses should not be underestimated.

Sunset in Chowilla (photo courtesy of Lesley Alton).