Title [5435]: *Direct and indirect interactions between lower estuarine mangrove and saltmarsh habitats and a commercially important penaeid shrimp*

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Definitions:

- 'penaeid' means any prawn of the family Penaeidae, many of which have economic importance.
- 'nektonic' refers to aquatic animals that swim and move independently of water currents.
- 'Effective juvenile habitat' is habitat that contributes greater than average numbers of recruits to the adult population.

Summary

Effective juvenile habitat for Eastern King Prawn was found in both the North Arm and Main River Channel of the lower Clarence River estuary, New South Wales. These areas also supported a higher abundance of juvenile prawns than the southern channels of the estuary, which were not effective habitat possibly due to reduced connectivity with the incoming tide. Saltmarsh grass was the dominant primary producer supporting juvenile Eastern King Prawn productivity across the area.

What prompted the research

Food and refuge are two of the most important attributes that estuaries provide for the juveniles of exploited aquatic species, including Eastern King Prawn (EKP). Vegetated habitats in estuaries may provide a structural refuge and food supply in the same place, but benefits are also derived where a productive food source and suitable habitats are adjacent to each other.

Larger estuaries in New South Wales which contribute to fisheries productivity often have significant areas of mangrove and intertidal saltmarsh. However, the nursery role of different habitats needs to be better understood in order to prioritise and target areas for rehabilitation.

The installation of flood gates and historic reclamation for agriculture and development has led to substantial habitat loss in estuaries in New South Wales. For example, comparison between the extent of habitat in the Clarence River estuary in 1942 and 2009 indicates that 63% of saltmarsh habitat (512 ha) and 79% of seagrass habitat (316 ha) have been lost, mostly from the lower estuary. Conversely, mangrove habitat has increased by about 6%. In addition, more than 60 ha of waterway area has been lost during this period. Just inside the entrance of the estuary, a rock wall directs the bulk of tidal flow up Main Channel and North Arm.

What we did

This study assessed the importance of different habitats in the lower Clarence River estuary for EKP. This is a mature wave-dominated barrier estuary and the largest estuarine system in New South Wales. The relative contribution of different areas within the lower estuary to the adult component of the EKP population was identified using the variation in stable isotope composition between different areas within the estuary.* Prawns are first captured from possible nursery areas

throughout the estuary to characterise the isotopic composition specific to that area. Then emigrating prawns coming from nursery areas throughout the estuary were captured near the mouth as they run to sea and matched back to nursery areas on the basis of isotopic similarity.

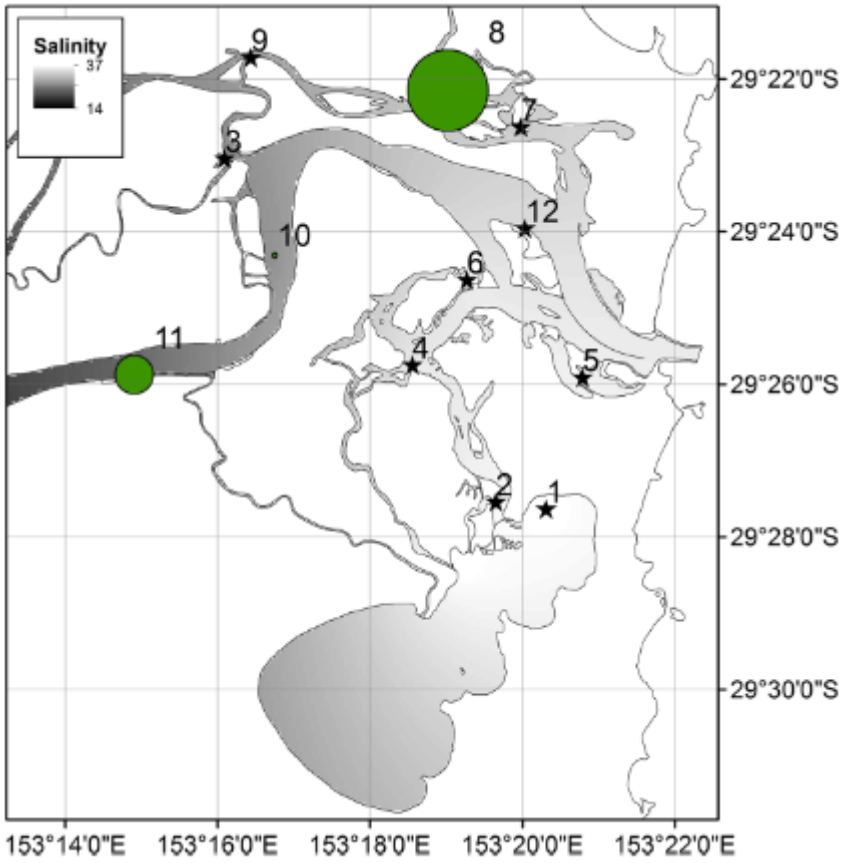
We assessed how abundant EKP were across 20 sites identified from the broadscale analysis described above. Each site was sampled after dusk in the last quarter of the moon using a sled net. Water depth, temperature, salinity, dissolved oxygen and turbidity were also recorded.

What we found

The EKP heading back out to sea showed highly asymmetric patterns in terms of the possible nursery habitat areas they had come from. The vast majority of emigrating prawns came from the network of subtidal channels and deltaic islands within the North Arm of the lower estuary. This habitat is primarily shallow, unvegetated, subtidal soft sediment with limited seagrass cover but is surrounded by extensive intertidal mangrove and saltmarsh habitat. The greatest abundance of prawns was also found in Main Channel and also in North Arm, 8–12 km from the estuary mouth. The remaining emigrating prawns had come from areas within the main river channel. No prawns were assigned to areas within the south arm of the estuary or Lake Wooloweyah despite there being similar habitats around the islands connecting the Lake to the Main Channel as that present in North Arm.

Only 2 areas were able to be identified as effective juvenile habitat (see figure below).

The saltmarsh grass (*Sporobolus virginicus*) was found to be the dominant source of nutrition for EKP across all sites (47-97%). *S. virginicus* represents a maximum of 35% of the vegetated area. In contrast, mangrove habitat represents up to 100% of the available vegetated habitat, but mangroves only support a maximum of 8% of EKP diet.



The relative contribution of possible nursery habitat areas to the emigrating Eastern King Prawn population, indicated by circle size. Areas that did not contribute shown as stars.

Implications

The patterns observed indicate that nursery function of different areas within the lower estuary is a product of connectivity, recruitment and nutrition derived from primary productivity of plants.

In the Clarence River, a rock wall forms a prominent feature of the morphology of the estuary mouth, ultimately directing the bulk of tidal flow up Main Channel and toward North Arm. This may affect the ability of ocean-spawned EKP postlarvae to recruit into the south arm of the estuary and Lake Wooloweyah. This provides an explanation for the low abundance of EKP in this area and the lack of any detectable contribution of this part of the estuary to the adult population. Consequently, despite there being abundant macrophyte habitat and appropriate salinity to support juvenile EKP, limited connectivity may contribute to recruitment limitation for this species in the southern part of the lower estuary.

Saltmarsh is an important habitat supporting productivity of juvenile EKP within the estuary. Much of the lost saltmarsh habitat is around the mouth of Lake Wooloweyah, where high numbers of EKP recruits are unlikely to occur. However, outwelling of saltmarsh material from this area to other areas of the estuary is likely, so the impacts of this loss may be relevant across the estuary. Also, substantial losses of saltmarsh habitat have also occurred along Main Channel in the lower estuary, and it is likely that the loss of this habitat has had consequences for the productivity of EKP, as well as other species that feed in food webs supported by saltmarsh productivity.

Repair of estuarine habitat through the reinstatement of tidal flow is a potential management action which would both re-establish key estuarine habitat and most probably support increased productivity of a range of nektonic species, including EKP. Research in the Clarence River itself has showed that floodgate remediation enhanced the passage and connectivity of crustaceans and fish, including exploited species, highlighting how reinstatement of connectivity within the estuary can result in significant beneficial ecological outcomes for commercially important species.

* * In order to identify nursery habitat, a method using the stable isotope signature of muscle tissue was developed which enables researchers to know where in an estuary an aquatic animal has been feeding. This two part process involves firstly collecting animals from across the estuary (including from what appear to be nursery habitat areas) to develop a library to which animals of "unknown origin" can be assigned. The second part of the process involves collecting animals as they emigrate from the estuary to join the adult population, and matching the muscle stable isotope signature from these individuals to potential nursery habitat areas to derive the most likely area from which they originated. (See the paper 4723 '*A rapid approach to evaluate putative nursery sites for penaeid prawns*' for a detailed description of this method).