Title [4866]: *Recruitment and connectivity influence the role of seagrass as a penaeid nursery habitat in a wave dominated estuary*

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Definitions:

- 'penaeid' means any prawn of the family Penaeidae, many of which have economic importance.
- 'isotope' are variants of a particular chemical element which differ in the number of neutrons within the atom. Isotopes of an element, for example, Carbon, all share the same chemical properties.

Summary

There were clear, asymmetric patterns in recruitment and emigration of Eastern King Prawn found in Lake Macquarie. Seagrass beds in the northern basin of the estuary received greater numbers of recruits and there was a concentration of effective juvenile habitats and nursery habitats in this region.

What prompted the research

There has been a substantial loss of estuarine fish habitats, including many potential fish nursery habitats in the last two centuries. Recent work in Australia and elsewhere has identified habitat restoration and rehabilitation as one of the few avenues of management whereby large gains in fisheries productivity can still be made. In Australia, case studies indicate that restoration efforts targeted at enhancing valuable penaeid prawn species are likely to yield substantial economic benefits. Effective targeting, however, relies on a comprehensive understanding of how aquatic organisms use estuaries, which habitats serve an effective nursery function, and where such habitats are located.

While estuaries play an important role in the early life history of many penaeid prawn species, little is known about recruitment and the nursery function of different habitats in the southern Australian estuaries which supply a large portion of Eastern King Prawn (*Penaeus [Melicertus] plebejus*), one of the most valuable prawn species exploited off eastern Australia. This study used a combination of stable isotope ecology and quantitative sampling to examine recruitment and the nursery function of seagrass habitats.

What we did

This research studied Lake Macquarie, a large, immature, wave dominated barrier estuary, with a waterway area of 114 km and extensive seagrass beds, dominated by *Zostera capricorni* and *Posidonia australis*, but minimal intertidal and submerged rocky reef area.

The first stage of the research used stable isotope composition to identify the source of adults emigrating from the estuary. Twenty potential nursery habitat areas were sampled around the lake

for juvenile EKP using sled nets. In addition, EKP were collected at the mouth of the estuary using dip nets as they emigrated to the sea. Muscle tissue from each individual prawn was then analysed to identify its isotope signature. Emigrating prawns were then able to be assigned to areas where there were juveniles with a significantly similar isotope signature.

The assignment data was used to determine whether each site may be considered a nursery habitat (NH) or effective juvenile habitat (EJH). The key difference between these two approaches is that the former assigns a nursery role on the basis of a greater than average contribution per-unit-area of habitat, whereas the latter approach relies only on a greater than average contribution from a particular area. The Nursery Habitat approach can exclude habitats that may have a small contribution-per-unit-area to adult populations, but may still be important for adult populations; the latter approach would include such habitats. For this reason, we have included both approaches.

Quantitative surveys were then done at targeted locations which the first stage indicated were likely to be the most important nursery habitats. In addition, video transects of about 200 m were used to determine the percent cover of seagrass at each of these locations. The percent coverage of vegetation of each species was identified through analysis of 40 randomly determined frames.

What we found

The isotopic composition research showed that most numerically important nursery areas were in the northern and eastern regions of Lake Macquarie. In the targeted quantitative survey, EKP were present at a global average density of 165 ± 11 EKP per 100 m^2, and sizes ranged from 2.7–29.1 mm carapace length. Prawn density peaked at an intermediate distance-to-mouth of around 6,000 – 9,000 m from the lake entrance. Seagrass percent cover varied among sampling locations in the targeted quantitative survey, with means ranging between 25 and 98%. Prawn density did not change among locations where cover was 50%, however increasingly denser seagrass cover was correlated with declining numbers of prawns.

Seagrass beds in the northern basin of the estuary received greater numbers of recruits and there was a concentration of EJH and NH in this region. With the exception of one site, there was little evidence that seagrass beds in the southern basin of the lake received recruits or supplied individuals to the emigrating population, meaning it is unlikely that this region contains important nurseries for the species.

Within the northern basin of the lake, the supply of recruits was greatest at intermediate distances from the estuary mouth, particularly in an area which includes several shallow seagrass covered embayments on the eastern edge of the estuary 2000–3000 m past the end of the entrance channel. A greater abundance of prawns was also associated with less seagrass, but conversely prawns sampled in denser seagrass tended to be larger.

Finally, the effect of temperature on prawn abundance was likely a seasonal one, as the peak in abundance at 25 °C reflected the temperature in December.

Implications

The observed patterns in EKP abundance among potential nursery habitat sites within Lake Macquarie point to a conceptual model of current-driven recruitment. Lake Macquarie is a tidal system with a permanently open mouth, and experiences rapid tidal currents along the entrance channel of the system. However, at the western point of the entrance channel where it exits into the main lake, the tidal influence rapidly dissipates. In the lake body, winds from the south and south-east produce strong northward flowing currents, enhancing the flow of oceanic water toward the north-eastern edge of the lake, whereas wind from the north and west tends move water toward

the entrance channel. Seasonal variation in wind conditions for Lake Macquarie shows that for the summer when recruitment occurs, the lake experiences predominantly easterly and south-easterly wind, and the wind is generally at its strongest.

As with many other systems, post-larvae initially enter the system on the flood tide, and are carried along the entrance channel by the strong tidal currents. At the end of the entrance channel, the wind conditions during the recruitment season are conducive to the transport of prawns into the northern section of the lake. This conceptual model of post larval transport mediated by both the tide and wind forcing largely describes the abundance patterns observed and the concentration of recruits in the northern basins of the lake.

This study highlights the importance of understanding characteristics of an estuary and its influence on the supply of recruits when planning targeted fisheries enhancements like habitat rehabilitation. For the EKP, seagrass rehabilitation efforts (such as replacement of swing moorings with seagrass friendly moorings) could prioritise areas between 6 and 9 km from the estuary mouth.