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Evaluating the effect of soak time on bottomfish abundance and length data from stereo-video surveys

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ABSTRACT

Baited stereo-camera surveys of fish assemblages provide conservative estimates of abundance and length-frequency distributions. While underwater camera systems have numerous advantages over traditional fishing and diver surveys, limitations in sampling capacity, data processing time, and resultant data still exist. Previous studies have shown that shorter camera soak times can increase sampling efficiency and reduce per-sample data processing time without affecting overall data quality. Using data from stereo-video surveys of bottomfish in the main Hawaiian Islands, this study evaluates the effect of camera soak time on relative abundance metrics, fish length data, sampling efficiency, and power to detect differences in relative abundance and fish lengths. A soak time of 15 min was found to be the shortest duration able to capture bottomfish abundance and length metrics while 30 min generated data that did not significantly differ from the standard 40-min soak time. These shorter soak times allow for better survey efficiency and improved cost–benefit through increased levels of field sampling and reductions in video-processing time, while maintaining the power to detect differences in bottomfish relative abundance and lengths. The main drawback to shortening soak time was the concurrent reduction in the number of length measurements collected per species. An increased sample yield can alleviate this effect but only for bottomfish with a higher frequency of occurrence. Species-specific patterns in abundance were apparent in this study suggesting a strong influence of fish behavior on stereo-video abundance metrics. While a soak time of 15 to 30 min was found to be sufficient for effectively sampling bottomfish, the cost–benefit of employing a given soak time in future stereo-video surveys should be assessed based on the target species and survey goals.

1. Introduction

The emergence of underwater video-survey techniques in fisheries science has given researchers the ability to move beyond fishery-dependent data and reduce some of the restrictions of depth, habitat, and fish behavior inherent to diver and fishing surveys (Cappo et al., 2007). By generating standardized species-specific estimates of fish abundance that have been found to positively correlate with fish density (Ellis and DeMartini, 1995; Priede and Merrett, 1996; Willis et al., 2000; Willis and Babcock, 2000; Yau et al., 2001; Cappo et al., 2003; Stoner et al., 2008), baited camera systems have proven to be a valuable tool in spatial (e.g. Westera et al., 2003; Moore et al., 2013), temporal (e.g. Denny et al., 2004; Sackett et al., 2014), and ecological (e.g. Gledhill et al., 2005; Misa et al., 2013) surveys of fish assemblages. Furthermore, underwater camera systems offer a non-extractive alternative to traditional research fishing methods, which make them ideal for studying marine protected areas (e.g. Cappo et al., 2003; Willis et al., 2003; Sackett et al., 2014) and conducting monitoring programs (Murphy and Jenkins, 2010).

While stereo-camera systems offer a number of advantages over fishery-dependent or other extractive sampling techniques (Cappo et al., 2007) and allow for sampling beyond normal diver depths (Langlois et al., 2010), limitations exist in the methodology, data processing, and resultant data. Until advances in automated image processing (Shortis et al., 2013) facilitate its regular use on a broader scale, the time requirement for data processing remains a major consideration. The majority of video data processing is currently done by means of human analysts (Somerton and Gledhill, 2005; Lee et al., 2008), and the increasing volume of image data commonly exceeds analyst capabilities. To be useful in regular stock assessments and fishery studies, a faster turn-around from video data collection to numeric data output

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is necessary. As data processing time is proportional to video duration (Cappo et al., 2007), shortening video recordings by decreasing camera soak time has been proposed as a straightforward approach to reduce per-sample data processing time. This approach assumes no significant reduction in overall data quality as a result of shortened soak time. Therefore, an evaluation of abundance metrics with respect to camera soak time may reveal avenues for increased efficiency.

Fish relative abundance has been analyzed against soak time in previous baited underwater video studies to look into species accumulation rates (Willis and Babcock, 2000; Stobart et al., 2007; Haratsi et al., 2015) and differences in abundance at various set times (Stobart et al., 2007; Gladstone et al., 2012; Haratsi et al., 2015). From these studies, it can be inferred that a camera soak time between 15 and 30 min is sufficient for collecting relative densities of shallow-water reef fish. Bottomfish species in the families *Lutjanidae*, *Serranidae*, and *Carangidae* are the main focus of this study. While these fish have a broad Indo-Pacific distribution, they are more prominent at mesophotic depths (100–400 m; Kelley and Moriwake, 2012) and exhibit distribution patterns that differ from their shallow-water cogeners. An assessment of how abundance metrics change with camera soak time has yet to be published for bottomfish species.

Accurate and consistent methods to estimate species-specific size-structured abundance are critical for effective fisheries management (Costa et al., 2006; Lee et al., 2008). Stereo-video systems are able to sample a wider range of fish sizes compared to experimental fishing surveys due to the absence of hook selectivity (Langlois et al., 2012) and can be conducted at depths greater than that attainable in diver surveys (Langlois et al., 2010). Stereo-video metrics can also be coupled with habitat data (Moore et al., 2009; Moore et al., 2010) to provide additional information on a fish assemblage that, when paired with more traditional stock assessment metrics (e.g. catch per unit effort [CPUE]), can yield a more accurate representation of the status of a fish stock.

A recent study by Schobernd et al. (2014) suggested that the video abundance metric MeanCount has a linear relationship with true abundance. This type of data could substantially improve the stock assessment of given fish species, however, further evaluation on a species- and region-specific level is necessary. While the more commonly employed stereo-video relative abundance metric, MaxN, is used in the present study, the validity and cost–benefit of the MeanCount method in generating species-specific size-structured abundance of target bottomfish species will be assessed in future work.

The goal of this study is to evaluate differences in relative abundance metrics, fish length data, sampling efficiency, and data-processing costs at three different soak times by using video from bottomfish stereo-video surveys in the main Hawaiian Islands (Fig. 1). Furthermore, this study aims to provide an assessment of the effect of soak time on the statistical power to detect differences in relative abundance and length data.

2. Materials and methods

2.1. BotCam

The bottom camera bait station (BotCam) is a baited stereo-video camera system developed by Merritt (2005) to collect species-specific size-structured abundance information for commercially important Hawaiian deep slope bottomfish populations. This system has proven effective in recording bottomfish species in their habitats across a variety bottom types and slopes at depths of 100–300 m (Merritt et al., 2011). BotCam is outfitted with two ROS Navigator™ ultra-low

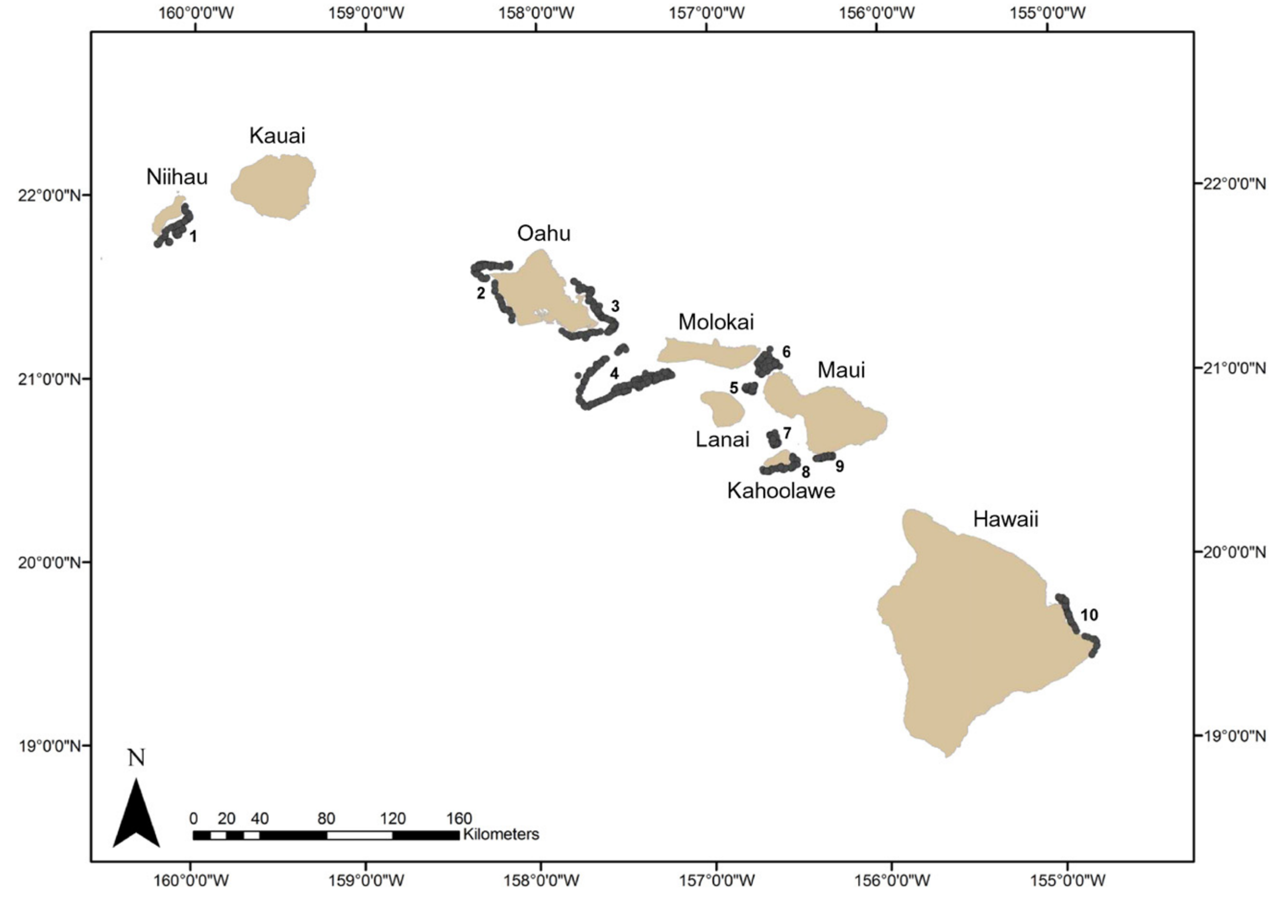

Fig. 1. Map of BotCam sampling regions in the main Hawaiian Islands: Niihau (1), West Oahu (2), East Oahu (3), Penguin Bank (4), Auau Channel (5), Pailolo Channel (6), Kealaikahiki Channel (7), Kahoolawe Island Reserve (8), Alenuihaha Channel (9), Hilo (10).