Deep-Sea Research I 98 (2015) 10–20

Contents lists available at ScienceDirect

Deep-Sea Research I

journal homepage: www.elsevier.com/locate/dsri

Comparison of baited longlines and baited underwater cameras for assessing the composition of continental slope deepwater fish assemblages off southeast Australia

D.L. McLean [a,*], M. Green [b], E.S. Harvey [c], A. Williams [b], R. Daley [b], K.J. Graham [d]

[a] The UWA Oceans Institute and School of Plant Biology (M470), The University of Western Australia, 35 Stirling Highway, Crawley 6009, WA, Australia
[b] CSIRO Marine and Atmospheric Research, Castray Esplanade, Hobart 7001, TAS, Australia
[c] Department of Environment and Agriculture, Curtin University, Perth 6845, WA , Australia
[d] Australian Museum, College Street, Sydney 2000, NSW, Australia

ARTICLE INFO

Article history:
Received 12 June 2014
Received in revised form
6 November 2014
Accepted 9 November 2014
Available online 5 January 2015

Keywords:
Demersal longlines
BRUVs
Gulper shark
Fish assemblage composition
Fishery management
Fishery monitoring

ABSTRACT

Expansion of demersal fisheries into the deep sea has driven a need for methods to provide information on the status of deepwater fish assemblages, especially for vulnerable species. For this purpose, we compared co-located sampling by baited longlines and baited remote underwater video systems (BRUVs) off southeastern Australia and found these techniques observed different elements of the continental slope fish assemblage, but were complementary for monitoring needs. Of the 94 species surveyed in total, only 32% were common to both survey techniques, with BRUVs sampling fewer species, with 51 species detected compared with 73 species captured by longlines. Species detected exclusively by BRUVs (21 spp) included those not vulnerable to longline hooks, and those with large-body size—including several chondrichthyans. One group of chondrichthyans, gulper sharks (*Centrophorus*) were the focus of this study because they are listed as conservation dependent under Australia's Environmental Protection and Biodiversity Conservation Act, and are subject to a management plan that requires their recovery to be monitored. Very few gulper sharks were observed by BRUVs ($n=10$). Longlines captured 773 gulper sharks suggesting this technique provides a more effective means of sampling. However, most longline caught sharks were either dead or in poor condition on capture, further depleting this vulnerable species. BRUVs are non-lethal, but a high sampling intensity is likely to be needed to detect changes in gulper shark abundance within typical management timeframes (years).

1. Introduction

Heavy exploitation of many coastal and continental shelf fish species, in combination with advancements in fishing technology, drove an expansion of demersal fisheries onto deeper (~200–1500 m) continental slope areas globally in the 1960s and 1970s (Koslow et al., 2000). Initially, catch rates of slope fishes were often high because stocks were virgin and/or because large spawning aggregations were targeted, e.g. orange roughy (Bax et al., 2006) and blue grenadier (Punt et al., 2001). Low productivity, low fecundity, slow growth, late maturity and long life spans typical of many deep-living species rendered them particularly vulnerable to overfishing (Horn et al., 1998; Cailliet et al., 2001; Devine et al., 2006; Kyne and Simpfendorfer, 2007). As a result, sequential depletion of various commercial benthopelagic species aggregations around the globe has led to overexploitation and even the collapse of target stocks in mid-slope depths (~700–1200 m) (Koslow et al., 2000).

In Southeastern Australia, upper slope (~200–700 m depths) fishing commenced in 1968, rapidly expanding in the 1970s and 1980s (Graham et al., 2001). This led to a significant reduction in total fish biomass and the abundance of most commercial upper slope species (Andrew et al., 1997). These fishing impacts have been notably high on deep-sea sharks, with many squaliforms depleted before the late 1990s (Graham et al., 2001; Daley et al., 2002). Most severely affected were gulper sharks (*Centrophorus* species), which are believed to have the lowest reproductive potential of all chondrichthyans (Kyne and Simpfendorfer, 2007). Initially gulper sharks were a major component of the bycatch and were later exploited for meat and liver oil (Graham et al., 2001). A lack of information on the biological status and ecological requirements of gulper sharks and other deep-sea chondrichthyan and scalefish species compounds their inherent vulnerability to overfishing. Such information is

* Corresponding author.
E-mail address: dianne.mclean@uwa.edu.au (D.L. McLean).

http://dx.doi.org/10.1016/j.dsr.2014.11.013
0967-0637/

logistically difficult to obtain from the deep-sea, and is therefore largely sourced from commercial fishery catches (e.g. Daley et al., 2002; Bergh et al., 2009). There is a need for alternative fish population sampling techniques that are non-extractive and fishery-independent, and which can ideally be calibrated with estimates based on commercial catches.

One potentially suitable, non-extractive technique for collecting data on fish species diversity, relative abundance and length is baited remote underwater video (BRUV). This technique has been used extensively in Western Australia to assess the assemblage composition of fishes in shallow coastal and continental shelf environments (e.g. Langlois et al., 2010; McLean et al., 2010, 2011; Watson et al., 2009, 2010; Harvey et al., 2012, 2013). The potential of this technique to provide data on continental slope fish communities is illustrated by a recent study to depths of 1200 m off New Zealand (Zintzen et al., 2012).

In this paper we use BRUVs to examine patterns in the diversity and abundance of continental slope fishes off southeastern Australia and compare the results with co-located catch data from demersal longlines. The study area is mainly within the Australian Southern and Eastern Scalefish and Shark Fishery (SESSF). This is a multi-gear fishery targeting a wide variety of scalefish and shark stocks (AFMA, 2011a) in which better information on the diversity, abundance and size structure of upper continental slope fish communities has been identified as having particular value to fishery managers (AFMA, 2011b). Identifying cost-effective data collection and monitoring strategies is fundamental to obtaining such information for upper continental fish assemblages, and drives the three key aims of the present study:

1. Determine the composition of fish assemblages sampled by demersal longlines and BRUVs.
2. Compare and contrast the results of these baited sampling tools in the context of the factors influencing their selectivity.
3. Discuss the implications of our results for monitoring species impacted by fishing, especially vulnerable groups such as gulper sharks.

2. Methods and materials

2.1. Study sites

Surveys were conducted over a 37-day period between 1st September and 7th October, 2009 from the 22.8 m fishing vessel FV 'Diana'. During this time, a total of 22 sites were surveyed on the upper continental slope along the east coast of Australia from northern NSW (28°10′S, 153°56′E) to eastern Tasmania (41°59′S, 148°38′E), spanning approximately 870 nm. In addition, the Taupo Seamount, ~200 nm east of Newcastle, was also sampled over two days (Fig. 1). By definition, the upper slope includes all habitats in depths between 200 and 650 m (Williams et al., 2005). Effort was concentrated in the 300–600 m depth range with a mean depth surveyed of 465.3 ± 5.1 m SE. Williams and Bax (2001) identified a change in faunal community along the latitudinal gradient and subsequently we assigned sites into three broader region categories (from north to south: 'warm temperate', 'transition' or 'cold temperate'). These were based loosely based on an apparent faunal disjunct identified near Cape Howe (IMCRA, 1998); this being in the centre of our 'transition' region (Fig. 1), Each study site was surveyed using two sampling techniques, bottom-set longlines (automatically baited commercial gear) and BRUVs, with sampling effort detailed in Table 1. BRUVs were positioned adjacent to the longlines, but at a distance to avoid surface float-lines tangling and any fishing interference or influence between the gears. Longlines were set first because they took most time to deploy; being able to rapidly set BRUVs immediately afterwards ensured near-equal sampling periods by each technique.

2.2. Longline surveys

Longlining used a Mustad Coastal auto-line system which automatically baits two hooks per second while the longline is set at a 5 kn vessel speed. The mainline was 7 mm Mustad roto line (swivelled) with 1500 hooks per line; snoods were at 1.4 m intervals, 300 mm long and made from either 1.8 mm monofilament or braided nylon. Hooks were 12/0 Mustad 'super baiters' which were baited with squid sourced from New Zealand and Tasmania; approximately 15 kg of bait was used for each line. The line was anchored at each end with 50 kg steel weights and marked with a surface float and buoy-line; smaller weights and floats were attached at intervals along the line in an attempt to keep the line close to, but above the seabed, according to seabed terrain.

Settings of longlines commenced before dawn and were retrieved in daylight after a soak time of between 3 and 5 h. The distance sampled by a longline was typically ~2000 m from start to end position. A total of 63 successful longline sets was completed, i.e. approximately three replicates at each of the 23 sites, but with a few exceptions where strong currents and hard terrain made it difficult to anchor the longlines in a fixed position (see Table 1).

Each fish caught was identified to the lowest taxonomic level possible. The average number of each species from the three longlines at each station was used to represent relative abundance, resulting in measurements of species diversity and mean relative abundance for each station. Length and sex data were also collected for many species, particularly for commercial teleosts and sharks, but are not reported here. All specimens of *Centrophorus harrissoni*, *Centrophorus zeehaani* and *Centrophorus moluccensis* were sexed and measured (see Graham and Daley, 2011), and many were tagged with dorsal fin tags and released as part of a broader study investigating movement and home-range.

2.3. Video surveys

Each BRUV system consisted of two Sony HC15 digital camcorders (stereo-configuration) within waterproof pressure housings. Further information on the design and calibration of BRUVs can be found in the literature (e.g. Harvey and Shortis, 1995, 1998; Watson et al., 2005). The stereo-video configuration permitted collection of length data for additional research not presented here. Due to the depths sampled, the cameras were set to a night shot recording mode and each system fitted with a Royal Blue light-emitting device (LED) with a wavelength ranging from 450 to 465 nm. The blue LED illuminated the area in front of the cameras to a distance of 5 m. Bait arms, 1.5 m in length and made from 20 mm plastic conduit with a plastic coated wire bait canister fastened to one end, were attached to the BRUVs frames. Each deployment was baited with ~1 kg of squid.

BRUVs were deployed in the immediate vicinity (500–1000 m) of each longline set and were remote, i.e. not tethered to the vessel. At this distance we assumed there was minimal interaction between gear types. Replicate BRUVs were set at least 350 m apart to minimise the likelihood of the same fish being viewed on neighbouring deployments (see Cappo et al., 2004). In areas where there were considerable currents, the BRUVs were inclined to drag or tip over despite being heavily weighted. This was the principal cause of the 11 unusable deployments (Table 1). Each BRUVs deployment recorded 2.5 h of seafloor time. On Taupo Seamount three of the BRUVs operations were on top of the feature, in 133–145 m. These were not used in the comparative analyses, as they were not in the same depth range as the longline operations.

From video imagery, relative abundance counts were made for all species using EventMeasure software (www.seagis.com.au).