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Short Note

Do we need to count everything? Monitoring conspicuous epibenthic communities using seabed imagery

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ABSTRACT

The purpose of this paper is to identify whether sub-sampling methods such as the Generalised Visual Fast Count can provide adequate inferences from video data. This is done by comparing the results from sub-sampling video data on species counts from the Fladen Grounds, U.K. with those results from the full data set. We show that the GVFC method can provide complete information on species richness and that estimates of key species' densities are adequate compared to those from the full data. This is achieved from counting only 10% of the individuals present – thus saving time and money.

1. Introduction

The UK is required under international conventions (e.g. OSPAR, the Convention on Biological Diversity), European legislation and directives (e.g. the Birds and Habitats Directives), and domestic policy (Marine and Coastal Access Act) to contribute to an ecologically coherent network of Marine Protected Areas (MPAs) to conserve marine biodiversity and protect species and habitats of conservation importance. Monitoring using robust and repeatable methods of data acquisition and analysis is essential for assessing the status of marine biodiversity required by the policy objectives, as well as to underpin adaptive management of protected sites.

Underwater imaging offers one method of data acquisition for monitoring biodiversity. It can provide qualitative or semi-quantitative data on the physical characteristics of the seabed, such as substrate type, and the presence and enumeration of associated epibenthic communities. It can be particularly valuable for characterising features which cannot be sampled using a grab (e.g. rocky reef), or when monitoring solitary and relatively dispersed benthic megafauna such as sea-pens or sea fans. Seabed imagery also delivers data covering greater spatial scales than point sampling (grabs or cores). Drop camera and camera sledge systems have been used to collect georeferenced seabed video and still images to inform the production of habitat maps and to develop methods for monitoring sensitive features such as subtidal biogenic (*Sabellaria spinulosa*) reefs (Jenkins et al., 2015). One advantage of the sledge system is that the camera is mounted at a constant height above the seabed – providing a fixed field of view that facilitates the quantitative analysis of the data generated, such as counts of conspicuous epifauna.

Individual species counts are made by an analyst viewing the whole video and recording all identifiable organisms. This can be a time-consuming process, particularly when dealing with large monitoring datasets (Turner et al., 2016). Given that monitoring resources are increasingly tight, a relevant question is: *Are there ways to adequately answer the policy objectives of the monitoring which do not involve processing all the data?* For example, if the policy objective is to monitor species richness then only the presence and count of a species per unit area needs to be observed. Also, if a sufficiently precise density estimate for an important species can be obtained from processing only a sub-sample of the data then this is a better and more efficient approach than counting all individuals observed in the video footage.

One potentially useful sub-sampling method is known as the Visual Fast Count (VFC). The standard VFC method, first proposed by Kimmel (1985), works by dividing a video tow into segments. Initially, counts are made of individuals of all species present in the first segment. Counting then proceeds to the second segment. However, here, counts are made only of individuals from species not seen in the first segment. This process continues until the last segment such that once individuals from a species are counted in a segment that species is not counted again. Thus, the method produces only a single non-zero segment count for each species seen. So, for example, the counts for a species found in the third segment might be 0, 0, 4.

One advantage of the VFC method is that it identifies all species within a transect. Barry and Coggan (2010) showed that the VFC method, on average, overestimates species' densities, particularly for rare species. Essentially, this positive bias is because sampling for any

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species stops on a positive species count – i.e. the procedure does not constitute a proper random sample of segments within a transect. Barry and Coggan (2010) also came up with new estimators that produce better results than VFC. The best of these was a method of moments estimator based on the assumption that counts of a species follow a negative binomial distribution. Barry et al. (2015) extended this work to derive a Generalised Visual Fast Count (GVFC) method of moments estimator for the situations where counting of a species in a tow of s segments stops after d positive (d = 1,…,s) counts of the species have been recorded.

The purpose of this paper is to assess whether sub-sampling estimators are adequate to fulfil the monitoring objectives of a specific MPA in the Fladen grounds. Specifically, we compare the performance of the GVFC estimators (d = 1,2) and a method that involves randomly selecting d of the segments within a video transect for counting. These are compared to the results achieved from complete sampling.

2. Materials and methods

2.1. Test dataset

Data used in this study was collected during a joint JNCC/Cefas survey (code CEND0514) on the *RV Cefas Endeavour* between the 20th and 31st March 2014 at the Fladen Grounds, which is in the northern North Sea approximately 80 nautical miles east of Orkney (Fig. 1) (McIlwaine, 2015). Video observations were made using a camera sledge system – the set-up and operation of which followed the MESH 'Recommended Operating Guidelines (ROG) for underwater video and photographic imaging techniques' (Coggan et al., 2007). Camera tows lasted a minimum of 10 min, (sledge being towed at ~0.5–0.7 knots) with still images captured at regular one-minute intervals with additional opportunistic images taken if specific features of interest were encountered. One hundred and sixty-two video tows were analysed following recommended guidelines (Coggan et al., 2007), providing complete counts for 78 species. Each tow was comprised of one-minute segments and, in total, there were counts of each species from 1779 segments of video (mean of 11 segments per tow, minimum 8, maximum 19). Note that the counts used in this paper are relative in that they have not been converted to counts per m^2.

Five of the most common species, including specific key species which characterise the habitats of conservation importance designated within the site, were selected from the total species list identified across all video tows (Fig. 2). Sea-pens *Pennatula phosphorea* (67,934 total count) and *Virgularia mirilabis* (36,288) are characterising components of the "Seapens and burrowing megafauna in circalittoral fine mud biotope" (JNCC, 2015) and their densities per m^2 have been calculated in the development of monitoring options for the Fladen Grounds and mud habitat more generally (Murray et al., 2016) (Fig. 2a, b). The sea urchin *Gracilechinus actus* (63,352) was selected as it was frequently recorded in underwater footage (Fig. 2c), and *Bolocera tuediae* (2084) was selected as it is one of the largest anemones in the North Sea, growing up to up to 250 mm across the base (Fig. 2, d). *Flabellum* sp. (6576) is a solitary cup coral whose distribution in the North Sea is currently scarcely understood (Fig. 2e).

2.2. Statistical comparisons

The following estimators were calculated:
GVFC1: Generalised Video Fast Count estimator with d = 1
GVFC2: Generalised Video Fast Count estimator with d = 2
RS1: Random choice of 1 segment
RS2: Random choice of 2 segments.
For these four estimators we calculate

(a) the number of species detected
(b) the number of individuals counted – which gives an indication of the time saved by the sub-sampling method.

Evaluation was also made of the precision of the sub-sampling method estimates of species density using the percentage absolute error. For species *m* in tow *j*, this was

$$PAE_m = 100\frac{|EST_{m,j} - ALL_{m,j}|}{ALL_m}$$

where $EST_{m,j}$ represents the sub-sampling estimate per segment of the *j*th tow, $ALL_{m,j}$ is the observed mean per segment of all the segment counts in the *j*th tow, and $ALL_m = \sum_{j=1}^{162} ALL_{m,j}/162$ is the mean per segment over all 162 tows. ALL_m was used rather than $ALL_{m,j}$ as this avoided division by zero in the tows where there were no occurrences of the species.

The precision was summarised by calculating means over several species categories. These were

(a) All species

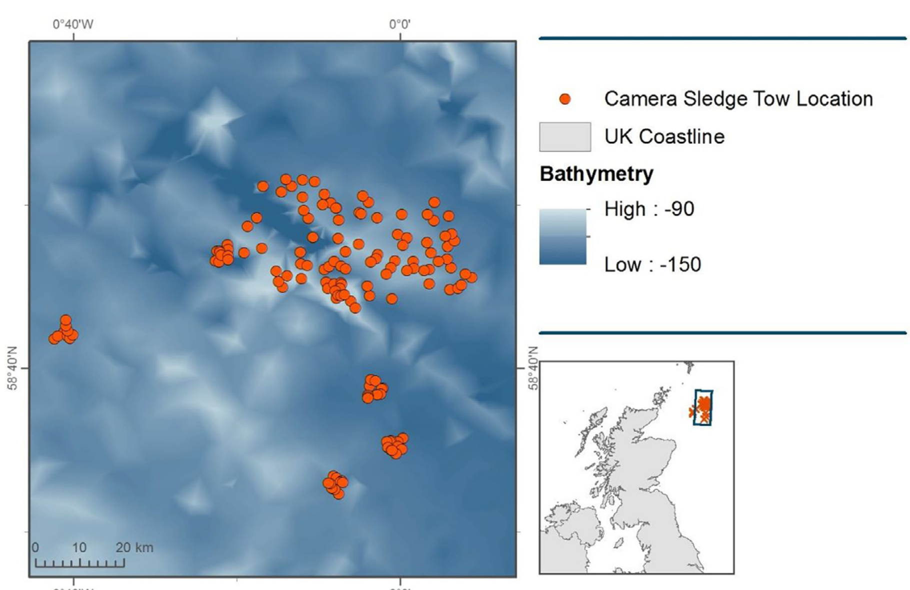

Fig. 1. Location of Camera Sledge tows at the Fladen Grounds which were collected on a joint JNCC/Cefas survey on the RV Cefas Endeavour in 2014.