Dynamics of phytoplankton in relation to tuna fish farms in Boston Bay and near-shore Spencer Gulf, South Australia

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A thesis submitted for the Degree of

Doctor of Philosophy (Marine Biology).

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December 2007

Declaration

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree or diploma in my university. To the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

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Rosemary Paxinos
December 10, 2007

Abstract

Interest in the effect of fish farming practices on the marine environment has arisen because there is concern that the wastes that fish farms produce may be contributing to eutrophication in coastal areas and the problem of harmful algal blooms. The focus of this thesis is an examination of phytoplankton distribution and abundance in relation to tuna fish farms in Boston Bay and near-shore Spencer Gulf. This is the first study in South Australia to define the short-term biomass fluctuations of chlorophyll and *in vivo* fluorescence, identify phytoplankton species distribution and abundance, including two potentially toxic dinoflagellates, and describe patch distribution relative to tuna fish farms in Boston Bay and the near-shore waters of Spencer Gulf. An ecological interpretation of phytoplankton distribution and abundance is determined and shows that community composition was different in lower Spencer Gulf compared to Boston Bay and upper Spencer Gulf sites. Pico- and nanophytoplankton were often the most abundant organisms. Diatoms and gymnoids were most common. Season and currents predominantly influenced the distribution of phytoplankton in Boston Bay and Spencer Gulf. Individual species may be influenced by inputs from the fish farms.

Chlorophyll levels were different between the Spencer Gulf and Boston Bay sites and no differences were recorded, using mean levels of chlorophyll, between tuna cages and controls. Chlorophyll levels were higher east of Boston Island in autumn of 1999. Chlorophyll levels appeared to show a slight increase between years. This may have been an anomalous natural variation and future research may investigate this in the long term. In addition, Principal Components Analysis (PCA) was used to investigate differences between treatments and the functional grouping model supported an ecological interpretation of the factors from the PCA. A total of 131 taxa of phytoplankton were identified in this study. The 14 dominant taxa were used in the PCA and of these, 9 were diatoms. Phytoplankton abundance was not different between tuna cages and controls. However, when examining individual species, *Karenia mikimotoi* was more prevalent at tuna cages, close to shore, east and west of Boston Island than at other sites. PCA showed how different species bloomed together and were seasonal. *Karenia brevis and K. mikimotoi* featured predominantly in the PCA with *K. brevis* the dominant organism during summer and autumn along with *Gyrodinium* spp. and smaller gymnoids. *K. brevis* blooms were most likely influenced by water temperatures and fixation of nitrogen from a *Trichodesmium erythaeum* bloom. *K. mikimotoi* bloomed bimodally and may be influenced by ammonia excreted from fish from the tuna farms but , on the other hand, may be limited by the high salinities of South Australian waters. Currents in the region distribute both organisms.

The final aspect of this study assessed finer temporal and spatial sampling using directional transects around tuna cages and controls using *in-vivo* fluorescence and size fractionated chlorophyll. The chlorophyll *a* sampling showed little spatial variability within a site in the 1000 m^2 that the sampling area covers but far greater temporal variability (days). In contrast, fluorescence `mapping' expands the window of variability both spatially (within a site) and temporally (along transects and between days). This has given a spatial definition, which is unavailable from a single point sample, and thereby leaves room for much greater interpretation. Small patches are evident from the fluorescence mapping where this is impossible to detect from the single point samples. Therefore, the fluorescence `mapping' and patch definition show that the trend is widespread (spatially) and quite persistent (temporally) around the fish farm area.

Size fractionated chlorophyll samples provided further insight into phytoplankton dynamics in this study where diatoms were favored over dinoflagellates and were responsible for the larger fraction of chlorophyll found at the tuna cage one (TC1) site. We suggest that seasonal fluctuations, high nutrient input from the farm activities and turbulence may be responsible for the different chlorophyll/fluorescent structures found at TC1. Future research may look at the long-term regional impact on phytoplankton size structure, biomass and communities from fish farm activities.

As a good part of this journey involved counting phytoplankton using the Utërmohl technique, a short paper, published in the *Journal of Plankton Research,* on reducing the settling time of this method, is presented in Appendix 2.

Acknowledgements

It has been a great privilege to have the opportunity to study at Flinders University and I would like to acknowledge the ongoing support provided by the Biological Sciences Department.

Great thanks go to my Supervisor, Associate Professor Jim Mitchell (Flinders University) for his never-ending, mostly patient encouragement and support on what has been an overly extended and somewhat joyful but harrowing journey.

To Dr. George Matsumoto (Monterey Bay Aquarium Research Institute), who was my original Supervisor but left for better horizons very early on, I would also like to extend my great thanks for the friendly and supportive advice on the nature of the project and for keeping that 'door' open when he left for the US.

Associate Professor Mike Schwarz (Flinders University) was amazingly patient and helpful with the statistics on one of the largest databases I had. Where statistics have always confounded me, Mike made them simple and fun and I will be eternally grateful for the support he gave me!

Mark Thomas (past Manager, Lincoln Marine Science Centre) was incredibly helpful and supportive whilst I was in Port Lincoln. He tirelessly gave me advice on everything from 'take out' places to eat at, after some very long days processing samples, using the computer system at LMSC, to driving my boat in the most terrible weather when there was no other boat driver available. Thank you Mark, you were fantastic!

Mick Clarke (SARDI Aquatic Sciences), who drove my boat on one occasion and with his enigmatic sense of humor, gave great technical advice on boat handling, made me take a break and swim on the beautiful coastline of Lincoln National Park when I would normally have chosen to go on working! Thank you too.

Andy Smith a technical staff member in the Flinders University Marine Biology Department showed me that new dive suits could be a hazard and persevered with my novice and dangerous early attempts at diving! Thank you.

Jason Nicholls (Master Driver) drove my boat on one occasion and has the dubious honor of lending me his ‘shorts’. Jason’s marvelous tantrum on the beach will stay in my memory for ever. Thanks Jason it was fun.

To all the other people who drove the boat or assisted at different stages, Steve Clarke (SARDI Aquatic Sciences), Peter Christy (SA Water), Hugh Davies, Neil Austin, Birgitta Hanson, John Leach, John Clark, Brett Glencross, Roger Swahlou, Ben Dearman, and Mike Leach, I extend my great thanks for their complete expertise which left me free to do my work without ever having to worry about what the boat was doing.

I would like to acknowledge a team of others from Flinders University who provided support in so many different ways: Lyn Pearson for her microbiological support, Lynne Giles and Kylie Lang for their statistical guidance; Jim Bickford and Bruce White for all kinds of computer tinkering and Dick Edyvean was endlessly helpful with making up bits of equipment and tools.

Dr Gustaaf Hallegraeff (University of Tasmania) was encouraging and helpful. Gustaaf was both honest and forthright and provided guidance on the identification of phytoplankton in the early stages of my candidature. He also confirmed the identification of some organisms sent to him either in samples or on micrographs. For this I am grateful.

My two beautiful children, Stephen and Kelly who sometimes, and always un-begrudgingly, took second place to this work but made it ‘something’ to be proud of, I am so grateful for your patience, love and encouragement. My partner, Gordon. You stood by me through the blood, sweat and tears, provided a safe haven to work in, a board to bounce from, utterly unfailing support to spread my wings into an unfamiliar world and much warmth to fall back into, thank you. Last but not least, my ‘Latte’ aunts and girl friends that have traveled this journey beside me offering love and encouragement during the low times and enjoying my bliss in the high times, thank you Girls!

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