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Application of baited remote underwater video stations to assess benthic coverage in the Persian Gulf

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ABSTRACT

A baited remote underwater video station (BRUVS) is generally considered an appropriate sampling tool for fish. The applicability of BRUVS to determine the substrate coverage was assessed by comparing stills from BRUVS videos to traditional point intercept transect (PIT) data to estimate percentage cover (PC) of different benthic substrate categories. Mean PCs of hard corals, rock, sand, and coral growth forms yielded statistically identical values with the two survey methods, while PCs of motile epibenthic invertebrates were underestimated by BRUVS in areas of both high and moderate relief. Yet, multivariate analyses revealed that the two methods yield similar substrate assemblage in an area of moderate relief. Results of our study suggest that the BRUVS can be effectively used to quantify both the presence/absence of a basic set of benthic habitat characteristics and diversity of coral growth forms on coral reefs in the Persian Gulf.

1. Introduction

Coral reef fish are highly associated with their surrounding habitat and actively respond to changes in habitat structure (Sale, 1991). As such, accurate information on relationships between habitat structure and reef fish communities seems fundamental to understanding the effects of natural/ anthropogenic disturbances on coral reef functioning (Jones and Syms, 1998). The main attributes of a marine habitat are structural complexity (topography/rugosity), total biological coverage, and habitat composition (Öhman and Rajasuriya, 1998). Percentage cover (PC) is a widely used metric of habitat structure that can provide estimates of both biological coverage and habitat composition (Hill and Wilkinson, 2004), and is widely used as an indicator of ecological change. For example, PC of live corals can be used as an indicator of the health of coral reefs (Hill and Wilkinson, 2004), changes in microalgae algae cover can be monitored to detect coral–algal phase shifts (McManus and Polsenberg, 2004), and changes in PC of abiotic/ biotic substrata can be used to predict altered settlement and recruitment in reef fish (Tolimieri, 1995). Accurate information for PC is usually obtained by diver-based survey methods (e.g. Manta tow, line intercept transect, point intercept transect (PIT), and timed swimming) (Hill and Wilkinson, 2004). These methods, however, have certain limitations in terms of the diving time and depth, and the availability of trained divers (Hill and Wilkinson, 2004). Remote systems (e.g., remotely operated vehicles, autonomous underwater vehicles, drop video systems) have accordingly been developed (Mallet and Pelletier, 2014; Singh et al., 2004).

A baited remote underwater video station (BRUVS) is a drop video system which is usually used for assessing fish populations. Yet, attempts have been made in recent years to make use of BRUVS in estimating PCs by point sampling of the stills taken off the video from a BRUVS (Cappo et al., 2011; Dorman et al., 2012). In this case, the BRUVS method can be viewed as a promising alternative to the diver-based methods for determining PC which suffers from SCUBA diving limitations. Additionally, it will provide estimates of both cover and fish abundance (and species richness) in a single observational unit, thereby requiring less labor-intensive operations in the field. Meanwhile, performance of the BRUVS as a tool for determining PC may be affected by general problems associated with image analysis and/or point sampling procedures, e.g., detectability issues in complex/rugose environments (Leonard and Clark, 1993), and accuracy issues related to the way(s) that the photos are examined using different point sampling strategies (Endean et al., 1997). The present study was designed to explore the use of BRUVS still photos for estimating benthic cover on coral reefs in the Persian Gulf. We looked for the accuracy of the method by comparing the estimated mean PCs of different substrate categories with the same measurements taken by performing PIT (a diver-based point sampling survey method) surveys. We tested two main hypotheses: (i) suitability of the BRUV method for determining benthic cover is dependent on the habitat rugosity/complexity (expressed as coral relief; (Carpenter et al., 1981)), and (ii) reliability of the estimated PC is dependent on the patterns of points overlaid on BRUVS photos.

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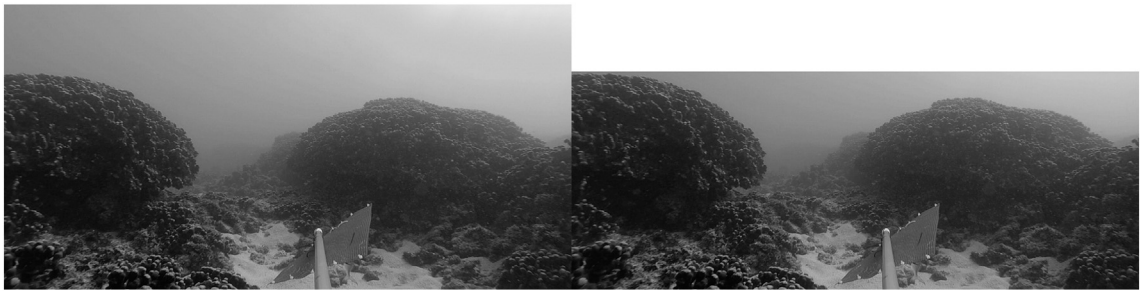

Fig. 1. A BRUV video photograph before (left) and after (right) cropping. Note the reduced proportions of the water column in the cropped image.

2. Materials and methods

2.1. Study area

This study was performed in June 2014 as a part of the Nayband Marine Park monitoring program that assessed the fish assemblages of Borkouh Bay (27°18.345′N, 52°40.389′E; an area of high hard coral relief), eastern Nayband Bay (27°24.153′N, 52°35.378′E; an area of moderate hard coral relief), and western Nayband Bay (27°28.205′N, 52°35.921′E; an area of low hard coral relief). Experimental sites were selected according to their live hard coral covers which were determined in the previous study (Ghazilou et al., unpublished results).

2.2. Experimental procedure and data collection

Two levels of PC measurement were employed:

1- General abiotic/biotic substrate categories including live hard coral (HC), soft coral (SF), sponge (SP), nutrient indicator algae (NIA: Padina sp.; (Nejatkhah-Manavi et al., 2011)), recently killed coral (RKC), rock (RC), sand (SD), rubble (RB), and motile epibenthic invertebrates (MEI).
2- Growth forms of live hard corals including massive, submissive, columnar/digitate, and encrusting.

A horizontal look-outward system was used for BRUVS deployments. In general, two types of BRUV systems, a horizontal-BRUVS (HBRUVS) and vertical-BRUVS (VBRUVS), have been developed for monitoring fish populations but the VBURVS has been shown to be less appropriate for studying coral reef fish communities (Langlois et al., 2006). The BRUV sampling apparatus included a GoPro® HERO3 Black Edition HD camera, fixed 0.30 m above the base of a stainless steel frame, and a plastic bait bag 1.2 m from the camera. All videos were recorded at depths of 4–6 m (a depth range of highest coral cover in the area; (Wilson et al., 2002)). Each cast recorded 60 min of front-view videos using full HD and wide-angle (170°) casting modes. Twelve drops (an optimized sample size for estimating reef fish abundances in the area; Ghazilou et al. unpublished data) were deployed at each study area (Borkouh Bay, eastern Nayband Bay, or western Nayband Bay) separated by a minimum of 250 m (Dorman et al., 2012). Snapshots from the recorded videos (one snapshot per video) were captured in the laboratory, imported into Adobe Photoshop CS4, and cropped to produce 10.66 × 4 in., 300 pixel/in. TIFF images (Fig. 1). The PC of each substrate category or as well as the proportion of coral growth forms were computed for edited images using Coral Point Count with Excel extensions (CPCe) software (Kohler and Gill, 2006). Predetermined numbers of random (10, 25, 40, 65, or 80), stratified random (40), or stratified (40) sampling points were overlaid on each image (Fig. 2). The points were then previewed, and a substrate category was assigned to each point. Those sampling points which were overlaid on the water column were excluded from the analyses.

PIT surveys were performed at the same locations. For each PIT survey, a 100 m fiberglass tape measure (Freemans® — India) was first laid straight on the substratum at the same depth range as BRUV deployments. Close-up top view photos of the substrate were then taken at 0.5-m intervals along four intermittent transect segments 20 m in length (modified from PERSGA, 2004). A total of three transect lines were surveyed at each study area. The PC of the substrate categories and hard coral growth forms were determined by recording the corresponding categories of substrate that occurred exactly beneath the considered point for each photo.

2.3. Data analysis

The comparative ability of the BRUVS to estimate the benthic coverage was evaluated by univariate (i.e. PC of different substrate categories, coral growth form richness and diversity coral growth form diversity) and multivariate (i.e. substrate assemblage) analyses.

2.3.1. PCs of substrate categories

The assumptions of normality and homoscedasticity for the univariate analyses were first assessed using Kolmogorov–Smirnov and Levene's tests, respectively and arcsine square-root transformation was applied to achieve normal distributions (Zar, 1998). A one-way analysis of variance (ANOVA) followed by Tukey's HSD test assessed the impact of the survey method on the estimated PC of each category.

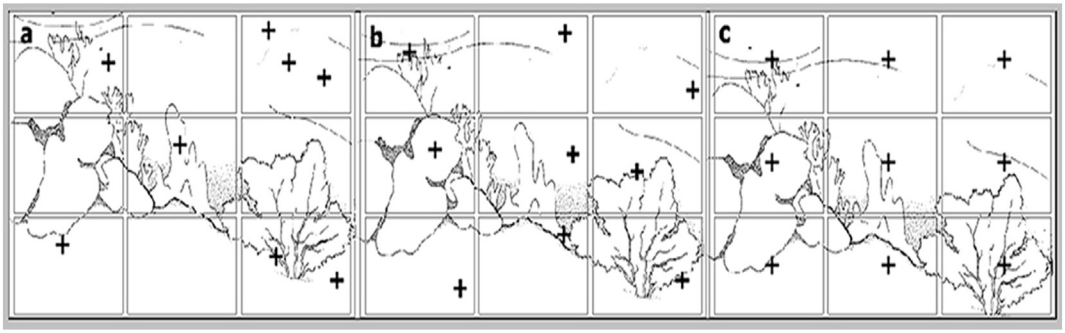

Fig. 2. Strategies by which sampling point were overlaid on BRUV stills: (a) random, (b) stratified random, and (c) stratified.

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