Incorporation of larval fishes into a developing anti-cyclonic eddy of the Leeuwin Current: timing, sources and pathways

Submitted by

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Declaration

I declare that this thesis is my own account of my research and contains, as its main content, work which has not been previously submitted for a degree at any tertiary education institution.

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Abstract

Meso-scale circulation and cross-shelf transport of planktonic biota associated with the formation of an anticyclonic (warm-core) eddy of the poleward-flowing Leeuwin Current (LC) were examined during a month-long, multidisciplinary voyage off south-western Australia. The study was based upon Lagrangian examination of upper ocean circulation and stations for depth-integrated (bongo nets) and depth-stratified (EZ nets) sampling of larval fishes were linked primarily with the locations of satellite-tracked oceanographic drifters.

The regional dominance of a modified LC water mass, particularly in the eddy field, indicated strong mixing between LC, shelf and oceanic subtropical surface water and the eddy had physical, chemical and biological signatures reflecting these source waters. High concentration of chlorophyll *a* (0.5 μg L^{-1}) in the eddy was derived, at least in part, from the shelf and was much greater than that in the surrounding ocean. In the study area, the horizontal distributions of larvae of fishes with both neritic and oceanic origins indicated strong onshore-offshore coupling. High concentrations of larval fishes in the eddy (1.0 – 3.0 larvae / m^3) contrasted with those in the surrounding ocean. Assemblages were dominated by the larvae of oceanic meso-pelagic taxa such as Myctophidae. Larvae of tropical neritic taxa (e.g. Bothidae, Pomacentridae) which were in much lower concentrations (<0.01 / m^3) within the eddy, identified the LC as the major transport route for incorporation of neritic larvae. Incursions of the LC onto the shelf north (upstream) of the study area appear to be important for initial entrainment of neritic larvae into the current. In contrast, the occurrence of larvae of oceanic meso-pelagic fishes in the eddy appear to be the product of localised spawning in, or near, the eddy.

The night-time vertical distribution patterns of larval fishes showed highest concentrations between the surface and 80 m depth throughout the study region. These vertical distributions appear to be a function of size and developmental stage of larvae rather than a response to environmental conditions and the velocity field. A time of 8 days for transport around the eddy perimeter, as well as ejection of a drifter from the eddy, have important implications for the transport and fate of neritic larvae during eddy evolution Opportunistic sampling across another eddy in 2007 allowed comparison of interannual variability in the LC eddy field. The seasonal regularity of warm-core LC eddies, which are characterised by enhanced productivity, may be important in the ecology of oceanic fish populations in the region. However, the low

abundance of neritic larvae in the eddies suggests that the spring/summer spawning of many temperate coastal species allows avoidance of the potentially deleterious transport associated with the LC and eddy field in the austral autumn/winter.

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Publication List

I am co-author on a paper published in a peer-reviewed journal which describes the physical oceanography of the 2006 eddy and is presented as Supplement 1 at the end of this thesis.

Paterson, H. L., Feng, M., Waite, A. M., Gomis, D., Beckley L. E., **Holliday, D**., Thompson, P. A. 2008. Physical and chemical signatures of a developing anticyclonic eddy of the Leeuwin Current, Eastern Indian Ocean. *Journal of Geophysical Research* **113:** C07049.

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