Understanding shelf-break habitat for sustainable management of fisheries with spatial overlap

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Non-Technical Summary

OUTCOMES ACHIEVED

The shelf-edge is the region of seafloor where the flat continental shelf drops away rapidly to form the continental slope in about 150 to 400 m depths. Although important to fisheries, shelf edge habitats off Tasmania were poorly known due the difficulty of conducting research at such great depth. This project provided fisheries managers with information to evaluate whether bottom trawling had an adverse impact on the habitats of giant crabs in the area where trawl and giant crab fisheries overlapped.

'Bryozoan thicket' (dominated by emergent bryozoans plus small erect sponges and ascidians) was one of four main habitats identified, and the dominant habitat where giant crabs are fished.

Our risk analysis showed the bryozoan thicket was potentially at risk from trawling but not crab trapping. The primary factors resulting in this difference between gears were: (i) the entire Tasmanian distribution of this habitat being available to the trawl fishery; (ii) very high overlap of trawl effort with its distribution (high encounters), and (iii) relatively high degree of impact of trawls that are heavy and have a large footprint.

There was no evidence that degradation of bryozoan habitat was directly detrimental to giant crabs based on loss of prey because prey did not show a strong association with the bryozoan habitat. However, a distinctive spatial pattern was observed in abundance of undersize crabs, with greatest density off NW Tasmania. This hot-spot appears to be more a function of larval advection than habitat traits. These observations show the need to evaluate habitat use in the context of fishery spatial management, especially since very little of the bryozoan habitat falls under formal spatial management arrangements for ongoing protection.

The shelf-edge is the region of the seafloor where the flat continental shelf drops away rapidly to form the continental slope – the steep edge of the continental margin that continues to the abyssal plains. The depth of the shelf edge is roughly between 150 and 400m. It's an important area for fisheries and is targeted by trawl and trap fisheries around Tasmania. This project was developed to address a need for improved understanding of the benthic habitats in these areas. Prior to this project there was little information on habitats in these areas because sampling at these depths is challenging and requires specialised gear. Management of fisheries operating in the area had no habitat information to inform decision making - and this was especially needed for discussion of interaction of different sectors operating in the region (i.e. bottom trawl and giant crab fisheries).

Objective 1. Define and map key habitats on the shelf edge (~80-180 fm, 150-330 m) at locations around Tasmania where fisheries using different gear types interact.

A range of methods was used to examine habitat along the shelf break including towed video, digital stills, swath mapping, sled tows and current and temperature profiling. Video transect data was emphasised in analyses for the project and provided qualitative information on faunal assemblages plus quantitative information on faunal categories, substratum type and geomorphology.

Key habitats on the shelf break were defined and mapped. Four categories of sessile fauna predominated: (1) ‘thicket or turf’ dominated by emergent bryozoans plus small erect sponges and ascidians; (2) low and/ or encrusting bryozoans and sponges; (3) low microfauna in association with detritus; and (4) absence of epifauna (often with bioturbation). Latitudinal variation in habitat was slight with differences between samples driven by depth, and whether the samples were from within canyons.

Observations of microhabitat use by exploited species were made with video and digital stills data. Although finfish tended to avoid the gear, giant crabs were less responsive and 75 were observed. They were often observed excavating sediment, sometimes partially buried, while many were using small-scale habitat features including ledges and larger sponge for shelter.

Objective 2. Evaluate the resistance and resilience of habitats to impact from fishing gears using the semi-quantitative 'Ecological Risk Assessment' framework

The ecological risk assessment process applied here used the same approach as applied for the Ecological Risk Assessment of the Effects of Fishing (ERAEF). This is a scoring process for potential risk or vulnerability (low, medium or high) against a series of attributes related to ‘availability’, ‘encounterability’, ‘selectivity’ (when multiplied together = susceptibility) and ‘productivity’. Ranks are sub-fishery (gear) specific, with the rank score for each attribute derived via a series of tables and decision rules. A final risk rating is calculated from a 2-dimensional plot of susceptibility and productivity.

Summarising the risk scores for each sub-biome showed that the shelf-break (200-300 m) is the area of highest risk in respect of both trap and trawl fisheries: > 50% of all habitat images on the shelf-break rated as potentially high risk for trawl, and as medium risk for trap. The outer shelf habitats were mostly not vulnerable to either fishing method. Vulnerability of habitats to gear type was mapped along the coast, which provides guidance for spatial management.

This project offered a unique opportunity to examine the physical impact of a heavy towed epibenthic sled on shelf edge seabed habitat over a 1-year time period between two surveys. Photographic observation detected no obvious signs of habitat recovery in this period.

Clearly defined gear marks were identified in 8671 video-frames, or around 3.2% of the total scored. Of these 20% were observed on the outer shelf (< 200 m), 7% on the shelf-break and 73% on the upper slope (54% in the 350-450 m depth range). Thus, the shelf-break, which was identified as potentially at high risk to impacts from trawl gear and moderately vulnerable to traps, showed the least amount of gear marks. Gear marks observed on the seabed appeared to come mainly from demersal trawls. The distribution of observed gear marks showed a good overall correspondence with areas recorded by logbooks as having trawl effort.

Our ERA analysis showed there is one conspicuous vulnerable habitat type, the bryozoan turf /thicket, potentially at high risk from trawling. The primary factors resulting in this outcome were: (i) its entire Tasmanian distribution was available to the trawl fishery (based on the management boundary); (ii) there was a very high overlap of trawl effort with its distribution (high encounters), and (iii) relative to other gears including crab traps, a trawl has a high degree of impact because it is heavy and has a large footprint. In addition, the habitat occupies a relatively small area, it has low physical resistance to this gear, and its fauna is fragile and completely removable. It occurs in deep water meaning it has relatively low resilience, having evolved in an environment with low natural disturbance and having a slow recovery following impact. Although the intrinsic vulnerability of bryozoan turf/thicket makes it potentially at risk to impact from any gear, it did not score at high risk from crab trapping. This was mainly because there is a lower impact from a lighter, static gear with a smaller footprint.

Objective 3. Detail the distribution of exploited shelf-edge species in relation to habitat features

The information collected on habitat distribution enabled comparison between habitat types and the distribution of commercial species. The distribution of species was mainly inferred from catch rates derived from commercial logbook data, although some information was also obtained through the video data collected for this study. Of particular interest was the distribution of catches relative to (1) the bryozoan habitat and (2) the shelf/shelf break sediment terrace, for morwong, flathead, ocean perch, ling and giant crab.

Giant crabs mainly occupy the bryozoan turf habitat. This distribution overlaps with several commercial finfish including flathead (mainly taken between 150 and 170 m) and morwong (especially 160 and 180 m) while ling catch tended to be further offshore (>350 m).

The data show clearly an increase in catches of flathead and morwong in more recent years (2001-2004 time period), which corresponds to the trawl fishery exploring shallower fishing grounds in that time. Note that change in the blue grenadier catch also occurred through this period, with the majority of that catch taken by midwater trawl where there are fewer interactions with the seabed.

Microhabitat utilisation was also observed for several commercial finfish and giant crab.

Objective 4. Evaluate ecosystem links within habitats based on trophic, temperature and current-flow data.

Potential and known prey items of giant crabs were compared across habitat types. The collective distributions of prey (and inferred prey) groups of the giant crab did not show a strong association with the structured and vulnerable bryozoan habitat occurring in the interaction area. Thus, there was no evidence that degradation of bryozoan habitat is directly detrimental to giant crabs based on loss of habitat for their prey. Conversely, occasional observations carrion on the seabed suggests the discarded component of trawl catches may provide an additional food source.

Patterns in CPUE of undersize and male crabs from western Tasmania were consistent with movement to deeper water in winter and shallower water in summer. This pattern may be driven by the seasonal patterns in water temperature with crabs moving to deeper water in response to warmer water in winter (i.e. the reverse of surface waters).

Undersize crabs appeared to occupy the same depth range as legal sized catch although a distinctive spatial pattern was observed with a concentration of undersize crabs along the NW region of Tasmania. We explored whether this hot-spot of undersize abundance was a function of habitat / environmental traits of the region or of larval supply. Observations on habitat in this NW region did not identify any traits that would explain the greater abundance of juvenile crabs in this region. In contrast, simulation of larval advection suggests that this region may be a larval sink, thus explaining the abundance of undersize in this region. The observation highlights the potential importance of the NW for any discussions of spatial management.

Objective 5. Evaluate the use of video to obtain stock assessment information such as abundance, sex ratio, condition and size of target species, primarily the giant crab.

A variety of target species were observed in videos, including pink ling, morwong, gemfish and giant crab. Fish species typically fled from the towed camera platform, and thus the value of fish observations was limited. In contrast, giant crabs typically showed little sign of avoidance. We observed 75 giant crabs that could be positively identified in the 77 hours of video collected throughout the surveys. This clearly indicated that abundance and density estimation by video to contribute to regular assessments would not be feasible due to cost. However, video data have complementary and valuable for point estimates of some assessment input data.

Two potential and valuable applications of video data for the crab fishery are: (i) quantification of gear selectivity, as a portion of the crabs observed could be measured by stereoscopy; (ii) validation of model based estimates of crab abundance of a smaller subset of the fishery using swept area methods.

KEYWORDS: shelf break habitat, ecological risk assessment, video sampling, trap impacts, trawl impacts, benthic habitat, *Pseudocarcinus gigas*.