Estuarine, Coastal and Shelf Science 183 (2016) 150–162

Contents lists available at ScienceDirect

Estuarine, Coastal and Shelf Science

journal homepage: www.elsevier.com/locate/ecss

Linking nutrient inputs, phytoplankton composition, zooplankton dynamics and the recruitment of pink snapper, *Chrysophrys auratus*, in a temperate bay

Kerry P. Black [a, b], Andrew R. Longmore [a], Paul A. Hamer [a, c], Randall Lee [d], Stephen E. Swearer [a], Gregory P. Jenkins [a, *]

[a] School of BioSciences, University of Melbourne, Victoria, Australia
[b] Sanctuary Beach Pte Ltd, Singapore
[c] Fisheries Victoria, Queenscliff, Victoria, Australia
[d] Environment Protection Authority Victoria, Macleod, Victoria, Australia

A R T I C L E I N F O

Article history:
Received 28 July 2016
Received in revised form
5 October 2016
Accepted 25 October 2016
Available online 27 October 2016

Keywords:
Nutrients
Copepod
Larval fish
Plankton dynamics
Recruitment
Port Phillip Bay

A B S T R A C T

Survival of larval fish is often linked to production of preferred prey such as copepods, both inter- and intra-annually. In turn, copepod production depends not only the quantity of food, but also on the nutritional quality, edibility and/or toxicity of their micro-algal food. Hence, larval fish survival can become de-coupled from levels of nutrient input depending on the resulting composition of the plankton. Here we use a plankton dynamics model to study nutrient input, phytoplankton composition and copepod, *Paracalanus*, production in relation to interannual variation in recruitment of snapper, *Chrysophrys auratus*, in Port Phillip Bay, Australia. The model was able to simulate the ratio of diatoms to flagellates in the plume of the main river entering Port Phillip Bay. Interannual variability in the copepod, *Paracalanus*, abundance during the *C. auratus* spawning period over 5 years was accurately predicted. The seasonal peak in *Paracalanus* production depended on the timing and magnitude (match-mismatch) of nutrient inputs and how these were reflected in temporal change in the diatom:flagellate ratio. In turn, the model-predicted *Paracalanus* abundance was strongly related to inter-annual variability in abundance of snapper, *C. auratus*, larvae over 7 years. Years of highest larval *C. auratus* abundance coincided with a matching of the spawning period with the peak in *Paracalanus* abundance. High freshwater flows and nutrient inputs led to an early seasonal dominance of diatoms, and consequently reduced abundances of copepods over the *C. auratus* spawning period with correspondingly low abundances of larvae. Conversely years of very low rainfall and nutrient input also led to low phytoplankton and copepod concentrations and larval *C. auratus* abundances. Highest abundances of larval *C. auratus* occurred in years of low to intermediate rainfall and nutrient inputs, particularly when pulses of nutrients occurred in the spring period, the latter supporting the match-mismatch hypothesis.

1. Introduction

Recruitment variability is a key driver of the population dynamics of many marine fish stocks (Thorson et al., 2014) and is often found to be independent of reproductive potential (Morgan et al., 2011). One of the foundation hypotheses to explain recruitment variability in marine fish stocks was put forward by Hjort (1914), and held that there was a critical period at the point of first feeding by larvae where the presence of suitable amounts and types of food would determine year-class strength. In the intervening years, other hypotheses relating to recruitment variability such as the match-mismatch hypothesis (Cushing, 1969, 1990) and the growth-mortality hypothesis (Houde, 1987; Anderson, 1988) have extended Hjort's original hypothesis to a broader focus encompassing the entire pelagic larval phase characterised by high mortality (Houde, 2008), and potentially extending into the early juvenile phase (Campana, 1996).

The match-mismatch hypothesis is based on the observation that spawning times of marine fish species are often relatively fixed, while the timing of production of planktonic prey can be

* Corresponding author.
E-mail address: gjenkins@unimelb.edu.au (G.P. Jenkins).

http://dx.doi.org/10.1016/j.ecss.2016.10.032
0272-7714/

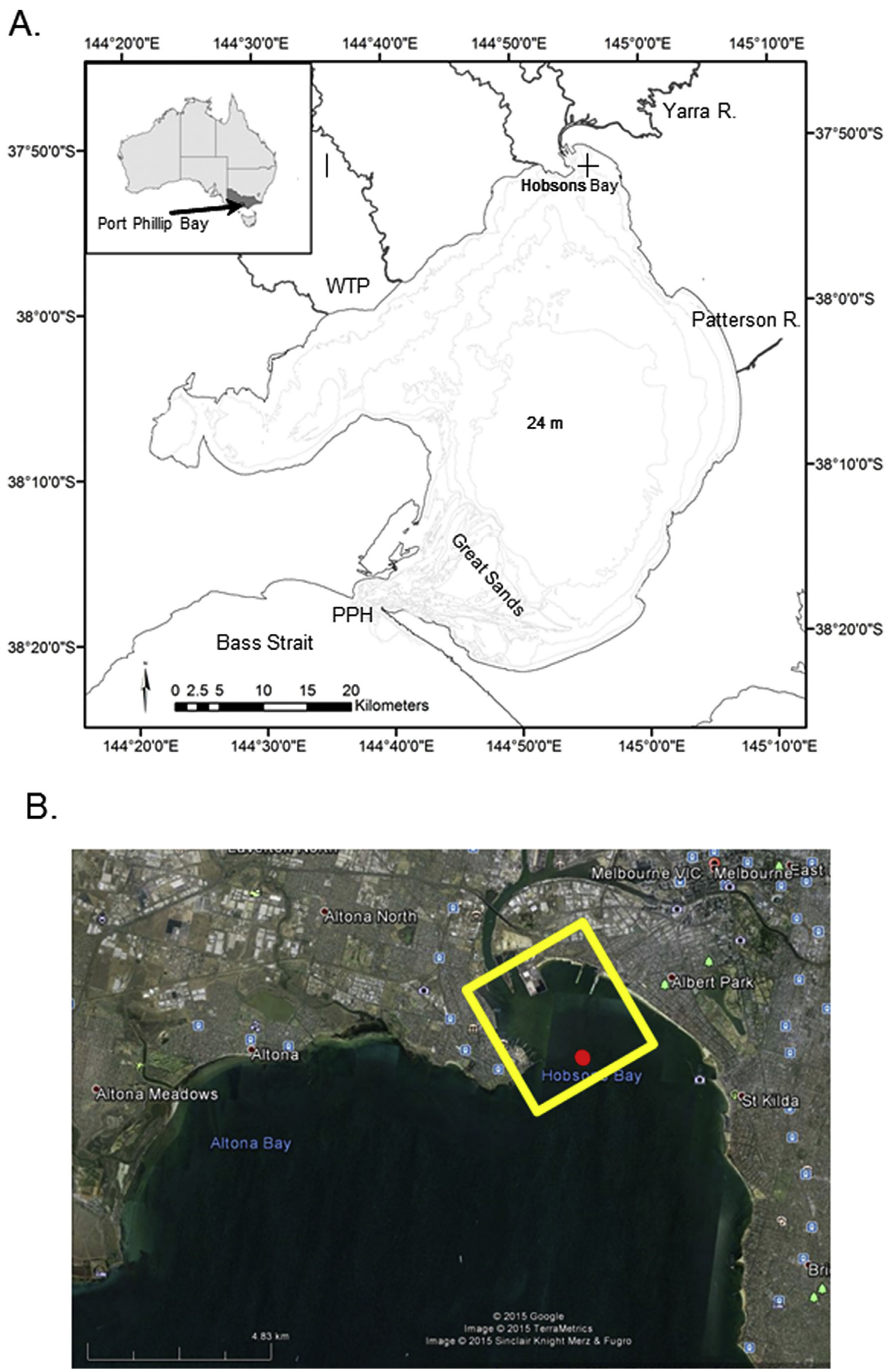

Fig. 1. A. Port Phillip Bay showing the open ocean entrance to Bass Strait (Port Phillip Heads - PPH), the 'Great Sands' region and the discharge location of the Yarra River. The + indicates the site in Hobsons Bay where water physico-chemical parameters, Chl-*a* measurements and phytoplankton community composition and abundance data were collected. B. Northern Port Phillip Bay showing the Yarra River and Hobsons Bay. The continuous monitoring site (red dot) is shown within the 4 $\times$ 4 km modelling region. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)