Potential applications of automated video-image analysis in the pelagic and demersal environment including the deep-sea

J. Aguzzi (1), Costa C. (2), Menesatti P. (2), Manuel A. (3), Del Río J. (3), García J.A. (2) Fujiwara Y. (4), Iwase R. (4)

(1) Instituto de Ciencias del Mar (ICM-CSIC), Paseo Marítimo de la Barceloneta 37–49 - 08003 Barcelona – SPAIN. Tel.: ++34-93-230-9550 e-mail: jaguzzi@cmima.csic.es

(2) AgritechLab - Agricultural Engineering Research Unit of the Agriculture Research Council (CRA-ING), Via della Pascolare, 16, 00016 Monterotondo (Roma) – Italy.

(3) SARTI (Remote Acquisition Systems and Information Treatment Development Center) – CTVG. Rambla Exposició, s/n. 08800 Vilanova i la Geltrú (Barcelona) - Spain

(4) Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2-15 Natsushima-Cho, Yokosuka, Kanagawa 237-0061 – Japan

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Introduction

The identification of species, the estimation of their biomasses and associated behavioural rhythms is acquiring increasing importance for fishery management and biodiversity estimation in deep-water continental margin areas and the deep-sea [1].

In the past two decades, the number of submarine video-stations has progressively along with socio-economic interest ocean exploration. In this context, expandable Submarine Stations at different depths such as JAMSTEC's *Real-Time Deep-Sea Floor Permanent Observatory* of Sagami Bay (1100 m) and SARTI-UPC's western Mediterranean *OBSEA* (20 m) were installed to measure several submarine parameters, including videos [2].

Accordingly, we have elaborated a novel morphometry-based protocol for automated video-image analysis of data from the JAMSTEC and UPC-SARTI cameras. Our approach accomplishes species identification with Fourier Descriptors and Standard K-Nearest Neighbours analyses on their outlines, and performs animal movement tracking (by frame subtraction), both in the demersal and in the pelagic realm.

Materials and methods

For Sagami Bay we analysed one week of footage (09-04-2009 to 16-04-1999), from the infrared 3CCD video-camera.

For OBSEA, ten minutes of footage were obtained at midday (23-06-2009), from the OceanCam OPT-06 video camera.

Video-image analysis for both cameras followed the same procedure: A) selection of the frame to be analyzed; B) definition of a region of interest; C) identification of displacing objects in consecutive frames by Area thresholding (within the circle (which circle?)); D) grey-level scale thresholding; E) display of original greyscale image with object identified in overlay representation for comparison

Figure 1 illustrates the identification of unknown biological objects by a trained operator in Sagami footage. Object selection (Figure 1A); class attribution (Figure 1B); the saving of newly classified objects as single images for their later individual processing by Four

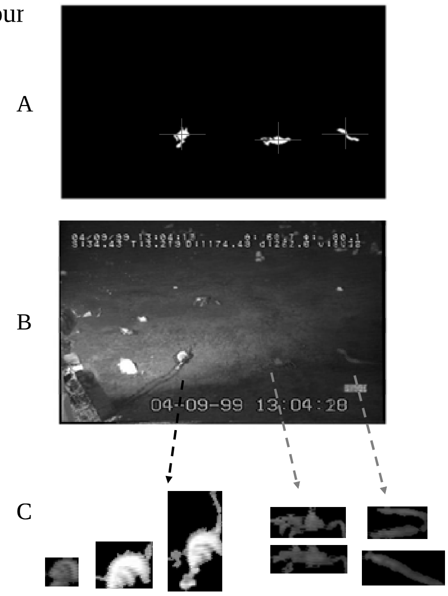

Fig. 1. The object selection by Expert Supervision

In Figure 2, the output of automated identification of fishes in the OBSEA footage is presented onto consecutive frames (Gigures 2A, 2B) as proof of correct visualization.

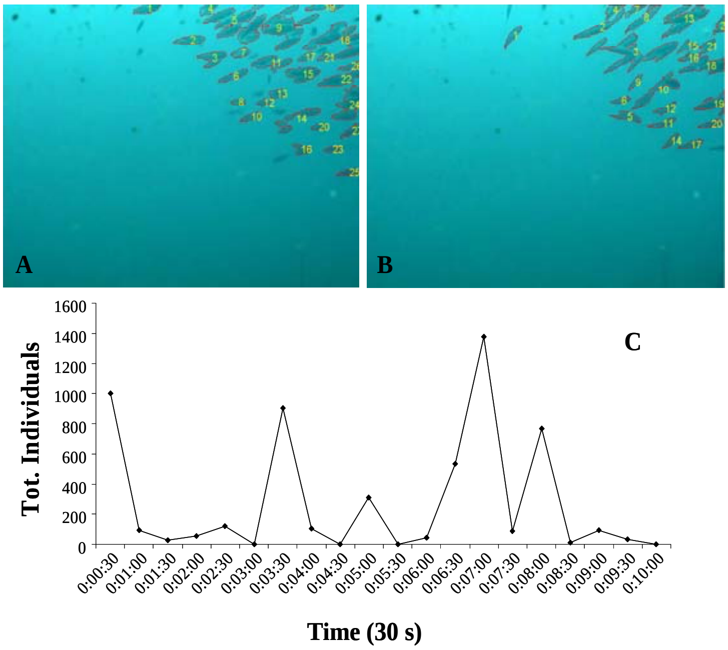

Fig. 2. Automated counting of fishes in the OBSEA footage. Two consecutive frames at 30 s distance (A, B) are reported as well as a time series of individuals per unit of time as an example of biomass counting applications

Results and Discussion

Sagami bay footage.

Three displacing species were identified as the most recurrent: Zoarcid fishes (eelpouts), red crabs (*Paralomis multispina*), and snails (*Buccinum soyomaruae*)

Double-plot actograms referring to the number of observed moving eelpouts, crabs, and snails are presented in Figure 3. Complex rhythmic patterns appeared with varying strengths in the corresponding time series, being especially(?) marked in fishes (Figure 3A). As revealed by the program analysis (Figure 3B), eelpout rhythmic behaviour presented a periodicity of 1049 minutes (equal to 17.5 hours), fitting inertial currents frequency.

OBSEA footage.

The automated protocol efficiently detected a variable number of fish specimens over consecutive frames. These data can be efficiently represented as a time series (Fig. 2C).

Conclusions

The understanding of ecosystem dynamics in the sea is to date still constrained by datasets This situation is rapidly changing as systems that provide high-quality long-duration datasets are deployed. The analysis presented in our work can be potentially performed on diverse video sources form very different depth environments, where permanent stations are acquiring (or may acquire in the future) footage of very long duration spanning months or years.

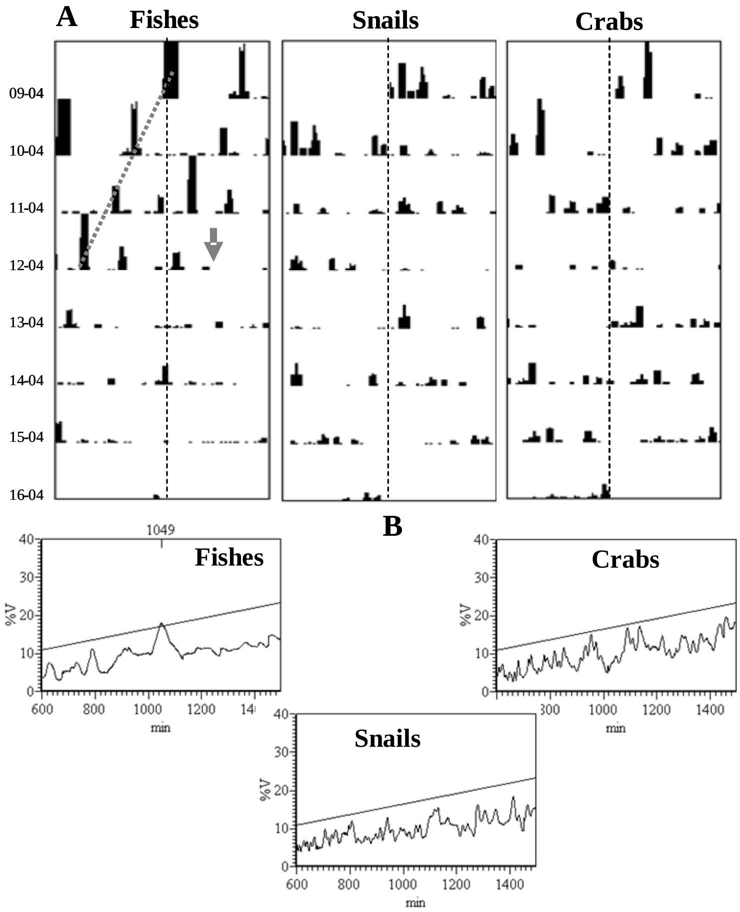

Fig. 3. Double-plot actograms (A; vertical dashed line is the 24-h based limit) and outputs of periodogram analysis (B).

References

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