Background and proposed design for an experiment to estimate discard mortality of line-caught Tailor (*Pomatomus saltatrix*) in Australia’s east coast recreational fishery

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This publication describes a proposal for a study of discard mortality of line-caught Tailor, one of Queensland’s premier sport angling fishes, and summarises similar work from other fisheries.

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1. Introduction

Australia’s east coast Tailor stock supports a substantial recreational fishery, with its annual catch currently estimated to be 3–4 times the size of the commercial catch of the same stock (Dichmont et al. 1999). Estimates of recent harvest rates indicate that up to 80% of fish available to the fishery are actually caught in a year (Leigh and O’Neill 2004).

The population has a south to north distribution along Australia’s eastern states but the major fishery extends only from the Victoria-New South Wales border to Queensland’s central coast (Latitude = 24ºS). Sexually mature adults (males 260mm, females 280mm) form schools that move into the ocean beach surf zone and around rocky headlands between Byron Bay, NSW and Sandy Cape, Fraser Island (Zeller et al. 1996).

The largest spawning tailor aggregation occurs in the inshore waters between Indian Head and Waddy Point, Fraser Island. Adults migrate northward to spawning areas in southern Queensland from June to October. This coincides with the time that tailor are heavily targeted by recreational fishers in Queensland (Zeller et al. 1996).

Fishing pressure is extremely heavy on many one-year-old fish (~30–50%) and all fish aged 2 or more. Although there is no evidence that fishing pressure is affecting recruitment, the possibility of a downturn in recruitment for even a single year could lead to a complete closure of the fishery for several years to allow recovery, which would not be guaranteed. The survival of the fishery should require that at least one full age class be able to reproduce (Leigh and O’Neill 2004).

Reductions (~50%) in both exploitable biomass and egg production since the 1970s present clear evidence that fishing pressure on tailor is increasing to potentially unsustainable levels (Leigh and O’Neill 2004). Two-year-old fish have also become significantly smaller over the same time period, most likely as a result of increased fishing pressure combined with the growth of small one-year-old fish, which are not selected by the fishery, into small two-year-olds (Leigh and O’Neill 2004).

Current stock management strategies in Queensland include a minimum legal size of 300mm (TL), an annual two-month (August-September) closure to all forms of fishing in the spawning area (Leigh and O’Neill 2004) and more recently, a recreational bag limit, an option which was generally favoured by anglers prior to its implementation (Zeller et al. 1996). In May 2002 the limit was set at 20 fish, with Fraser Island as an exception allowing a limit of 30 fish for visitors staying 3 nights or more (Leigh and O’Neill 2004).

After recent assessment of the east coast tailor stock, Leigh and O’Neill have recommended that an increased minimum size limit (to 400mm TL) be implemented in both Queensland and NSW as an additional protection measure in the face of current and future fishing pressure (Leigh and O’Neill 2004). The success of this measure will be largely dependent on acceptable discard mortality rates.
2. Previous discard mortality experiments

2.1 Methods

2.1.1 Field studies versus laboratory studies

Experiments assessing discard mortality have generally favoured ex-situ conditions for release environments. This is largely due to the logistical difficulties of releasing fish into net pens or cages in a marine environment, including the incapacity to control environmental conditions (Davis 2002).

A major shortfall of holding fish in cages or pens after capture is the absence of predators (Davis 2002). In marine systems a large component of discard mortality results from increased predation pressure (Cooke & Philipp 2004). Tag and recapture studies maintain the effects of predation but are unable to discriminate between natural and catch-related causes of mortality (Davis 2002), thus should only be used as an accessory to the main experiment.

A variation on tag and recapture studies involves the implantation of transmitters into the gut of caught fish, a procedure requiring less than 30 seconds, minimal handling and no anaesthetic (Cooke & Philipp 2004). This method of assessing discard mortality is, however, time-restricted and usually allows for a monitoring period of less than 24 hours (Cooke & Philipp 2004).

Long holding periods require excellent environmental conditions, use of valid controls, and careful monitoring of fish health. Delayed discard mortality rates can be overestimated when disease and parasite outbreaks occur due to crowding of injured fish (Davis 2002).

Although field studies can incorporate the numerous interactions among fishing equipment, environmental conditions, and fish species, patterns and generalities are more likely to be revealed with systematic laboratory experiments. A combination of lab and field studies is essential (Davis 2002).

2.1.2 Transport and holding tanks

Short-term studies on discard mortality have generally employed relatively small holding tanks for observation. Ayvazian, Wise and Young (2002) held discards for two hours in a plastic circular seawater holding pool of 3m diameter by 0.5m depth (~3500 litres). This pool was then further divided into 5 compartments, one for each hook type.

However, several long-term studies have also utilised compact discard holding tanks. For example, a Pacific Halibut discard mortality experiment held fish in 1m × 1.5m × 1.2m deep aluminium tanks with a loose cover over the top. Despite the large body sizes of captured fish (56–90cm), each tank held eight discards for 4–10 days (Kaimmer and Trumble 1998). Additionally, Fabrizio et al. (2002) held tailor for up to 86 days in glass laboratory aquaria.

In comparison, a study on the cumulative, long-term effects of catch and release fishing on bonefish held them in a predator-free lagoon where they were repeatedly
caught with a rod and reel using baited hooks. Mortality rates were only 4.1% despite up to 10 catch and release events (Cooke & Philipp 2004).

Whereas discard mortality experiments have used holding tanks of various sizes, materials and configuration, transportation apparatus’ have been fairly consistent between studies. Ayvazian, Wise and Young (2002) used small, aerated plastic holding tanks for the transport of tailor caught on boats. Malchoff (1995) held tailor onboard in similar tanks (378 l) and transferred them to insulated fish boxes (680 l) for subsequent road transport to cages, floating pens and an enclosed lagoon.

2.1.3 Data recorded

In Botany Bay this year, survival of caught-and-released recreational fish species was assessed through the vehicle of a catch-and-release competition (Broadhurst 2004). Anglers presented their catch to designated research stations for tagging, data collection on the capture process and subsequent transportation to sea cages (Broadhurst 2004). The affixation of tags to individuals is a means of recording details such as catch circumstances, hook type, hooking location and environmental conditions (Reiss et al. 2003).

Data recorded by Malchoff (1995) in the USA included: trial duration, water temperatures at capture site and holding site, hook number, presence/absence of barb, bait type (artificial or natural), depth at capture, unhooking gear, and fishing mode (boat or shore).

Additional data on fish condition were collected by Ayvazian, Wise and Young (2002) and Kaimmer and Trumble (1998). Injury classes specified by the former were: no observable injury, abrasion, puncture, tear, and hook lodged in fish. Condition codes were assigned by the latter based on a close inspection of hook removal injuries, bleeding and gill colour, evidence of predation, and muscle tone.

2.1.4 Controls

The purpose of collecting control fish for discard mortality experiments is to eliminate the effects of baseline mortality due to restraint (Reiss et al. 2003). Methods for catching control fish vary but generally involve netting or electrofishing.

Two different methods have been used for specific tailor studies. Malchoff (1995) collected control fish from a commercial pound net operation and reported higher rates of mortality in the control fish than the experimental discards. Poor survival may have been due to compounding of the existing stress of confinement in a pound net box (Malchoff 1995). Alternatively, Ayvazian, Wise and Young (2002) identified the shortcomings of netting control fish and instead caught controls using barbless single hooks. This method only posed a problem when the hooks were swallowed (Ayvazian pers. comm.).

2.2 Key Mortality Factors

2.2.1 Hooking location

Location of hooking wound is the single most important factor influencing catch-and-release mortality (Reiss et al. 2003). Deep-hooking (gullet or gills) causes relatively
high mortality (up to 35%) whereas normal hooking (lips or jaw) causes minimal mortality (consistently <5%) (Reiss et al. 2003).

Ayvazian, Wise and Young (2002) concluded that hooking mortality rates of tailor were significantly affected by injury position. Gill injuries were responsible for significantly higher mortality rates than other injury positions (throat, eye, lower jaw, upper jaw, head and body). Mortality rates of 3.0% for jaw-hooked and 31.3% for gut-hooked tailor have been reported by scientists engaged in unpublished catch-and-release survival studies (Ayvazian, Wise and Young 2002).

2.2.2 Hook type

The location of a hooking injury is generally a function of hook size and type, and bait type (Reiss et al. 2003). Ganged hooks are more likely to cause jaw injury, whereas single hooks, both barbed and barbless, are more likely to cause gill injury (Ayvazian, Wise and Young 2002). Tailor is commonly angled using large gangs with whole pilchard bait and small gangs or single hooks with whole sandy sprat bait (Ayvazian, Wise and Young 2002).

Ayvazian, Wise and Young (2002) found significant differences in short-term mortality rates of tailor across different hook type categories (treble, large gang, small gang, single barbed, single non-barbed). Ganged hooks with terminal trebles imposed higher mortality rates than other hook types on all size classes of tailor. A proposed factor influencing this higher mortality rate is the physiological stress caused by the substantial handling time required to remove multiple and treble hooks.

2.2.3 Fish size/age

Tailor were categorised by Ayvazian, Wise and Young (2002) as below legal minimum length (then 250mm TL; currently 300mm) and above legal minimum length. They found short-term hooking mortality rates to be lower for sub-legal fish than legal-sized fish, suggesting that the current Western Australian minimum size limit is an effective stock management tool. Mortality rates were also low for legal-sized fish, supporting the use of a bag limit.

Discard mortality experiments in the USA by Fabrizio et al. (2002) discovered that the risk of mortality in adult tailor decreased with increasing age. A 5 yr-old tailor is 1.63 times more likely to survive being discarded than a 4 yr-old fish. Ages of tailor have been determined in the past by studying otolith rings or through tagging programs, as performed by Young et al. (1999) in Western Australia’s Swan Estuary.

2.2.4 Physiological stress

Stressors that may induce physiological responses in fish include capture stressors (wounding, exhaustion), fishing conditions (time, equipment, environmental conditions, handling procedures), and biological attributes (behaviour, size and species) (Davis 2002). When fish are exposed to interacting stressors during or after capture, visible injury may not accompany mortality and behaviour may be a more sensitive measure of fish condition and potential mortality (Davis 2002).

Stress is measured using indicators such as changes in behaviour, blood physiology and mortality. More specifically, deficits in feeding, orientation, and predator evasion and mortality increase with stressor intensity. These factors cannot be readily
measured in field studies (Davis 2002). Because stress causes a shift from anabolic to catabolic processes, measurement of factors that control growth (IGF-I and growth hormone) could be valuable for assessing discard fitness and mortality (Davis 2002).

Exercise performed by fish during a catch event, or caused by angler handling methods creates measurable physiological responses (Reiss et al. 2003). Large tailor fight to exhaustion when hooked (Leigh & O’Neill 2004). Strong tackle and heavy lines allow fish to be landed rapidly, avoiding exhaustion and minimising extreme exercise and negative stress effects (Reiss et al. 2003).

Excessive handling increases the likelihood of loss of body slime and physical injury due to struggling (Reiss et al. 2003). Researchers in the USA have discovered that tailor potentially suffer long-term fungal infections to the skin after being handled (Leigh & O’Neill 2004; A. Butcher pers. comm.)

2.3 Mortality results

There appears to be a paucity of data on discard mortality rates in line-caught tailor. The three identified studies on the topic have utilised largely varying experimental methods. Table 1 summarises their findings.

Table 1: Summary of results of previous tailor discard mortality experiments.

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Study type</th>
<th>Trial duration</th>
<th>Mortality rate</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>#1 Ayvazian et al., 2002</td>
<td>Western Aust.</td>
<td>Plastic seawater holding pools</td>
<td>2h</td>
<td>3.0%</td>
<td>1155</td>
</tr>
<tr>
<td>#6 Fabrizio et al., 2002</td>
<td>USA</td>
<td>Glass aquaria</td>
<td>24h 86 days</td>
<td>25% 54%</td>
<td>67 67</td>
</tr>
<tr>
<td>#9 Malchoff, 1995</td>
<td>North Atlantic</td>
<td>Cages, pens, artificial lagoon</td>
<td>3 days</td>
<td>10.3% (juv. 5.4–21.4%) (adult 12.4%)</td>
<td>132</td>
</tr>
</tbody>
</table>

Although study #1 utilised a substantial sample size, the holding time of discards appears to be insufficient to draw conclusions on short-term mortality. Study #6 appropriated a longer study period, however reliability is compromised by the small sample size. Holding period is sufficient in study #9 but the number of discards sampled is still quite low. Like their experimental methods, the results of these studies are highly variable, making it difficult to draw any generalisations or conclusions about discard mortality rates in line-caught tailor.
3. Proposed experimental design

3.1 Timing and specifics of fishing

Fishing will be completely shore-based and shall occur over a period of 1–2 weeks so as to keep relatively consistent environmental conditions and to ensure large enough sample sizes to reduce error and increase statistical integrity. The restricted size of pens will necessitate trial replication.

If allowable resources and personnel are seen to be insufficient, it may be necessary to employ the assistance of anglers (e.g. a catch-release fishing contest) to increase catch effort. This would put the responsibility on the angler to record data on hook type, hooking location and air exposure time plus handling time. The fish will then be tagged accordingly with a numbered red, yellow, blue or green coloured band for each factor.

3.2 Hook use and removal

The project will assess discard mortality across different hook types. The hooks to be employed are barbless single hooks (control), barbed single hooks, ganged hooks (i.e. three joined hooks) and ganged hooks with a terminal treble.

Hook removal procedures will be classified as either careful or careless (in relation to air exposure time and handling time). Careful removal includes events that expose the fish to air for up to 30s and remove the hook within 40s. Careless removal includes any event that exposes the fish to air for more than 30s or leaves the hook in the fish for more than 40s. Handling techniques will also be considered.

3.3 Controls

Seine nets are seen to be an undesirable option for capture of control fish because it is documented that there is almost no chance of survival of fish discarded by the ocean beach seine-net fishery (Leigh & O’Neill, 2004). Gill nets are also undesirable due to the considerable damage and stress they impose on caught fish.

Ayvazian, Wise and Young (2002) used barbless single hooks to capture control fish. However, these hooks are only useful if they are not swallowed. Our project will make use of barbless single hooks but only if sufficient numbers can be caught this way without the hook being swallowed.

3.4 Data collection

Environmental conditions are to be recorded immediately prior to each catching event. Release style, hook type and injury location will be recorded immediately following each landing. Sizes of fish shall be recorded subsequently and categorised as sub-legal (<300mm) intermediate (300–399mm) and large (400mm+). Factors and classifications are summarised in Table 2.
### Table 2: Data to be collected for each tailor landing.

<table>
<thead>
<tr>
<th>Release style</th>
<th>Hook type</th>
<th>Hooking location</th>
<th>Hooking severity</th>
<th>Size class (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Careful, fast</td>
<td>Single barbed</td>
<td>Jaw/lips</td>
<td>Minimal injury/abrasion</td>
<td>Sub-legal (&lt;300)</td>
</tr>
<tr>
<td>Careless, slow</td>
<td>Single barbless</td>
<td>Eye</td>
<td>Puncture</td>
<td>Intermediate  (300–399)</td>
</tr>
<tr>
<td></td>
<td>3-hooked gang</td>
<td>Gut/gills</td>
<td>Tear</td>
<td>Large (400+)</td>
</tr>
<tr>
<td></td>
<td>3-hooked gang with terminal treble</td>
<td>Other</td>
<td>Irremovable</td>
<td>——</td>
</tr>
</tbody>
</table>

#### 3.5 Holding tanks, transportation and pen design

Small, aerated cooler boxes, similar to those used by Ayvazian, Wise and Young (2002) and Malchoff (1995), will be provided for on-site storage of caught fish until the sample size is sufficient for 4WD translocation to and release into pens.

Tailor can damage mesh nets with their teeth (Dichmont et al., 1999) and can also damage their soft skin by rubbing up against mesh. Therefore, we will assemble rigid, plastic mesh enclosures in a relatively calm area of the surf zone. These pens will be constructed using wire cutters and cable ties. A circular configuration is the most desirable option, as it has been speculated that fish may damage their membranes on cage corners (Ayvazian pers. comm.).

The pens will be anchored to the benthos with heavy weights and floated to the surface with buoys. It may also be necessary to apply further strongholds, such as ropes, in order to prevent excessive movement of the pens with currents.

Evidence suggests that large *P. saltatrix* individuals are cannibalistic (Dichmont et al., 1999) so it will be necessary to physically separate the three different size classes into adjacent pens.

#### 3.6 Feeding during holding period

During their 72-hour captivity period, discards will require at least one feeding. Suitable, natural food sources such as pilchards and other baitfish will be administered to the cages during this time. As to whether the food will be live will depend on availability and the mesh size of the pens.

#### 3.7 Assessing condition/mortality

Mortality counts will be conducted at the conclusion of each 72-hour period. Condition ratings, however, are to be assigned immediately following the landing of a fish. Condition ratings will be based on a severity scale of 1 to 4, with 1 representing minimal injury or abrasion to the fish and 4 representing an irremovable hook within the animal.
3.8 Management outcomes

An increased minimum size limit for tailor relies heavily upon acceptable discard mortality rates. It is predicted that stakeholders would favour the increased minimum size limit over closure extensions or reduced bag limits. We plan to test this hypothesis through the administration and evaluation of angler surveys.

Specific tackle types and fishing techniques can also significantly reduce the mortality of catch and release fishing (Reiss et al. 2003). Discouraging use of treble hooks may be an effective accessory management strategy (Ayvazian, Wise and Young 2002).
4. References


