Automated marine animal sounds identification

As sounds travel far underwater, it is a privilege way of communicating for many marine species. Unravelling these communications can help to monitor populations, detect the presence of species and estimate fish abundance and diversity in ecosystems. With the recent development of automatic recording unit, large amount of data have become available to the point where it is very costly and even no longer possible to have them analysed by acousticians. New progress in data science and the development of AI have started to allow automatic acoustic data processing. However, the lack of reference sounds and annotated data available have impaired the development of automatic detection and identification of sounds underwater.

To fully utilize the potential of the information contained in soundscapes underwater, we developed an AI model automatically detecting sound events in audio recordings. Audio recordings were collected with hydrophones see [1] for more details. The approach was divided in two steps. First, getting large volumes of annotated data from different environments using the few shot learning framework adapted for bioacoustics detection. Second, training a robust deep learning model to detect sound automatically in long recordings. This model is getting integrated into an embedded system to do real time detection in situ. In the near future this will allow the combination of different sensors on the biodiversity sensing box project to improve the ecological assessment capabilities of the box, for example by triggering the sampling of environmental DNA when a species of interest is detected.

Hydrophones

Hydrophones are microphones specifically designed to record sound underwater. For the first deployments, data were recorded using the self-contained sound recorder SoundTrap ST-600 in the frequency range of 20Hz to 192kHz. The hydrophone is calibrated and able to record up to 200-meter depth. The low-cost hydrophone A5 from Aquarian was used to access the acoustic data in real time. The sensor was connected to the embedded computer Jetson Orin Nano from Nvidia through the audio interface AMS-22, providing phantom power to the hydrophone. The A5 hydrophone is not calibrated by the manufacturer, has a linear bandwidth ranging from 20Hz to 15Khz and can record up to 100-meter depth.

Automated marine sound ID

Raw data are .wav-files corresponding to the sound pressure level recorded underwater. In this project, the focus is on identifying sound events that are likely to originate from biological sources in long audio underwater recordings. Such sounds probably come from fishes but not exclusively (Figure 1). The diversity, abundance and characteristics of these sounds can then be evaluated to extract meaningful information about the ecosystems and the species constituting it.

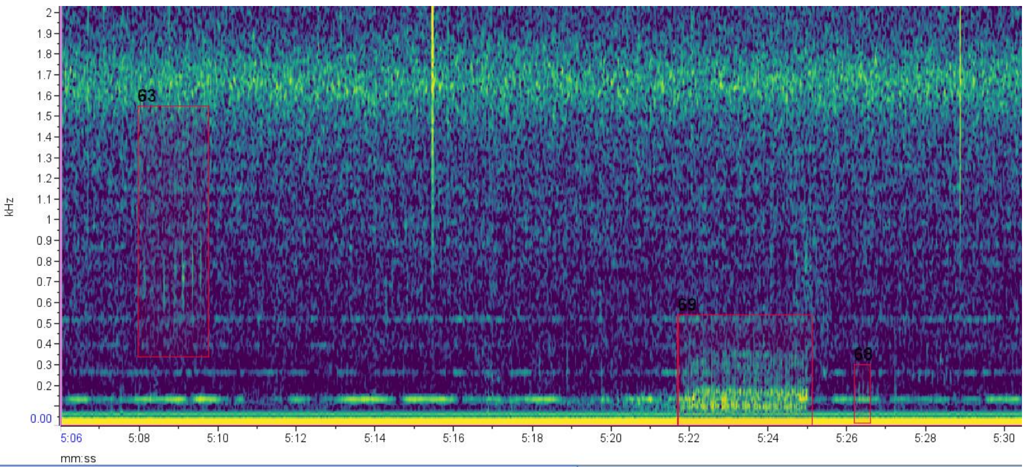

Figure 1. Spectrogram with 3 annotations (red boxes) of sounds likely to be produced by different fish species

Obtaining annotations, i.e. indications of when sounds start and end, can provide ecological insight but are also valuable to train machine learning algorithms. However, they typically require extensive manual work to obtain. Therefore, the first step of the project was to facilitate the obtention of large amount of annotations (Few shot learning on Figure 2). The second step is to use the large volume of annotated data to train a robust AI model that is aimed in the future to replace the human analyst completely (Deep learning classifier on Figure 2).

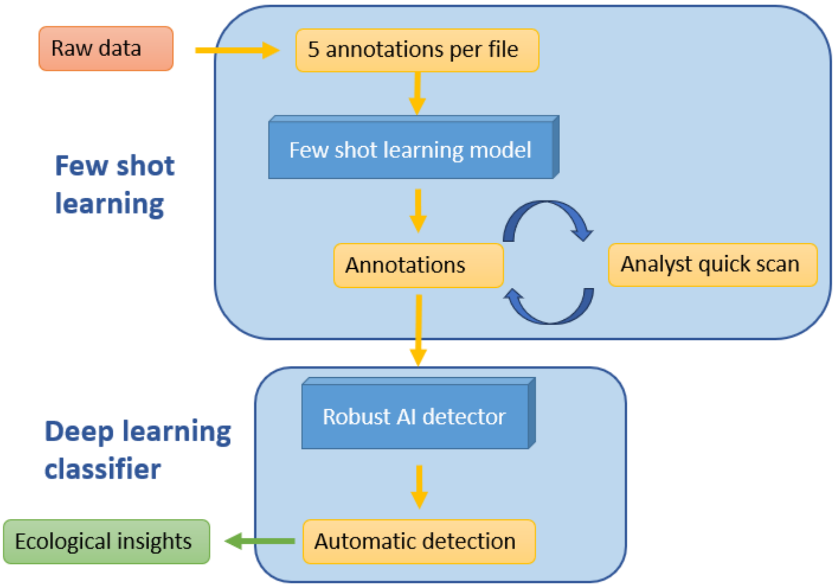

Figure 1. From raw data to meaningful information through few shot learning and deep learning classifier

Locations of scripts

Github repository (model for automatic detection of biotic sounds underwater), coming later.

Github repository (model for few-shot learning biotic sounds underwater), coming later.

Lessons learned

- The application of deep learning to bioacoustics is a rapidly evolving and promising field. One of the main challenges faced during this project was the need to constantly keep abreast of the most recent models and methods published in the field. Numerous parallel initiatives are continuously being developed, and exploring any of them requires significant time and effort.
- Therefore, connecting with fellow researchers who explore the topic of this research have proven especially crucial. By doing so, we can build on existing work, avoid redundant efforts and share learned lessons. The abundance of different initiatives of bioacoustics tools have complicate matters and navigating this landscape to find solutions for specific applications is time-consuming and require expertise.
- A substantial knowledge gap exists in the reference databases for fish sounds. Identifying species solely from their acoustic signatures remains challenging. Bridging this gap is essential for more effective monitoring of marine ecosystems. Interestingly, even unidentified sounds have provided valuable ecological insights in prior research.
- Developing a robust machine learning model relies on the quantify but also critically on the quality of the training data. Despite the scarcity of good data, exploration of specialized methods tailored for limited environments—such as self-training, active learning, and data augmentation—was undertaken. However, these techniques alone cannot fully compensate for high-quality training data.
- Generalization, the model's ability to perform across diverse tasks, presents a critical challenge. In this case, adapting to different sound types or environmental conditions remains limited due to the training data available.

- On another type of collaboration, data exchange, has high potential to significantly improve the quality and accelerate the development of automatic underwater sound detectors and classifiers.

List of people involved and their role

Name	Email address	Role in project
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Output

Presentations:

WIAS Science Day 2024 oral presentation: Detecting animal sounds faster in long recordings using 5 examples: Few shot Learning on fish sounds

5th World ecoacoustic congress in Madrid, communication (format TBD): Detecting animal sounds faster in long recordings using 5 examples: Few shot Learning on fish sounds