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Reducing bycatch mortality in crustacean traps: Effect of trap design on platypus and yabby retention rates

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ABSTRACT

The platypus (*Ornithorhynchus anatinus*) is known to be vulnerable to drowning in enclosed traps used to capture freshwater crayfish such as yabbies (*Cherax* spp.). To help quantify the degree of risk posed by such traps, we carried out 113 trials in Victorian streams and larger New South Wales rivers to assess the platypus's ability to escape from standard opera house traps (OH), a second commercially available enclosed trap design (closed-top pyramid traps, CTP), and opera house traps that had been modified by adding an opening in the roof (MOH). All 10 of the animals tested in OH failed to find an exit in the period allowed. In contrast, 82% of subjects tested in CTP ($n = 45$) and 83% of those tested in MOH ($n = 58$) escaped from traps within 2 min. Victorian animals took significantly less time to escape from traps (CTP, mean = 31 s; MOH, 33 s) than those tested in New South Wales (CTP, mean = 55 s; MOH, 53 s). In addition, juveniles were less likely than adults to escape from CTP and MOH in a timely manner. The results of trials comparing the number and size of yabbies captured in Victorian farm ponds indicate that MOH should at least equal and potentially exceed the performance of OH when used to harvest yabbies for human consumption.

1. Introduction

Adverse effects of fishing activities on non-target vertebrates have been most thoroughly documented in marine systems, but also remain a valid concern in freshwater environments (Raby et al., 2011). Air-breathing animals drown after entering submerged traps, getting entangled in nets or becoming impaled on hooks, either while fishing gear is being deployed or after equipment has been lost or abandoned ('ghost' fishing: Smolowitz, 1978). Mortality of non-target air-breathing vertebrates can be addressed by reducing the likelihood that they encounter fishing gear, by facilitating their escape from nets or traps, or by ensuring that they can reach the surface to breathe until they are released (e.g. Bury, 2011; Grant et al., 2004; Koed and Dieperink, 1999; Larocque et al., 2012; Lowry et al., 2005). Such strategies will be most readily adopted by fishers if they also maintain acceptably high catch rates of target organisms and are reasonably inexpensive and practical to implement. It is accordingly important to determine whether proposed bycatch reduction measures affect the catch rate for target species as well as bycatch, ideally tested across a range of body sizes (Favaro et al., 2013).

The platypus (*Ornithorhynchus anatinus*) occupies a wide range of freshwater habitats in eastern and southeastern Australia (Grant, 1992). However, many populations appear to be fragmented, genetically depauperate and/or declining, resulting in the species being recently classified as 'near threatened' (Woinarski et al., 2014). The platypus's aerobic dive limit when swimming (i.e. the interval until stored oxygen is depleted) has been estimated to be approximately one minute in an experimental setting (Bethge et al., 2001; Evans et al., 1994). By then switching to anaerobic metabolism, active animals can remain underwater for a maximum of around 2.3 min (Bethge et al., 2003) or 2.6 min (Grant et al., 2004) before having to breathe again.

A recent study of platypus mortality factors from the 1980s to 2009 in the state of Victoria found that 56% of deaths with an identifiable cause were due to drowning in traps or nets set by recreational fishers. About one-third of these cases involved use of enclosed traps (especially the inexpensive and widely available design known as opera house traps) set to capture edible crustaceans such as yabbies (*Cherax* spp.). Use of enclosed yabby traps (both opera house traps and other folding frame designs) became illegal in Victorian public waters in mid-2001. Nonetheless, the frequency of platypus mortalities in such traps reportedly increased in

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the study's last decade, presumably mainly due to misuse of traps sold for legal deployment in private ponds (Serena and Williams, 2010). The relatively large size of platypus home ranges (which can encompass >13 km and >4 km of channel in the case of males and females, respectively: Serena and Williams, 2012b) implies that mortality caused by regular deployment of traps at any given site may reduce population density for a considerable distance upstream and downstream of the site. Such mortality is particularly concerning in small streams supporting intrinsically low-density populations (e.g. 1.25–2.1 resident animals km^{-1}: Gardner and Serena, 1995; Serena, 1994 or ≤1.6 resident animals km^{-1}: Serena et al., 2014).

Trials designed to quantify the platypus's ability to swim through rigid square grids have found that adults weighing up to one kilogram can swim through a 55-mm-wide aperture (Grant et al., 2004), implying that it may be difficult to exclude these animals from yabby traps without reducing the take of large target crustaceans. As an alternative strategy to reduce platypus bycatch mortality, we investigated the potential for animals to escape from enclosed yabby traps after they enter. In the absence of prior behavioral studies, we carried out trials to describe the range of platypus responses inside two commercially available trap designs (opera house traps and closed-top pyramid traps), and assessed how many individuals are likely to locate an exit in a timely manner. We then asked whether adding an opening in the roof of opera house traps reduces the likelihood that animals drown after entering. We also investigated whether the time required for a platypus to escape from a yabby trap varies significantly with an animal's age, with location and habitat (New South Wales rivers versus Victorian streams) or (given that the species can be active diurnally and nocturnally, as reviewed in Serena and Williams, 2012a) in daylight versus darkness. Lastly, to complement the platypus findings, we considered whether the catch rate or size distribution of yabbies differs in standard opera house traps and traps fitted with an opening in the roof.

2. Materials and methods

2.1. Platypus trial methods

Trial animals were captured in fyke nets set overnight in streams draining the Great Dividing Range in eastern Victoria (from February 2012 to February 2014) following methods outlined in Serena and Williams (2012a), or in unweighted mesh (or gill) nets set through the first half of the night in the Wingecarribee and Shoalhaven Rivers in southeastern New South Wales (from December 2012 to February 2014) following methods outlined in Grant and Carrick (1974). The Victorian and New South Wales study areas were known to support substantial platypus populations based on previous fieldwork by the authors, and are separated by a distance of roughly 350 km. Captured animals were permanently marked using uniquely coded passive integrated transponder (or PIT) tags (Grant and Whittington, 1991) and weighed using hand-held spring balances (accurate to ±10 g). Age class (<1 year old = juveniles; ≥1 year old = adults and subadults, referred to hereafter as adults) and sex were assigned following criteria described in Williams et al. (2013).

The platypus's ability to escape from enclosed yabby traps was investigated by observing animals that had been placed inside the following three trap designs:

Opera house trap (OH) (Aussie Disposals). Trap dimensions = 660 mm long × 440 mm wide × c. 260 mm high. Entry/exit points consisted of two metal rings, each attached to the inner end of an inwardly-directed netting funnel (120 mm long) located in one of the trap's two shorter sides. Ring internal diameter = 88 mm, a size that can readily be negotiated by a platypus weighing up to at least 1.8 kg (Grant et al., 2004).

Modified opera house trap (MOH). Identical to the above, except that a metal ring (internal diameter = 88 mm) was inserted by the authors into the middle of the roof to create a third opening for potential entry or exit (Fig. 1a).

Closed-top pyramid trap (CTP) (Kulkyne Kampers). From February to April 2012, trap dimensions = 595 mm long × 595 mm wide × c. 170 mm high. Entry/exit points consisted of four metal rings (internal diameter = 88 mm), each set at the inner end of an inwardly-directed lip (25 mm long). One lip was located in each of the trap's four sides. Later trials utilised traps measuring 700 mm long × 480 mm wide × c. 190 mm high, with ring internal diameter reduced to 83 mm. In addition to metal ring openings, CTP incorporate an adjustable top centre opening defined by a loop of cord. This was tightened during trials to its minimum possible circumference of c. 240 mm from February to April 2012 and c. 100 mm thereafter (Fig. 1b).

In each trial, one platypus was carried in a calico bag from the bank to a test trap that had been submerged in the channel at a depth of 35–55 cm. The animal was released directly from the bag into the test trap through a randomly selected side opening. Two observers stationed next to the trap monitored the animal's subsequent behavior and the time interval after it entered, using a stopwatch or equivalent wristwatch function. When ambient light levels permitted, animals in Victoria were filmed using a hand-held Panasonic HX-WA10 underwater camera to provide a permanent record of behavior and a very accurate estimate of how long an animal remained inside a trap based on the time progression shown during playback. Observers remained as still and quiet as possible during trials and, in the case of night trials, artificial lights were

(a) (b)

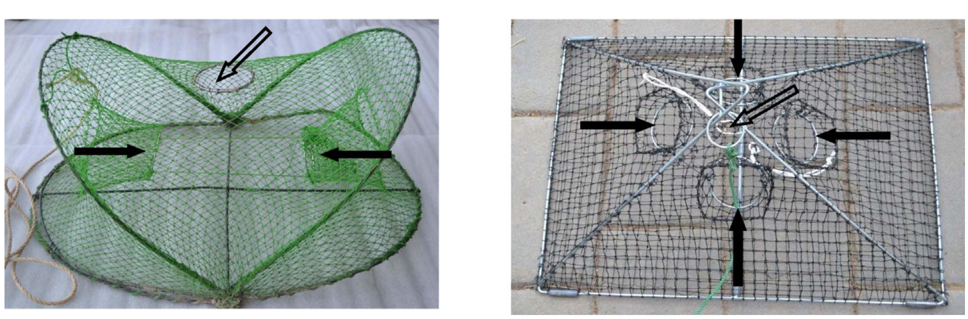

Fig. 1. Two of the trap designs tested in this study. (a) Modified opera house trap (MOH), side openings into trap marked by black arrows, escape ring at top of trap (the only feature distinguishing MOH from standard opera house traps) marked by open arrow; (b) closed-top pyramid trap (CTP), fixed-diameter side openings into trap marked by black arrows, adjustable top opening by open arrow.