

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

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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 erythraeum* 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 m² 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 Uttermohl technique, a short paper, published in the *Journal of Plankton Research*, on reducing the settling time of this method, is presented in Appendix 2.

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