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Relative efficiencies and durabilities of recreational hoop- and lift-nets targeting two Australian portunids

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ABSTRACT

The temporal efficiencies and durabilities of established and alternative recreational portunid crab (*Scylla serrata* and *Portunus pelagicus*) baited nets were assessed during two experiments (simulating conventional and 'ghost' fishing) with the objective of minimising environmental impacts. The established gear ('hoop nets') comprised a circular panel of large, thin-twined mesh designed to entangle portunids while approaching a centrally located bait. The alternative gear ('lift net') had an identical diameter and central bait, but instead of entangling catches, comprised thicker, smaller meshes that were raised in a barrier during retrieval to prevent egress. Both gears similarly caught more portunids during nocturnal than diurnal deployments. When actively fished (i.e. retrieved every 30 min), lift nets were equally effective as hoop nets for catching *S. serrata* (and caused less exoskeleton damage—mostly limb loss) and more than twice as effective for *P. pelagicus* (attributed in part to broader size selection). Lift nets were minimally damaged, but irrespective of the deployment duration, all hoop nets had broken/missing meshes (lost as marine debris), and those left for up to 12 days quickly became non-functional. The results illustrate the utility of simply substituting problematic gears—instead of attempting their modification—with those that are inherently more benign to reduce environmental impacts.

1. Introduction

Portunidae comprises some 550 species globally distributed throughout temperate and tropical near shore and estuarine areas (WoRMS, 2015). Several of the largest bodied species are important to fisheries, including blue swimmer crabs, *Portunus pelagicus* and giant mud crabs, *Scylla serrata* (and their cogenerics; Keenan et al., 1998; Lai et al., 2010); which are commercially (and artisanally) harvested throughout their indo-west Pacific distributions using various gears, including penaeid trawls (Kennelly et al., 1998), beach seines (Chande and Mgaya, 2003), gillnets (Gray et al., 2005) and traps (Boutson et al., 2009) for total landings of ~200 000 and 40 000 mt per annum, respectively (FAO, 2014).

In Australia, *P. pelagicus* and *S. serrata* also are widely sought by recreational fishers during the Austral summer (October–April, but mostly in the last three months), with ~9 million individuals caught annually, and mostly using various baited traps (Henry and Lyle, 2003; Butcher et al., 2012; Rotherham et al., 2013; Leland et al., 2013; Broadhurst et al., 2014, 2015). The regulations dictating recreational Australian portunid fishing gears vary among states according to regional requirements (i.e. minimum legal sizes of portunids, personal quotas, etc.; Butcher et al., 2012). Some gears are more selective than others, but none are completely effective for only the targeted sizes (Butcher et al., 2012; Leland et al., 2013). Consequently ~50% of all catches are released, along with mostly unknown quantities of non-portunid bycatch (Henry and Lyle, 2003).

While the associated immediate and short-term mortalities of discarded portunids generally are low, both species can lose limbs and ovigerous *P. pelagicus* often incur damaged eggs, which could have negative long-term implications (Uhlmann et al., 2009). Previous studies have identified that the magnitudes of such impacts are somewhat gear-specific, with one method in particular—hoop nets (used in New South Wales and also known as 'witches hats')—raising some associated concerns (Butcher et al., 2012; Leland et al., 2013; Broadhurst et al., 2015).

Hoop nets encompass a general design/fishing mechanism used in other regional and international crustacean fisheries (Kennelly and Craig, 1989; Gabriel et al., 2005); comprising a rectangular panel of netting that is sewn into a tube, affixed to a solid-ring base

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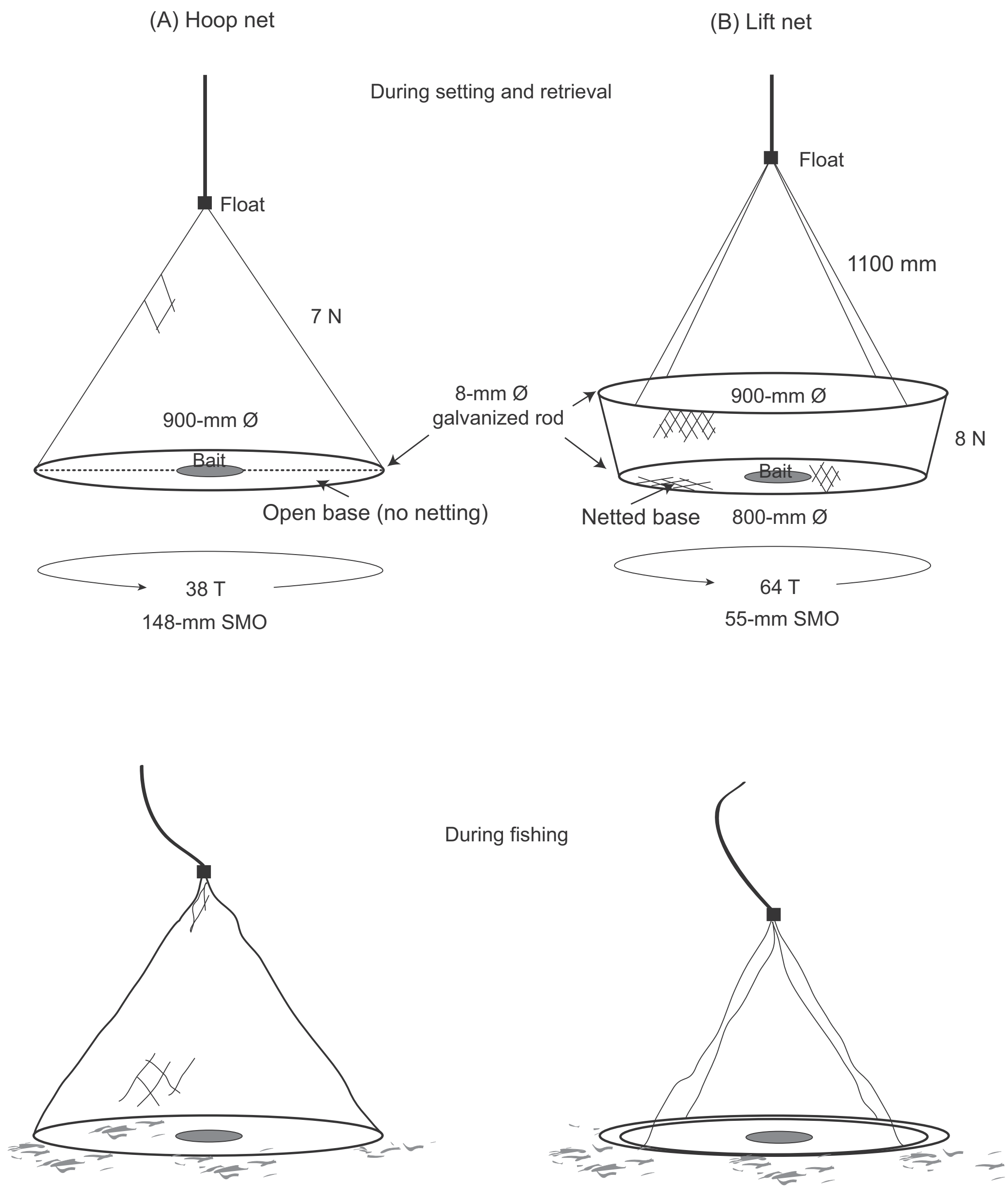

Fig. 1. Diagrammatic representation of (A) hoop and (B) lift nets during setting/retrieval and fishing. Ø, diameter; SMO, stretched mesh opening; N = meshes in the normal direction; T = meshes in the transverse direction.

at one end and closed together at the other to form an open-based inverted cone (Broadhurst et al., 2015; Fig. 1). A centrally located bait attracts portunids, which are then entangled during ingress (Fig. 1). No recent data are available describing wide-scale temporal or spatial hoop-net effort, but historically they have remained popular in NSW, with up to four permitted to be set per fisher (typically over deployments of 3–24 h) throughout more than 100 estuaries/rivers to target *P. pelagicus* and *S. serrata* (≥60 and 85 mm CL minimum legal sizes, respectively).

Beyond the potential for some impacts to discards, hoop nets often are lost and/or damaged—the extent of which is positively correlated to their deployment time. For example, Butcher et al. (2012), Leland et al. (2013) and Broadhurst et al. (2015) all observed that common hoop-net designs set for <24 h often had up to ~15 meshes (~8% of the total) broken or missing, while ~60% of those left for >24 h had >20 meshes (>11%) damaged and were considered unrepairable. At least some escaping portunids probably have twine entangled around their bodies. While these data suggest a limited potential for so-called 'ghost fishing' (ICES, 1995) by hoop nets beyond the short term (owing to their apparent destruction) there are no quantitative data. In any case, irrespective of ghost fishing, any loss of meshes to the environment raises concerns over marine debris. These issues are sufficient to warrant attention and resolution.

Prohibiting hoop nets is an obvious solution, and is the option adopted in many countries because similar gears are favoured by poachers (Vazquez Archdale et al., 2010). However, there is considerable resistance among NSW recreational fishers to ban what is considered an inexpensive, traditional and easily used design. Based on the clear positive relationship between mesh damage and hoop-net deployment duration, one possible operational procedure could be to minimise the deployment time. A related approach might be to assess other related gears such as lift nets which are used to target portunids in other Australian states and various decapods overseas (Thomas, 1953; Gabriel et al., 2005; Vazquez