



# Short-term survival of discarded pearl perch (*Glaucosoma scapulare* Ramsay, 1881) caught by hook-and-line in Queensland, Australia



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## ABSTRACT

Post-release survival of line-caught pearl perch (*Glaucosoma scapulare*) was assessed via field experiments where fish were angled using methods similar to those used by commercial, recreational and charter fishers. One hundred and eighty-three individuals were caught during four experiments, of which >91% survived up to three days post-capture. Hook location was found to be the best predictor of survival, with the survival of throat- or stomach-hooked pearl perch significantly ( $P < 0.05$ ) lower than those hooked in either the mouth or lip. Post-release survival was similar for both legal ( $\geq 35$  cm) and sub-legal ( $< 35$  cm) pearl perch, while those individuals showing no signs of barotrauma were more likely to survive in the short term. Examination of the swim bladders in the laboratory, combined with observations in the field, revealed that swim bladders rupture during ascent from depth allowing swim bladder gases to escape into the gut cavity. As angled fish approach the surface, the alimentary tract ruptures near the anus allowing swim bladder gases to escape the gut cavity. As a result, very few pearl perch exhibit barotrauma symptoms and no barotrauma mitigation strategies were recommended. The results of this study show that pearl perch are relatively resilient to catch-and-release suggesting that post-release mortality would not contribute significantly to total fishing mortality. We recommend the use of circle hooks, fished actively on tight lines, combined with minimal handling in order to maximise the post-release survival of pearl perch.

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## 1. Introduction

Pearl perch (*Glaucosoma scapulare*) are a recreationally and commercially important species found in schools (McKay, 1997) in depths to at least 200 m. *G. scapulare* is one of the four Glaucosomatids that occur in Australia and is endemic to the east coast between 23° S and 33° S (McKay, 1997). Although once considered incidental in a multi-species line fishery mainly targeting snapper (*Pagrus auratus*) in southern Queensland, *G. scapulare* are now targeted due to a combination of significant reductions in snapper catch rates and more stringent management arrangements in recent years. Recreational and commercial fishers use similar fishing methods to target pearl perch – handlines or rod-and-reel using either monofilament or braided fishing lines rigged so that baited hooks are attached to branch lines located above lead sinkers.

In both Queensland and New South Wales, *G. scapulare* are managed by minimum legal size and recreational bag limit regulations that result in the mandatory discarding of individuals, termed regulatory discards by Kelleher (2005). The survival of these regulatory discards is unquantified but current management measures would

only be effective in conserving stocks if released fish survive capture and subsequent release (Broadhurst et al., 2005a; Butcher et al., 2007, 2008). The survival of discarded individuals represents a large source of uncertainty in estimates of total fishing mortality (Davis, 2002). Generally, total fishing mortality is synonymous with the portion of the catch that is retained and discard mortality is regarded as inconsequential (Muoneke and Childress, 1994). Given Taylor et al. (2012) estimated that 70% of the 89 386 *G. scapulare* caught by recreational anglers in 2010 were discarded, a low post-release survival rate would significantly increase total fishing mortality. For example, the congeneric West Australian Dhufish (*Glaucosoma hebraicum*), targeted by recreational and commercial fishers in similar latitudes and depths to *G. scapulare* on the west coast of Australia, exhibit poor post-release survival, and this has been estimated to increase fishing mortality for this species by 27% (St. John and Syers, 2005).

The survival of discarded line-caught fish is influenced by a variety of factors (see reviews by Arlinghaus et al., 2007; Bartholomew and Bohnsack, 2005; Muoneke and Childress, 1994). These factors have been the subject of numerous studies in recent years and include hook type or size (Aalbers et al., 2004; Butcher et al., 2008; Cooke et al., 2005; Graves and Horodysky, 2008; Grixti et al., 2007; Mapleston et al., 2008), hooking location (Alós et al., 2008; Butcher et al., 2007; McGrath et al., 2009; Pope and Wilde, 2004), landing

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apparatus (Barthel et al., 2003; Danylchuk et al., 2008; De Lestang et al., 2008) and duration of exposure to air (Gingerich et al., 2007; Reynolds et al., 2009).

Further, given that *G. scapulare* inhabit relatively deep water (McKay, 1997), bringing a fish to the surface can result in various pressure-related injuries referred to as barotrauma (e.g. St. John and Syers, 2005; Wilde, 2009). Typically, as line-caught fish are brought to the surface, gases within the fish's body expand according to Boyle's Law. As such, the volume of the gas within the swim bladder expands with decreasing pressure (i.e. depth), as do dissolved gases found in the blood and tissue cells, which leave solution and form bubbles (St. John and Syers, 2005). The expansion of gases results in symptoms of barotrauma such as the distension of the body cavity, eversion of the stomach and bulging eyes or exophthalmia (Brown et al., 2010). Prior to rupture, the expanding swim bladder may cause injuries to the adjacent organs (Rummer and Bennett, 2005; Wilde, 2009). Barotrauma has been reported as having a significant effect on the post-release survival of many line-caught demersal species worldwide (e.g. Jarvis and Lowe, 2008; Parker et al., 2006; Rummer and Bennett, 2005; Stewart, 2008).

Given the magnitude of discards, it is prudent to quantify the fate of these discarded animals in order to ensure the efficacy of the management strategies for *G. scapulare*, particularly as the post-release survival of the congeneric *G. hebraicum* is poor. The objectives of this study were to: (1) quantify the short-term (3-day) survival of *G. scapulare*; (2) examine factors affecting post-release survival; and (3) investigate whether barotrauma treatment strategies were necessary for this species.

## 2. Methods and materials

The post-release survival field experiments were conducted in an area adjacent to Double Island Point at the southern end of Fraser Island and in the waters off Cape Moreton (Fig. 1), in south east Queensland, Australia. These areas were chosen as they are known to support large populations of *G. scapulare* and allow for experiments to be conducted in both shallow (<80 m) and deep (>80 m) water.

### 2.1. Double Island Point – shallow (<80 m)

*G. scapulare* habitat in the Double Island Point (Area A in Fig. 1) experimental area consists of rocky reef, particularly surrounding the Wolf Rock Exclusion Zone, and flat, broken gravel substrates. Water depths in these areas range between 30 m and 80 m.

Post-release survival was assessed using the vertical enclosures described by Brown et al. (2010). Three cylindrical enclosures (hereafter referred to as cages) were constructed of #36 ply, 4-inch (101-mm) trawl mesh sewn into a cylinder 1.9 m in diameter and 15 m deep (see Brown et al., 2010 for an illustration). Seven galvanised steel (12 mm rod) hoops, 1.9 m in diameter, were used to maintain the cylindrical shape of the cages and were separated by 27.5 meshes (~2.5 m). The upper-most hoop, positioned at the sea's surface, was welded to an eighth hoop via four lengths of galvanised steel rod (12 mm diameter by 50 cm in length). This upper section was enclosed by mesh in order to prevent floating animals escaping and provided floating fish protection from predation by birds and sharks. Four large (50 cm diameter) polyethylene floats were attached to the inside of the upper enclosure to provide positive buoyancy, while three 13 kg weights were shackled to the lower-most hoop to ensure the enclosure remained vertical throughout the experiments.

To facilitate retrieval, four lengths of 4 mm stainless steel chain, each approximately 1.2 m, were shackled to the second-to-lowest hoop and then attached to a 20 m × 12 mm polyethylene retrieval

rope. A dan-buoy with a radar reflector was attached to the upper end of the retrieval rope. The portion of the mesh below the lower-most hoop was gathered together and a drawstring attached in the manner of a trawl-net codend. The 'floor' of the cages was lined with polyethylene shade cloth, a fine mesh screening material used in greenhouses and outdoor areas, to provide the captive animals with some protection from current and also prevent the escape of smaller individuals.

Each cage was anchored to the seafloor via, respectively, 60 m of 12 mm polyethylene rope, 10 m of 12 mm galvanised steel chain and a 16 kg fluke-style anchor. The anchor line was then attached to a cage via three bridles of 12 mm polyethylene rope and a quick-release clip. The cages were deployed close to the shore in approximately 20 m water depth at the start of each experiment as protection from the south-east winds and southerly current predominate in the area.

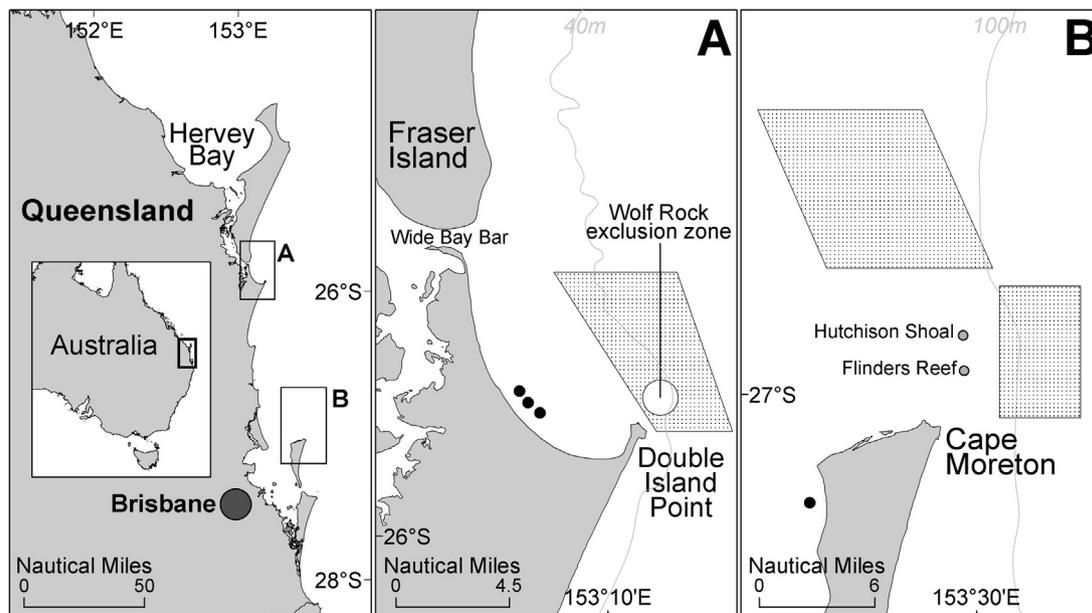
*G. scapulare* were angled from the Fisheries Research Vessel (FRV) *Tom Marshall*, a 14.5 m aluminium diesel-powered catamaran, and the MV *Makaira*, an outboard powered 5.8 m aluminium centre cabin, with two anglers allocated randomly to each vessel. Individual fish were angled using conventional rod-and-reel employing paternoster rigs (1–3 hooks attached to a 20–30 kg breaking strain monofilament mainline via 15 cm of 15–20 kg breaking strain monofilament branch lines above a lead sinker). The weight of the lead sinker ranged between 110 g and 450 g depending on depth and/or current. The hooks used were J-style Mustad "Big Red" in size 5/0 as used by recreational and commercial fishers, baited with pilchards (*Sardinops neopilchardus*), squid (Family *Loliginidae*) or mullet (*Mugil cephalus*).

Once a fish was caught, relevant data were recorded by the angler, including time of day, hook location, hooking-related injuries, handling-related injuries, capture depth and external signs of barotrauma. Fish were then tagged using a numbered Hallprint™ T-bar tag and placed in a holding container supplied with flow-through seawater. Two 1400 l polyethylene holding tanks were located on the stern deck of the *Tom Marshall*, while a modified and plumbed 110 l insulated fish box acted as the holding tank on the *Makaira*. Approximately 45 min after the first fish had been placed in a holding tank, the fish caught on the *Tom Marshall* were transferred to the holding tank aboard the *Makaira* before all fish were transported to a pre-determined cage for release. Once at the cage, tag number, the time since capture (i.e. surface interval) and the release condition of each fish were recorded. This procedure was repeated until fishing ceased for the day and repeated on subsequent days. Fishing was carried out over three days, with each cage containing the catch from separate days.

On the fourth day of each experiment, the first cage, containing the catch from the first day of fishing, was retrieved. The cages were designed to be retrieved so that the hoops came together in concertina-fashion, apart from the lower-most hoop, which formed a codend-like compartment at the base of each cage. Once the anchor line had been removed from the cage, via the quick-release clip, the dan-buoy was recovered and the retrieval rope was passed through a small snatch block at the end of a hydraulic crane, mounted on the stern of the *Tom Marshall*, before being attached to a capstan. Once the cage was aboard, the drawstring was released and the fish removed to one of the 1.4-tonnes holding tanks, at which time all fish were individually assessed for vitality.

### 2.2. Cape Moreton – deep (>80 m)

Given the distances of the fishing grounds from the sheltered waters required to deploy the cages, two methods were employed to hold captured fish from the Cape Moreton area. *G. scapulare* habitat in the fishing grounds off Cape Moreton consists of rocky reef, wrecks and gravel substrates, with depths ranging between 50 m



**Fig. 1.** Location of post-release survival experiments. (A) The Double Island Point area was the location for the shallow (<80 m) experiments. (B) The Moreton Island area was the location of the deep (>80 m) experiments. The black circles represent the location of the cages when used and shaded areas represent the fishing grounds.

and 130 m. Depending on prevailing weather and fishing location, captured fish were either left in the holding tanks for a period of 2–3 days or transferred to a modified cage on the western side of Moreton Island (see Area B in Fig. 1). One of the cages used in the Double Island Point trips was modified so that fish could be housed in the shelter of Moreton Island in water approximately 5–10 m deep. As such, the cage was modified by removing the middle sections so that the cage was approximately 5 m deep.

All fishing took place aboard the *Tom Marshall* using methods described above. Once again, captured fish were individually tagged before transfer to the flow-through holding tanks, after relevant data were recorded by the angler. Once fishing was complete each day, the fish were either left in the on-board holding tanks or removed to the modified cage, depending on the weather conditions and the distance to the modified cage. At the completion of the experiment, all fish were retrieved from the modified cage and placed in the holding tanks, at which time individual vitality was assessed.

In both shallow and deep experiments, all *G. scapulare* were euthanised and stored in the vessels' on-board freezer. Once back at the laboratory, all fish were dissected in order to determine the extent of barotrauma-related injuries. Before dissection, each fish was immersed in water and air injected into the gut cavity, via a small-bore hypodermic needle, to provide information regarding the likely escape route of swim bladder gases during capture.

Fish were then eviscerated carefully, in order to ensure the swim bladder remained intact. The swim bladder was examined and the presence/absence of a perforation was recorded, as was the size, shape and any signs of healing of perforations. The location of the perforation as a distance from the anterior edge of the swim bladder as a percentage of its length was also recorded. If no perforations were located, the swim bladder was injected with air, via the small-bored hypodermic needle, to assess whether it had healed and to detect the location of any perforation not located by first inspection.

In accord with methods described by Campbell et al. (2011), post-release survival was assessed using generalised linear modelling (GLM) via a binomial distribution with a logit link function, where vitality – a binary variable with 0 = dead and 1 = alive – was the response variable. Water depth and fish length were allocated to categorical variables, with depths allocated to shallow (<80 m) or

deep ( $\geq 80$  m) and total length allocated to sub-legal (<35 cm TL) or legal ( $\geq 35$  cm TL). The effects of several qualitative factors on survival were also tested including: signs of barotrauma present (none, exophthalmia, swollen gut cavity, everted stomach); the presence of bleeding (none, light, heavy); hook location (lip, mouth, throat, stomach, outside mouth); holding method (cage, modified cage, on-board tank); and the presence of any injuries (none, eye, gill, jaw, moderate scale loss and heavy scale loss). Trip (A, B, C and D) was also added to the model in order to assess the spatial and temporal variability in post-release survival across all experiments, while surface interval (time between capture and release to holding facility, in minutes) and time held after capture (in hours) were added as covariates. The final model was determined using the RSEARCH function in Genstat (2011), whereby the initial model contained all factors, some of which were removed via forward stepwise elimination until an appropriate model was found based on the adjusted correlation coefficient. Interaction effects were also tested but were excluded from the final model if the deviance ratio of the interaction term was less than an order of magnitude lower than the deviance ratio of either of the main effects (Campbell et al., 2011).

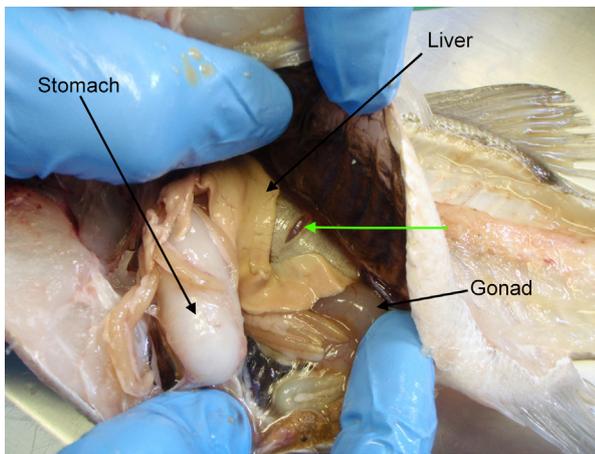
A second GLM was used to determine the effects of the aforementioned factors on barotrauma symptoms using the same procedure. This GLM tested the effect of relevant factors on the presence of barotrauma symptoms, a binomial response variable with 0 = no barotrauma symptoms and 1 = barotrauma symptoms present, via a binomial distribution with a logit link function. A third GLM was used to test the effect of various factors on the healing of swim bladder perforations. A swim bladder was classified as healed if (1) the perforation was covered with a film of tissue (Fig. 2) and/or (2) the swim bladder was partially inflated when inspected and/or (3) air could not be injected via the small-bore hypodermic needle. Again, swim bladder healing was assessed using a GLM via a binomial distribution with a logit link function.

### 3. Results

A total of 183 individuals, ranging in size from 19 to 61 cm TL, were used to assess the post release survival of *G. scapulare* caught during four field trips. Of these, 42 were over the MLS of 35 cm TL, while 91 were caught in depths less than 50 m. Table 1 provides the

numbers of individuals in each level of each factor used in the GLM analysis of post-release survival. 94% of captured fish exhibited no signs of barotrauma, while 93% were hooked either in the mouth or lip. For individuals presenting with barotrauma symptoms, everted stomachs were confined to the buccal cavity, unlike those observed in *P. auratus* caught incidentally during the field experiments which often had stomachs that protruded well beyond the buccal cavity. Exophthalmia was not observed in any individuals caught during the four field trips.

Of the 141 *G. scapulare* that had air injected into the gut cavity in the laboratory, air was found to escape the gut cavity through the vent in 124 (~88%) individuals. This suggests that, for the most part, as *G. scapulare* are caught and brought towards the surface, the air within the swim bladder expands until the swim bladder ruptures. At this point, air escapes into the gut cavity and continues to expand as the fish is brought closer to the surface. With decreasing depth, the alimentary tract perforates, allowing the air to escape the gut cavity through the perforated alimentary tract. 62 of the 141 swim



**Fig. 2.** Signs of healing in the swim bladder of a *G. scapulare*. Note the film of tissue covering the perforation in the swim bladder highlighted by the arrow.

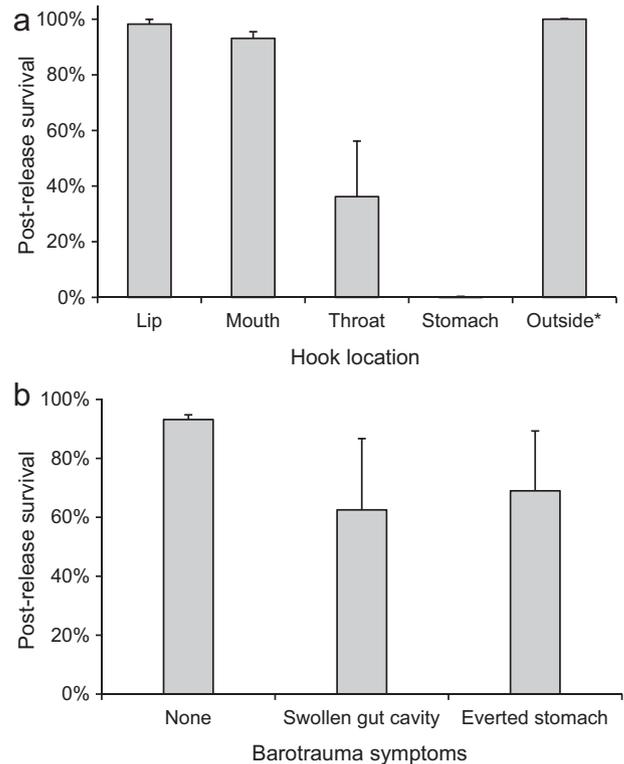
**Table 1**  
Number of *G. scapulare* as a function of trip, depth, size, depth × size, observed barotrauma symptoms, location of hook upon capture and storage method.

Factor	Level	Number of observations
Trip	A	93
	B	40
	C	17
	D	33
Depth	Shallow (<80 m)	92
	Deep (≥80 m)	91
Size	Legal (≥35 cm TL)	42
	Sub-legal (<35 cm TL)	141
Depth × size	Deep × legal	28
	Deep × sub-legal	64
	Shallow × legal	14
	Shallow × sub-legal	77
Barotrauma symptoms	None	172
	Swollen gut cavity	5
	Everted stomach	6
Hook location	Lip	53
	Mouth	117
	Throat	7
	Stomach	2
	Outside mouth	4
Holding method	Cage	93
	Modified cage	33
	On-board tank	57

**Table 2**

Accumulated analysis of deviance from the final GLM analysis of the post-release survival of line-caught *G. scapulare*. Hook location had five levels (lip, mouth, throat, stomach and outside) and barotrauma symptoms had three levels (none, swollen gut cavity and everted stomach).

Factor	d.f.	Deviance	Mean deviance	Deviance ratio	Approx. chi prob.
Hook location	4	32.479	8.120	8.12	$P < 0.001$
Barotrauma symptoms	2	6.544	3.272	3.27	$P = 0.038$
Residual	176	64.756	0.368		
Total	182	103.779	0.570		



**Fig. 3.** Short-term (<3 days) adjusted post-release survival of *G. scapulare* as a function of (a) hook location upon capture and (b) observed barotrauma symptoms. \*Outside represents hooks located outside the mouth upon capture.

bladders examined were observed to be partially inflated on dissection. Injection of air into partially inflated swim bladders revealed that, in most cases, a thin film of tissue had formed over the perforation (Fig. 2), allowing the retention of swim bladder gases as soon as 1–2 days after capture. This film of tissue remained intact during injection of air into the swim bladder, although in some cases the film ruptured under pressure allowing gases within the swim bladder to escape.

An initial GLM indicated that neither holding facility (cage, modified cage, on-board tank) or “Trip” (A, B, C and D) affected ( $P = 0.174$  and  $P = 0.445$ , respectively) post-release survival and, therefore, survival data from the four trips were pooled. The GLM with all terms added indicated that only the hook location upon capture ( $P < 0.001$ ) and observed barotrauma symptoms ( $P = 0.038$ ) significantly affected the post-release survival of *G. scapulare*, with the final model incorporating only these two factors (Table 2). This GLM indicated that the overall short-term post-release survival was 91.6%. No stomach-hooked fish ( $n = 2$ ) and only 36.2% of throat-hooked fish ( $n = 7$ ) survived. Fish hooked in the lip, mouth or outside the mouth had survival rates of 98.2%, 93.1% and 99.9%, respectively (Fig. 3a). The survival of throat-hooked fish was found to be significantly lower than both lip-hooked and mouth-hooked

fish ( $P < 0.001$ ). The low number of stomach-hooked fish made statistical comparison to other categories problematic, with [Genstat \(2011\)](#) suggesting there was no significant difference (i.e.  $P > 0.1$ ) between the survival of stomach-hooked fish and fish hooked in other locations, despite the fact that no stomach-hooked fish survived.

Observed barotrauma symptoms were also found to have affected the post-release survival of *G. scapulare* ([Fig. 3b](#)). Post-release survival was highest (93.2%) for fish that exhibited no signs of barotrauma ( $n = 174$ ). 69.0% of fish observed with an everted stomach ( $n = 7$ ) survived, while 62.5% of fish observed with a swollen gut cavity ( $n = 5$ ) survived. The reductions in survival for *G. scapulare* showing signs of a swollen or everted stomach, compared to those without obvious barotrauma symptoms, were statistically significant ( $P = 0.033$  and  $P = 0.048$ , respectively). The presence of barotrauma symptoms in angled *G. scapulare* was not affected by any factor tested (depth or size category).

Fish size was the only factor found to have significantly affected the incidence of the healing of swim bladder perforations acquired during capture. The incidence of healing in sub-legal *G. scapulare* was 54%, significantly ( $P = 0.018$ ) higher than in fish of legal size (32.5%). Mean perforation size in legal and sub-legal *G. scapulare* was 7 mm and 6 mm, respectively, and did not differ significantly at the 95% level of confidence ( $t_{78} = 1.99$ ;  $P = 0.21$ ).

#### 4. Discussion

The 91.6% overall *G. scapulare* post-release survival rate is at the higher bounds of reported post-release survival of discarded line-caught fish. [Bartholomew and Bohnsack \(2005\)](#) reported that catch-and-release discard survival averaged 82% (range 5–100%) in a meta-analysis of 274 studies of post-release mortality of freshwater and saltwater species, with 46% of survival estimates reported to be above 90%. This estimate included data from a previous study ([Muoneke and Childress, 1994](#)), which reported an average post-release survival rate of approximately 81.5% from a meta-analysis of 132 separate studies of freshwater and saltwater species.

In accord with [Bartholomew and Bohnsack \(2005\)](#) and [Muoneke and Childress \(1994\)](#), hook location was found to be the best predictor of post-release survival of line-caught *G. scapulare*. Survival was lower in both throat-hooked and stomach-hooked fish, with no stomach-hooked fish surviving capture. Hook location has been found to be a significant factor affecting the post-release survival of several species in Australia including *G. hebraicum* ([St. John and Syers, 2005](#)), mulloway *Argyrosomus japonicus* ([Butcher et al., 2007](#)) and yellowfin bream *Acanthopagrus australis* ([Broadhurst et al., 2005b](#)). As such, in order to maximise the post-release survival of line-caught *G. scapulare*, it is prudent to highlight methods that reduce the incidence of deep-hooking during capture.

Several authors suggest the use of circle or re-curved hooks, where the point of the hook is perpendicular to the hook shank, in order to prevent the ingestion of hooks (e.g. [Butcher et al., 2008](#); [Cooke and Suski, 2004](#); [St. John and Syers, 2005](#)). Further, in order to prevent ingestion of hooks by line-caught species, some authors have employed modifications to J-style hooks such as small pieces of wire attached to the hook shank ([Butcher et al., 2008](#); [Willis and Millar, 2001](#)), which prevents hooks from being swallowed. Further, [Grixti et al. \(2007\)](#) reported that baits fished on tight lines were less likely to be swallowed than those fished on slack line.

The removal of hooks has been shown to significantly affect the post-release survival of line-caught fish ([Butcher et al., 2007](#); [Wilde and Sawynok, 2009](#)). The removal of hooks from deeply-hooked fish intended for release provides a confounding interaction of three important factors affecting post-release survival – hooking location, trauma associated with hook removal and air exposure

or handling time. That is, the retrieval of hooks located in the stomach is likely to require increased handling time and subject the fish to excessive trauma during hook removal. In the current study, only two fish were stomach-hooked, of which one had the hook removed. Both stomach-hooked fish died. Of the five throat-hooked fish that died, two had the hook removed after capture. As such, there is insufficient information to make recommendations regarding the removal of hooks from deeply-hooked *G. scapulare*, however, given the significant increases in survival reported by [Butcher et al. \(2007\)](#) it would be beneficial to avoid hook removal in deeply-hooked *G. scapulare*.

The high survival rates for *G. scapulare* are in sharp contrast to the poor survival for the West Australian dhufish (*G. hebraicum*) reported by [St. John and Syers \(2005\)](#). These authors reported 49% survival for *G. hebraicum* caught at depths to 59 m, with survival as low as 14% for fish caught between 45 m and 59 m. However, these authors used much smaller, circular (75 cm diameter) cages compared to those used in the current study. [Brown et al. \(2010\)](#) found that the post-release survival of red emperor (*Lutjanus sebae*) was 0% in small cages compared to 98.4% using the larger cages deployed in the current study. [St. John and Syers \(2005\)](#) reported that duration of caging affected the mortality of *G. hebraicum*, while this factor was found not to have significantly affected the survival of *G. scapulare* in the current study. It is possible, therefore, that the results reported by [St. John and Syers \(2005\)](#) underestimate the post-release survival of *G. hebraicum*.

Only 11 (6%) of the 183 *G. scapulare* caught during the survival experiments exhibited barotrauma symptoms. In contrast, exophthalmia and swollen gut cavities occurred in a high proportion (~45% and ~58%, respectively) of *G. hebraicum* caught in depths between 45 m and 59 m ([St. John and Syers, 2005](#)). These symptoms were also present in *G. hebraicum* caught in shallower water (15–29 m and 30–44 m) although at lower frequencies. The incidence of barotrauma symptoms was significantly lower in *G. scapulare* caught during the current study with only 9% and 3% of fish caught in deep water ( $\geq 80$  m) and shallow water ( $< 80$  m), respectively, exhibiting barotrauma symptoms. Barotrauma symptoms were milder in *G. scapulare*, with no incidence of exophthalmia observed even from 130 m water depth.

Contrasting post-release survival rates in congeneric species was also reported by [Brown et al. \(2010\)](#), who found that two Lutjanids, *L. sebae* and *Lutjanus campechanus*, had post-release survival rates of 98.4% and 77% (as reported by [Rummer and Bennett, 2005](#)), respectively. [Brown et al. \(2010\)](#) offer no explanation as to the cause of the difference in mortality rates. [St. John and Syers \(2005\)](#) attributed the very low post-release survival rates of *G. hebraicum* to their susceptibility to barotrauma, highlighting that the blood chemistry of *G. hebraicum* impairs their recovery from high activity levels or pressure changes due to line capture. Further, although speculative, the difference in post-release survival between these two Glaucosomatids may be the respective habitats favoured by each species, with *G. hebraicum* most often associated with hard reef ([Hesp et al., 2002](#); [McKay, 1997](#)), while [McKay \(1997\)](#) states that *G. scapulare* are a “midwater feeder moving well up off the bottom”. As such, *G. scapulare* may be better able to adapt to changes in ambient pressure compared to *G. hebraicum*, resulting in milder and lower incidences of barotrauma symptoms in the former.

The stages of barotrauma observed in *G. scapulare* are consistent with those reported by [Brown et al. \(2010\)](#) for *L. sebae*. Bubbles were often observed rising to the surface as individuals were being angled due to the perforation of the alimentary tract and the gases escaping the gut cavity, with larger bubbles observed in greater depths suggesting that the rupture of the alimentary tract occurred at greater depths. As such, we assumed that all *G. scapulare* caught as part of the experiments suffered barotrauma and were likely to have had the swim bladder rupture at some point during capture.

The rapid healing of the perforated swim bladder is consistent with studies by Burns and Restrepo (2002) and Nichol and Chilton (2006) who reported the healing of swim bladder perforations in red snapper (*L. campechanus*) and Pacific cod (*Gadus macrocephalus*), respectively, occurred within four days. Further, both Humborstad and Mangor-Jensen (2013) and Midling et al. (2012) reported that the swim bladder of the Atlantic cod (*Gadus morhua*) is functional within days of perforation and capable of maintaining buoyancy.

The speed at which the swim bladder heals may be important in the survival of *G. scapulare* in the longer term. A ruptured swim bladder can result in an inability to maintain position at a given depth without significant finning due to negative buoyancy (Render and Wilson, 1994). *G. scapulare* were observed finning while in holding tanks aboard the *Tom Marshall*, with the caudal fin making S-shaped movements while the pectoral fins moved in a figure-eight pattern in order to maintain position within the tank due to the slight current generated by the seawater in-flow. This may lead to exhaustion in released fish, with increased predation expected in fish released with a perforated swim bladder.

In conclusion, *G. scapulare* appear to be a resilient species with regard to catch-and-release, with our experiments indicating that more than 90% survive capture and release after 3 days. *G. scapulare* swim bladders rupture during ascent from depth, before the alimentary tract ruptures, allowing swim bladder gas to escape via the stomach, resulting in low incidences of obvious barotrauma symptoms. Hook location was found to be the best predictor of post-release survival, with the survival of stomach- and throat-hooked fish significantly lower than those hooked in the mouth or lip. Regulatory discards are relatively low and are not likely to significantly impact estimates of fishing mortality. Using traditional fishing methods – baited J-style hooks on paternoster rigs – very few fish are stomach-hooked resulting in low post-release mortality. The use of circle hooks, fished actively on tight lines, combined with minimal handling will maximise the post-release survival of *G. scapulare*. Any hooks located in the throat or stomach should be left *in situ*, with the line cut outside of the mouth.

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