ID24 - DEEP SEA SPY: A COLLABORATIVE ANNOTATION TOOL

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Abstract
Since 2010, remote hydrothermal ecosystems are continuously being monitored using video cameras deployed on instrumented platforms. The acquisition of high-frequency video data from deep-sea observatories like EMSO-Azores or Ocean Networks Canada provide information on species behaviour, feeding habits, growth, reproduction and organisms' response to changes in environmental conditions. Video cameras acquire hourly data representing thousands of hours and Tera Bytes of footage but their manual processing is time-consuming and highly labour-intensive, and cannot be comprehensively undertaken by individual researchers. In order to help preliminary manual assessment of this huge imagery archive, a free online annotation tool was developed to gather contributions from a wider community. The Deep Sea Spy system offers a fun and engaging web interface to members of the public to help perform initial footage annotations. The platform now hosts 623 active annotators who contributed 179,663 annotations to 19,541 images. Preliminary analyses highlight a high variability among participants but show promising results to detect trends in species abundance variation over time. Ultimately, the information gathered via this approach can help improving the algorithms necessary to produce accurate automated detection in imagery using a machine learning approach.
Keywords. Citizen science, Database, Deep-sea observatories, Image annotation, Underwater imagery

1. INTRODUCTION
Most of the current knowledge of deep-sea ecosystems is based on limited oceanographic cruises. As a result, little is known about the temporal dynamics of faunal communities inhabiting these environments [1]. This last decade, the development of deep-sea observatories enabled their long-term quasi-continuous monitoring [2]. Located on hydrothermal vents, the Ocean Networks Canada cabled network [3] (oceannetworks.ca) and the EMSO-Azores autonomous observatory [4] (www.emso-fr.org/fr/EMSO-Azores) host an ecological observation module, TEMPO, which monitors the animals colonizing these environments [5]. Since 2010, the cameras have recorded more than 5,000 hours of video sequences that represent a crucial source of information for assessing natural variability as well as ecosystem responses to increasing human activity in the deep sea. But the manual processing of these data is time-consuming and highly labour-intensive, and cannot be comprehensively undertaken by individual researchers. Previous attempts to develop algorithms for automated detection of species have failed in these environments characterized by a complex background and are still far from replacing the human eye in extracting scientific information [6,7]. Alternatively, engaging the public in initial data processing or annotation (i.e. adding caption and metadata to a digital image) has yielded useful results [8]. It's in this context that the Deep Sea Spy online annotation tool was developed.

2. THE ONLINE ANNOTATION INTERFACE
The Deep Sea Spy online annotation tool was developed to help the processing of images by members of the public. The interface is available online (www.deepseaspy.com) with an internet connection. It was built as a game, with a fun and engaging interface (Fig. 1). After following a tutorial, participants work through levels by annotating an increasing number of images. The task is simple and consists in annotating individual species, in order to allow its use by a wide audience. All annotations are stored in pixel values in a database located at Ifremer, along with their associated metadata.

3. COMMUNICATION STRATEGY
An associated project website provides background information on the scientific context and on how results will help increase scientific knowledge of deep-sea animal communities. Maintaining communication with the users during the lifetime of the project is essential to insure the success of the programme, but is extremely demanding and requires a dedicated person. A number of public actions were undertaken, including the development of school programs in collaboration with national education entities to bring the project in classrooms. To this end, educational booklets for kids between 3 and 11 were developed to support teachers in the project development.

4. PRELIMINARY RESULTS

4.1. General statistics
18 months after the project launch, 623 active annotators have contributed 179,663 annotations to 19,541 images. In the current mission, all 3,918 images have been annotated at least once, and most of them have been annotated 3 or 4 times. Rates of new registration highlight the importance of communication efforts to maintain existing members and engage new ones.
4.2. Annotation results
Preliminary results highlighted a high variability in species abundances among participants, but the use of geo-spatial information as recorded by the pixel values of the animal can help validate individual annotations (Fig. 3). These information can help set a threshold based on the number of times an annotation occurred at a given coordinate.

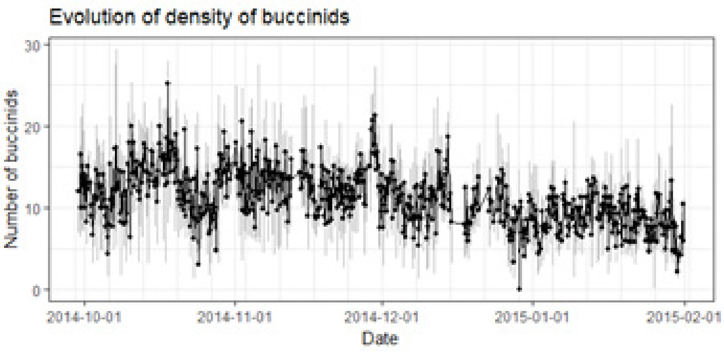

Fig. 3. Left panels: Evolution of the density of buccinid gastropods over 6 months showing the median value (black line) and variation range (grey bars). Right panel: Example of an image including the geospatial information of buccinid positions from the annotation, each colour represents a different participant.

5. CONCLUSION

The Deep Sea Spy online annotation platform now gathers hundreds of active annotators contributing to the analysis of images recorded by deep-sea cameras. Preliminary results highlight the potential of such an approach to not only facilitate the processing of the huge database acquired by deep-sea monitoring observatories, but also to engage the public in science, and thus increase ocean literacy. This approach is however still in its infancy, and validation procedures are still needed to optimize the use of the data gathered by a wide range of participants. Ultimately, the resulting database will help developing algorithms using machine learning approaches.

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