APLOSE: A web-based annotation platform for underwater passive acoustic monitoring

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Gabriel Dubus [a,b,*], Maëlle Torterotot [b], Julie Béesau [b], Mathieu Dupont [b], Anatole Gros-Martial [b,c], Mathilde Michel [b], Elodie Morin [b], Paul Nguyen Hong Duc [d], Pierre-Yves Raumer [b,e], Olivier Adam [a], Flore Samaran [b], Dorian Cazau [b]

[a] Sorbonne University, CNRS, Institut d'Alembert UMR 7190, LAM, Paris, France
[b] ENSTA Bretagne Lab-STICC UMR CNRS 6285, Brest, France
[c] Centre of Biological Studies of Chizé, CNRS, Chizé, France
[d] Centre for Marine Science and Technology, Curtin University, Perth, Australia
[e] Geo-Ocean, Univ Brest, CNRS, Ifremer, UMR 6538 and ENSTA Bretagne Lab-STICC UMR CNRS 6285, Brest, France

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ABSTRACT

Emerging detection and classification algorithms based on deep learning models require manageable large-scale manual annotations of ground truth data. To date, the challenge of creating large and accurate annotated datasets of underwater sounds has been a major obstacle to the development of robust recognition algorithms. APLOSE (Annotation PLatform for Ocean Sound Explorers) is an open-source, web-based tool which facilitates collaborative annotation campaigns in underwater acoustics. The platform was used to carry out research projects on inter-annotator variability, to build training and testing data sets for detection algorithms and to perform bioacoustics analysis on noisy datasets. In the future, it will enable the creation of high-quality reference datasets to test and train the new detection and classification algorithms.

1. Motivation and significance

Nr	Code metadata description	*Please fill in this column*
C1	Current code version	*APLOSE v1.8.3*
C2	Permanent link to code/repository used for this code version	https://github.com/Project-OSmOSE/osmose-app
C3	*Permanent link to reproducible capsule*	https://github.com/Project-OSmOSE/osmose-app/tree/1.8.3
C4	*Legal code license*	*GNU General Public License v3.0*
C5	*Code versioning system used*	*git*
C6	*Software code languages, tools and services used*	*Python / Django* *Typescript / React* *Docker*
C7	*Compilation requirements, operating environments and dependencies*	*Docker (if windows, it requires WSL 2)*
C8	*If available, link to developer documentation/manual*	https://github.com/Project-OSmOSE/osmose-app/wiki
C9	*Support email for questions*	osmose@ensta-bretagne.fr

1.1. Context

Continuous underwater Passive Acoustic Monitoring (PAM), carried out over long periods, has become an essential tool for studying the underwater environment. The collected acoustic data provide insights on species behaviour, distribution and habitat use across spatio-temporal scales [1–4]. It can also bring information on meteorology [5–7], geological events like earthquakes [8], and marine traffic impact on the overall soundscape [9]. The vast volume of acoustic data collected requires automated methods for detecting and classifying specific events. Deep learning models have shown promising outcomes in addressing this topic [10–12],. However, manual annotation is crucial to train and to evaluate the performance of these automated algorithms and remains significant for scientific insights [13].

Obtaining accurate annotations for PAM data is complex and can be influenced by multiple factors. Audible sounds in the marine realm are unfamiliar to humans and are often masked by high levels of ambient noise or altered by underwater propagation. In practice, manual annotation is carried out on spectrogram images, a time-frequency

* Corresponding author at: Institut Jean le Rond d'Alembert Lutheries Acoustique Musique, France.
E-mail address: gabriel.dubus@hotmail.fr (G. Dubus).

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representation of sound. It often requires a great deal of time and experience on the part of scientists. This explains why there is a limited number of large reference datasets for marine underwater sounds [14]. Moreover, most datasets do not thoroughly cover the diversity of marine sounds, and the quality level of annotated datasets are now frequently criticized or assessed [1,15,16],. These observations support the need for dedicated annotation tools able to easily scale up the manual annotation process, for example by distributing files among a larger number of annotators through participatory science experiments. On the technological side, this scaling involves requirements such as a high accessibility and user-friendliness of the tool. Consequently, standardization of the annotation process, from the pre-processing of data to the gathering of annotations from multiple annotators is essential. On the scientific side, research works will be needed to ensure that annotations from newcomers will be of sufficient quality (e.g. with the development of demonstration and teaching materials), and to develop cross-validation and aggregation strategies able to make the most of annotation efforts within a heterogeneous multi-annotator context.

Numerous software solutions exist to manually annotate audio recordings in ecoacoustics and bioacoustics [17]. As shown in the comparative Table 1 from [17], none of them covers all the functionalities needed to meet the challenges mentioned above. The columns of this table were filled with APLOSE's information in Table A.3. While the proposed tool, APLOSE, offers most of the classical annotation features (column Sections 3 and 4 of the comparative Table 1 from [17]), it was also developed as a cloud-based, ready-to-use platform to meet accessibility requirements. APLOSE enables structured and standardized annotation campaigns, a rare but essential feature in the field. By passing all annotation results through a common metadata database, APLOSE enforces a standardized representation of data which is now adopted by different institutes in France (e.g. France Energies Marines[1]). Moreover, APLOSE has been conceived with the idea of performing annotation campaigns that follow strict protocol requirements. Such requirements include, for example having a specific and fixed set of labels, to constrain the use of weak and strong annotations or to have specific and fixed scale and resolution of the spectrogram. This capability is particularly valuable for organizing large-scale annotation efforts and ensuring consistent data quality. Its online accessibility and user-friendly interface allow the most novice of users to start annotating a file from a simple webpage, which eliminates all cumbersome processes related to data manipulation and processing. Indeed, all heavy data processing behind APLOSE is handled on the server side through tile-based rasterization of pre-computed spectrograms. Additionally, APLOSE is provided as a free open-source tool (all codes are publicly available on GitHub) and has also been made reusable and interoperable by packaging it in Docker containers. APLOSE has been designed to handle a wide range of datasets in terms of sampling frequency, thanks to the player which can accelerate or decelerate the sound, and in terms of duration, thanks to the pre-calculation of spectrograms.

1.2. APLOSE in context

This paper introduces APLOSE[2] (Annotation PLatform for Ocean Sound Explorers), a web-based open-source platform for collaborative annotation of underwater sound events. APLOSE features a Graphical User Interface (GUI) and a workflow for efficient audio annotation. Key functionalities include drawing time-frequency boxes on spectrograms with multiple zoom levels. Data are pre-processed beforehand, using the OSEkit python scripts.[3] Documentation is available on Sphynx.[4] Unlike most audio annotation tools, APLOSE enables collaborative annotation without local data storage, by centralizing data on a web server accessible via login credentials. All annotations are continuously collected and written to a downloadable CSV file, which allows to update in real time the processing of the annotations.

APLOSE's simple data structure, based on text-files, exports annotations in a single CSV file per annotation campaign. Output files can then be manipulated with Python, MATLAB, R, or any tools for further analysis. As an open-source platform under the GNU General Public License v3, users can modify the code. Developed in TypeScript with React (front application) and Python with Django (feature data API), APLOSE is dockerized for easy server deployment. The front-end design draws inspiration from WaveSurfer in the CrowdCurio project [18]. Mozilla Firefox and Google Chrome are both supported. A user manual takes the user through the deployment on cluster structures, supplemented with screenshots and videos for user orientation.

Previous studies reveal that APLOSE is only one of many annotation softwares for bioacoustics [17,25], which unfortunately develop mostly in parallel without much interaction. In this context, the APLOSE team understands improving general FAIRness of softwares (through for example our works on Dockerization and APIs mentioned above) is crucial to better coordinating works and mutualizing efforts, as well as interfacing APLOSE to other software suites.

2. Software description

Manual annotation is the hand-operated action of assigning labels on spectrograms or on part of spectrograms of a dataset. A dataset is a group of audio files that will be annotated by one or several annotators during an annotation campaign. These audio files can be split into smaller audio segments for the annotation, depending on the sounds of interest. In each campaign, we will assign audio segments to the annotators and define which labels should be used for annotations. Labels are tags that define the sounds to look for on the spectrogram. They can correspond to broad categories of sound (biophony, geophony, etc.), groups of species (odontocetes) or more specific types of sound (air gun, blue whale d-calls, etc.). There are 2 categories of annotation, weak and strong annotations. Weak annotation: the annotator labels the whole spectrogram from the list of available labels. Strong annotation: the annotator draws a labelled time-frequency box around the targeted sound event.

2.1. Software architecture

APLOSE is based on a server-client model (Fig. 1). The server (back) uses the Django framework. It is linked to its PostgreSQL database through an ORM (object-relational mapping) provided by the framework. It also has access to the datasets (e.g. the audio files and associated spectrograms and metadata information). These datasets have been pre-processed with the OSEkit to have the spectrograms and metadata information needed by APLOSE. The client side (front) is made using React framework and communicates with the backend through the server REST API. To make the installation easier, APLOSE is deployed through a Docker environment. APLOSE has been deployed on several servers using Docker containers.[5]

2.2. Software functionalities

2.2.1. Pre-processing of dataset through the OSEkit python scripts

APLOSE is linked to a storage space and needs a processing workflow to compute the spectrograms. This workflow is made up of a set of Python scripts contained in the OSEkit package.

Metadata required. Launching an annotation campaign requires CSV files containing metadata on the recording campaign and audio data,

[1] https://www.france-energies-marines.org/en/.
[2] https://osmose.ifremer.fr/app/.
[3] https://github.com/Project-OSmOSE/osekit.
[4] https://project-osmose.github.io/OSEkit/.

[5] If you require further information about APLOSE deployment, with or without Docker environment, please contact us.

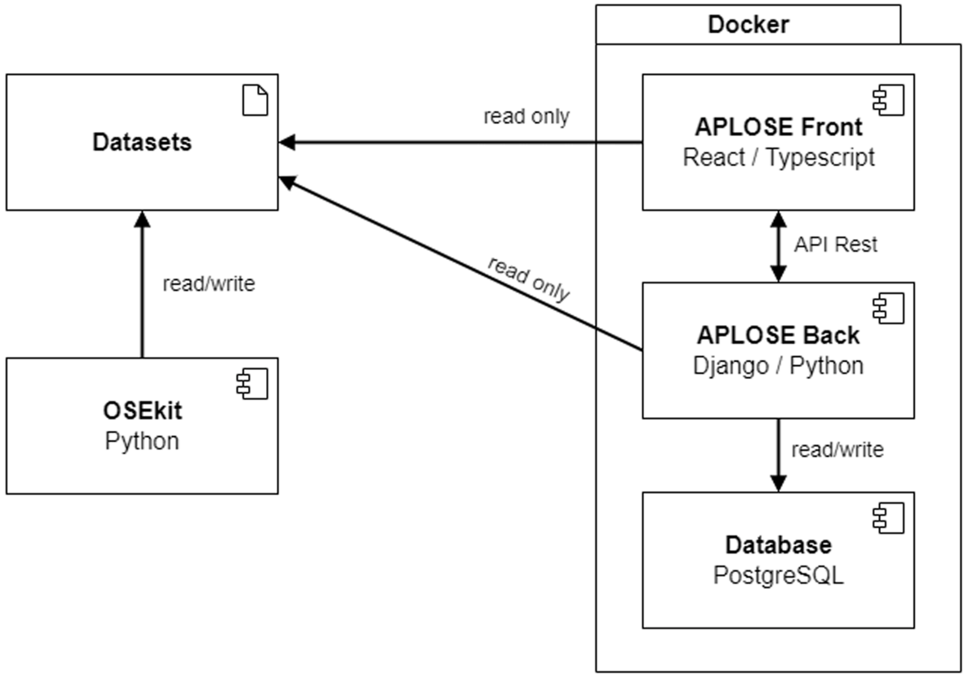

Fig. 1. APLOSE architecture and its link to the OSEkit Python package used to generate the spectrograms and their associated metadata.

including recording sites, acquisition campaign details, sampling rate, duty cycle, timestamp, and more. There are no limitations regarding these parameters, the OSEkit package and APLOSE are able to manage any sampling rate or file duration. For more information, please refer to the documentation.[6]

Data Representation. Before launching the annotation campaign, the campaign administrator must provide the full set of spectrograms to be displayed during the campaign and associated audio files. These spectrograms are computed with predefined settings, including the largest duration displayed, the number of zoom levels defining the smallest duration, the sampling rate, and all the spectrogram parameters (i.e. nfft, winsize, overlap.). While these parameters can be chosen without limitations, the playback control (utilized to play sound files at different speeds) is limited in the range [0.25x, 4x]. During the OSEkit workflow, these parameters are preset to ensure that annotators cannot modify the spectrogram settings during an annotation campaign. This is done to maintain consistency in how spectrograms are represented, as any changes could lead to inaccurate annotations. For each audio segment, multiple sets of spectrograms can be pre-generated using different parameters. To limit the loading time for displaying spectrograms on APLOSE, their definition must not be too high. To avoid this, the user will be informed if their size is too large when they are generated by the OSEkit package.

2.2.2. Annotation campaign creation

User profile. There are two user profiles: 1- administrators who can create campaigns, upload datasets, define campaign parameters; 2- annotators, invited with login details, who can access campaigns via the APLOSE webpage and log in to annotate each segment.

Annotation campaign parameters. Once the administrator has initiated a campaign and pre-processed the dataset to be annotated, he must define the set of labels to identify. It is also possible to ask for a level of confidence for each annotated event. These parameters are displayed on the campaign detail page (Fig. A.2). The campaign administrator must then assign the audio segments to be annotated by each annotator. Annotators can be associated with all files of the dataset or a subpart of them, to limit the number of files per annotator. It is always possible to add annotators at any time during the campaign.

2.2.3. Annotation process

If a set of spectrograms using different parameters (nfft, winsize, overlap) have been pre-calculated, then the user can choose from these different configurations. Playback controls allow users to play/pause the sound file playback or to adjust playback speed (from 0.25x to 4x), enabling the exploration of low or high-frequency sounds. Navigation in a given spectrogram is only through temporal dimension. It can be done by selecting the zoom level (on the upper left corner of the annotators' interface, see Fig. 2). If the zoom level makes the spectrogram longer than the web page display size, navigation through spectrogram can be done using the scrollbar.

Once a label is selected from the given set, a weak annotation is attached to the annotated file. A time-frequency box can then be drawn on the spectrogram by clicking and dragging over the area containing the feature. While overlapping annotations are permitted, a strong annotation can have only one label. Each annotation can be easily removed with the close button at the upper right of the annotation box. An overview of all annotations for the given audio segment is available in a table, including time and frequency bounds. If it has been asked in the campaign parameters, a level of confidence for each event annotated can be added. Annotators can also add comments for each annotation. Once all sound events of interest are labelled, annotators can save the annotations and proceed to the next file or return to the file list in case no file is available. In case of an absence of sound of interest (i.e. no labelling), the annotator still has to submit its review after which the audio segment will be considered as annotated. Note that some of the functionalities described above (label selection or validation of annotation) can be accessed through keyboard shortcuts to speed up the annotation process. Also note that even if annotations are submitted for a given audio segment, it can still be modified or deleted afterwards.

2.2.4. Monitoring campaigns

The campaign creator can monitor the annotator progress and export results at any time on the main page of the annotation campaign. The

[6] https://project-osmose.github.io/OSEkit/.

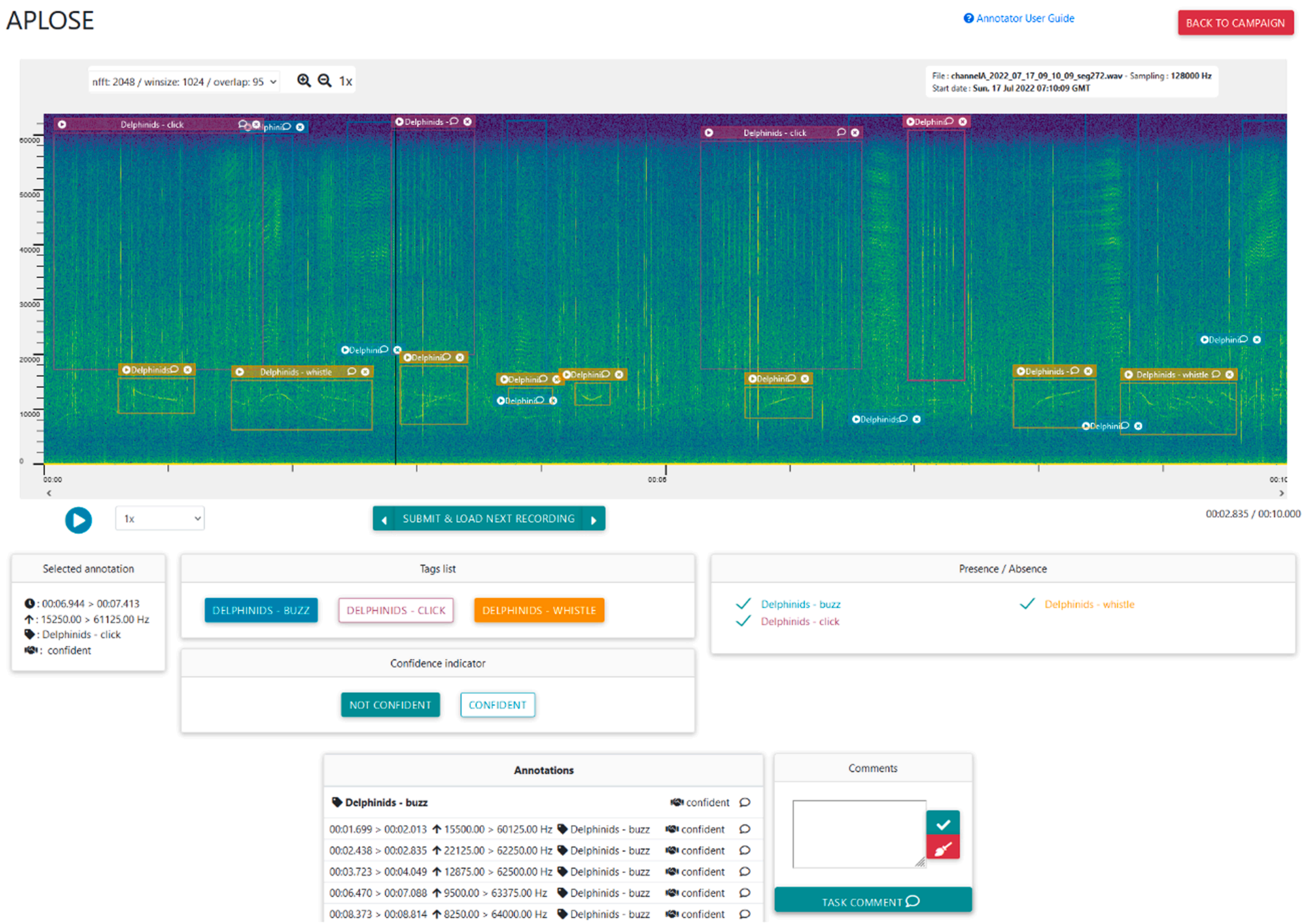

Fig. 2. Example of the annotator interface on APLOSE. The large image is the spectrogram. Boxes are annotations of three delphinid sounds defined by three coloured labels. The box titled "Tags list" enables the user to choose among the available labels. Under this box, the user can change the confidence indicator. All annotations are summed-up in the lowest table. A comment box is also available on the bottom right corner.

export generates a CSV file of all the campaign annotations ("results.csv", see example in Table A.2.). The file contains one line for each annotation made in the campaign, organized with multiple entries: name of the dataset, name of the audio segment, name of the annotator, label annotated, audio segment-relative start and end time of the time-frequency box, absolute start and end time of the time-frequency box given as datetime string, frequency bounds of time-frequency box, level of confidence (if asked), comments (if added by the annotator). Note that if the annotation is weak, the given time and frequency bounds are those of the audio segment.

As audio segments without annotations are not reported in the "results.csv" file, a second CSV file can be downloaded and used to differentiate between audio segments that are annotated but have no elements of interest, and audio segments that are not annotated at all. This CSV file ("task_status.csv", see example in Table A.1.) contains a list of all annotation files in the annotation campaign with their corresponding annotation status per annotator ("Finished" for audio segments which have been reviewed and submitted, "Started" for audio segments with have been reviewed but not submitted and "Created" for audio segments still not inspected). This second CSV file allows to retrieve audio segments that have been checked but do not contain any sounds of interest, which facilitate the analysis of annotations even when the annotation campaign is still in progress. Note that codes are proposed to transpose this formalism to other standardized ones, such as *Raven*, to allow users of different annotation platforms to keep their workflow, regardless of the platform used.[7]

3. Illustrative examples

The APLOSE platform was used in several research projects involving citizen science, marine mammal monitoring from a mobile hydrophone [19], Delphinidae monitoring along the French Mediterranean coast by the association MIRACETI,[8] automated detection algorithm performance evaluation [20] and geophony reference dataset creation [21]. Two of these applications are described hereinafter.

3.1. *Annotation of cetaceans' vocalization through citizen science*

A few citizen science annotation campaigns have been organized involving volunteers from Astrolabe Expeditions[9] organization and bioacoustics experts. The datasets that were annotated came from different regions (Indian Ocean, Canadian East coast, French West coast and Californian Southwest coast) and the targeted sounds were either from mysticete or odontocete species. The datasets were annotated by up to 45 annotators, gathering >25 000 annotations in total over several months.

[7] https://github.com/Project-OSmOSE/OSEkit.
[8] https://miraceti.org/.
[9] https://www.astrolabe-expeditions.org/.

Through the results of these campaigns, different research questions were tackled: the metrics to quantify inter-annotators variability [15], the influence of the annotator's experience on the annotation performances [16], and the influence of the annotation variability on the performance of automatic detection using deep learning models [20].

For this work, around 77 h of audio have been annotated by 8 to 20 annotators. The web design of APLOSE has made it easy to set up these collaborative annotation campaigns thanks to the instant sharing of this large quantity of data which were stored only on our server. The management of several annotators on the same campaign and the uniform parameterisation of annotation spectrograms of >77 h of recorded data have been made available with the platform. The download of annotations at any time during the campaign made the analysis easier as evaluation methods can be tested during the whole duration of the campaigns, even if they last several months.

3.2. Creation of a reference dataset for the geophonic events community

The geological activity in the ocean crust is responsible for a lot of specific hydroacoustic signals, among which discernible seismic and magmatic events. Their analysis was already shown to be cost effective and efficient [22] [23],. The automatic detection of these signals is a task still lacking a standard benchmark dataset that would enable the objective comparison of models. This motivated the creation of an annotation campaign.

As confidence in the annotations is of paramount importance in the context of benchmarking, several experts were prompted to take part in the campaign. The resulting inter-annotator variability analysis would then enable to quantify the subjectivity of the task and increase confidence in the obtained ground-truth. The multi-user capability of APLOSE was thus particularly relevant for this study.

The initiative resulted in the creation of two APLOSE annotation campaigns that aimed at providing two datasets representing different geographical contexts to assess the generalization of the developed detection models. Annotators were prompted to look at spectrograms, identify events and choose a label among T-waves (seismic origin), H-waves (mostly magmatic origin), uncertain or cryophony. The fact that several experts annotated the same files enabled a much more complete coverage as it appeared that most annotators missed some signals. About 2 % of the annotations showed total expert agreement, however it is less likely that a signal would be missed by all annotators [24]. In the end, each annotator worked an average time of 10 h and reviewed 2880 spectrograms of 2000 s each, leading to nearly 15,000 annotations.

The resulting annotations, part of a dataset that was published [21], were used to formalize a more complete study [24].

4. Impact

APLOSE has demonstrated its unique ability to facilitate large-scale, structured, and standardized annotation campaigns for underwater (PAM) data. Unlike traditional annotation tools, APLOSE was designed specifically to handle collaborative workflows with a focus on consistency and accessibility, making it particularly well-suited for participatory science initiatives and training campaigns

APLOSE facilitates the annotation of large datasets by a great number of users. The typical annotated datasets range from one-day long high frequency (Fe = 128 kHz) datasets dedicated to the annotation of delphinid clicks and whistles, to one-year long low frequency (Fe = 240 Hz) datasets dedicated to great baleen whale call annotation. Since its launching in 2020, from 10,000 to 50,000 annotations were added every year to APLOSE, to reach 160,000 in March 2024. These were made by 159 different annotators, among which 151 were citizen science novices or inexperienced trainees. These numbers could be achieved thanks to the accessibility of APLOSE: it is free and adapted to people with little knowledge in acoustics (e.g.: no need to choose spectrogram parameters). Moreover, unlike many annotation software packages, acoustic data are easily available online by all the annotators, with no download time or hard drive shipment required.

The platform's structured campaign functionality, which includes consistent workflows, high accessibility and user-friendliness through centralized data handling, distinguishes APLOSE from other tools in the field (such as *Raven* or PAMGuard [26]). By providing a standardized environment for annotations, APLOSE supports the development of training datasets for AI detection models and reference datasets for the PAM community.

Regarding impacts on research, all novice annotations allowed to fill the lack of comparative studies between underwater sounds annotated by beginners and by experts [16]. APLOSE was also used in studies to train models and assess detectors' performances [20], to generate reference geophony dataset [21] or to process marine mammal call detection on full datasets [19].

5. Conclusions

The open-source web-based tool APLOSE allows for collaborative annotation campaigns of PAM data on large scales, both in terms of annotator numbers and data volume to be processed. In the long run, APLOSE can unite our community and, with consistent parameters and naming conventions, promotes the standardization of the annotation task. The growing number of annotations also shows the potential of the platform to build cross-validated reference datasets for the PAM community. Many research projects were already conducted using annotations made on this platform, from inter-annotator agreement evaluation to comprehensive marine mammals monitoring programs. APLOSE was also used for educational purposes with students and citizen scientists.

In the future, the aims are to improve the design of the platform and to add new features such as the ability to change colormap and modify the contrast and brightness of spectrograms, the improvement of the user profiles' management, etc. The database linked with APLOSE should also evolve to integrate a hierarchical, orderly and standardized way of handling labels and to consider more metadata linked with the acoustic dataset.

CRediT authorship contribution statement

Gabriel Dubus: Writing – original draft, Validation, Methodology, Investigation, Formal analysis. **Maëlle Torterotot:** Writing – original draft, Validation, Supervision, Methodology, Conceptualization. **Julie Béesau:** Writing – original draft, Investigation, Formal analysis, Conceptualization. **Mathieu Dupont:** Writing – original draft, Validation, Supervision, Software, Resources. **Anatole Gros-Martial:** Writing – original draft, Validation. **Mathilde Michel:** Writing – original draft, Visualization, Supervision. **Elodie Morin:** Writing – original draft, Validation, Supervision, Software, Conceptualization. **Paul Nguyen Hong Duc:** Writing – original draft, Conceptualization. **Pierre-Yves Raumer:** Writing – original draft, Validation, Methodology, Investigation. **Olivier Adam:** Writing – original draft, Supervision. **Flore Samaran:** Project administration, Conceptualization. **Dorian Cazau:** Writing – original draft, Supervision, Project administration, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Figs. A1, A2 and Tables A1–A3.

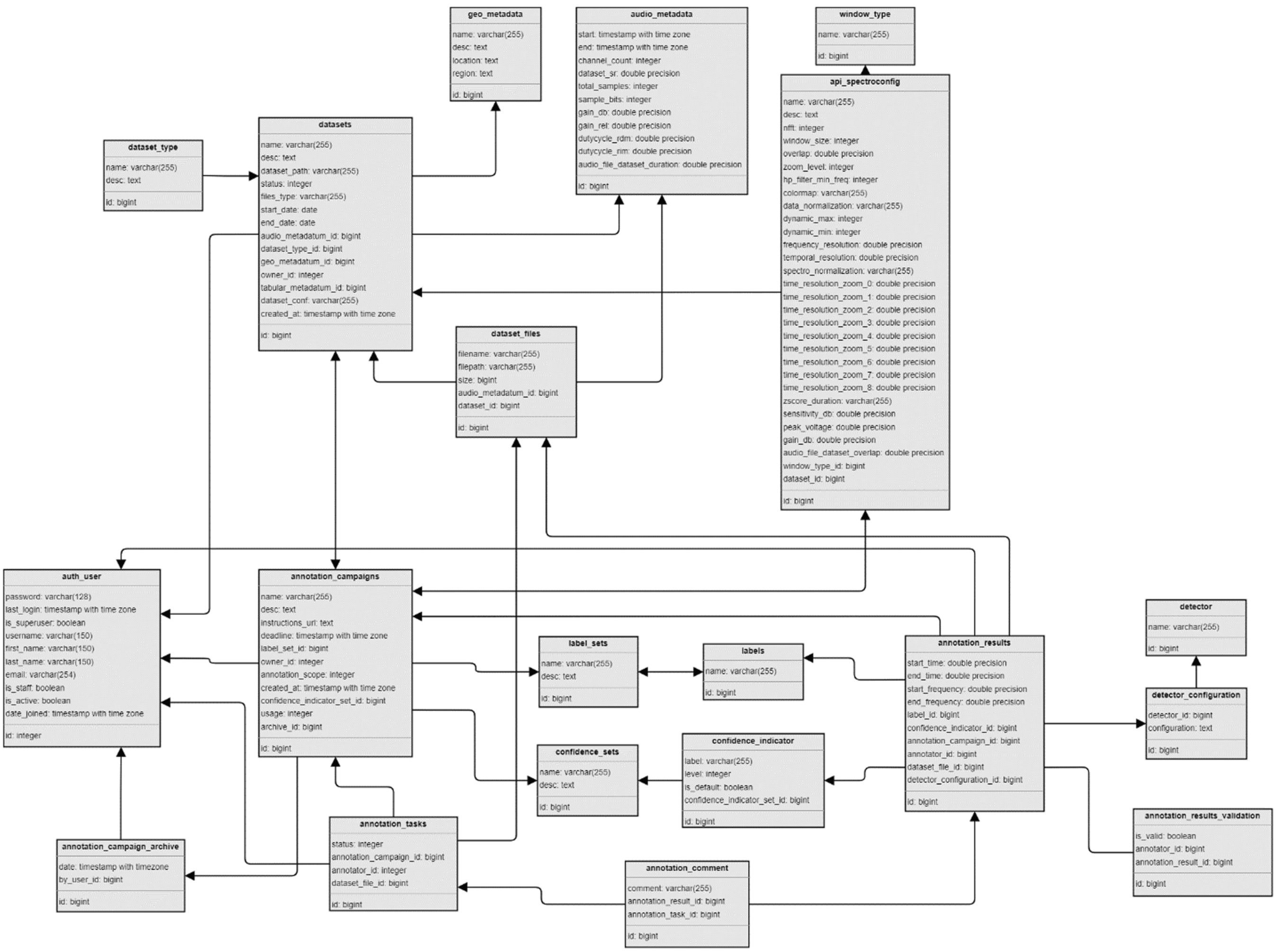

Fig. A.1. APLOSE database structure.

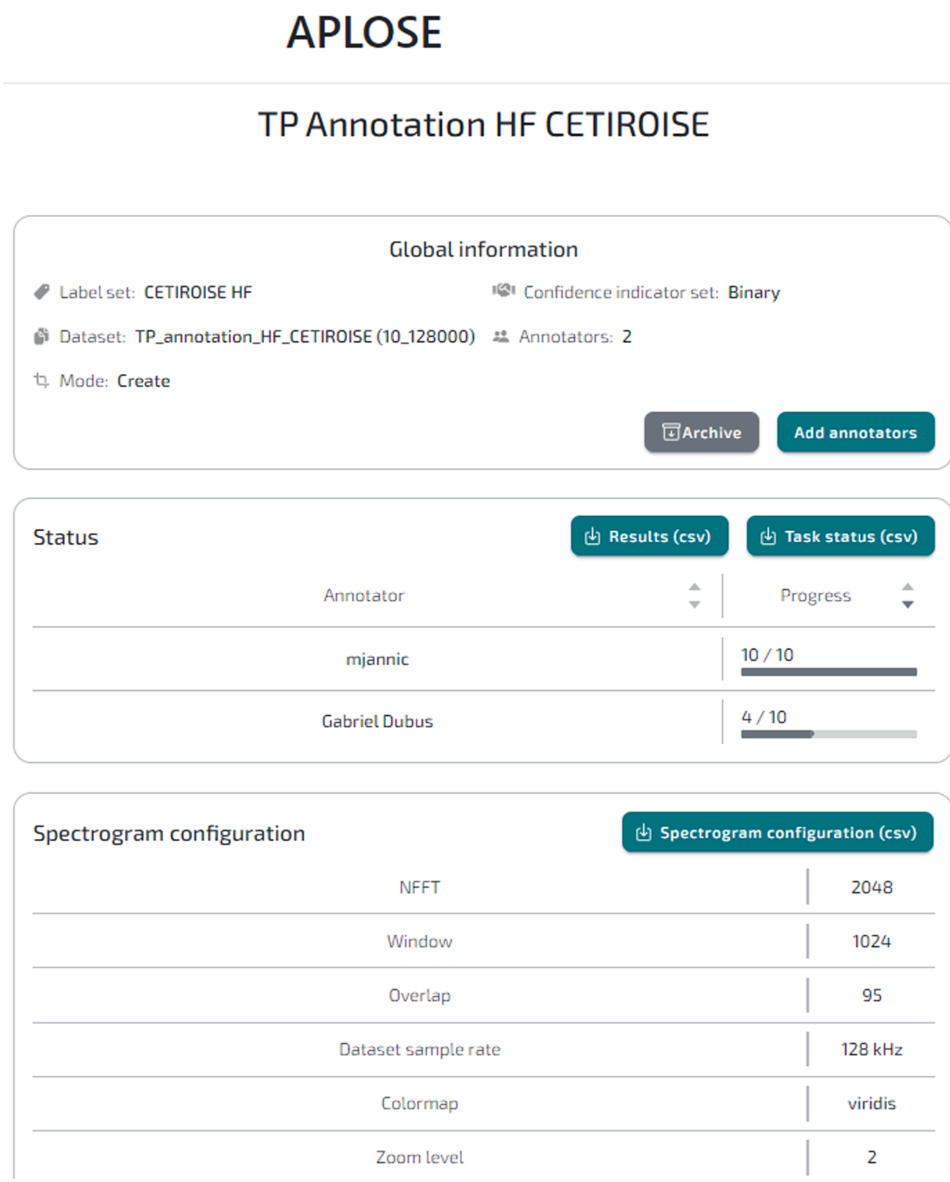

Fig. A.2. Campaign detail page.

Table A1
Example of a CSV file (“task_status.csv”) with 10 audio files. The annotator “gdubus” has annotated 6 files and started one file without finishing it. “mjannic” annotated all 10 files.

dataset	filename	gdubus	mjannic
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_00_25_46_seg000.wav	FINISHED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_00_25_46_seg016.wav	FINISHED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_00_25_46_seg175.wav	FINISHED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_05_53_30_seg069.wav	FINISHED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_05_53_30_seg087.wav	FINISHED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	FINISHED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_10_15_42_seg235.wav	STARTED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_19_00_06_seg063.wav	CREATED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_21_11_11_seg012.wav	CREATED	FINISHED
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_23_22_17_seg180.wav	CREATED	FINISHED

Table A.2
Example of a CSV file ("results.csv") with ten annotations of odontocetes type calls annotated by two annotators, "gdubus" and "mjannic".

dataset	filename	start_time	end_time	start_frequency	end_frequency	annotation	annotator	start_datetime	end_datetime	is_box	confidence_indicator_label
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	1.34241	2.886811	20,118	59,805	Odontocete buzz	gdubus	2022–07–17T07:10:10.342+00:00	2022–07–17T07:10:11.886+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	6.568554	6.961549	16,524	60,430	Odontocete buzz	gdubus	2022–07–17T07:10:15.568+00:00	2022–07–17T07:10:15.961+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	8.154324	8.781737	19,649	59,180	Odontocete buzz	gdubus	2022–07–17T07:10:17.154+00:00	2022–07–17T07:10:17.781+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	9.581516	9.967617	24,805	58,399	Odontocete buzz	gdubus	2022–07–17T07:10:18.581+00:00	2022–07–17T07:10:18.967+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	0	10	0	64,000	Odontocete buzz	gdubus	2022–07–17T07:10:09.000+00:00	2022–07–17T07:10:19.000+00:00	0	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	6.961549	7.395912	26,836	58,868	Odontocete click	gdubus	2022–07–17T07:10:15.961+00:00	2022–07–17T07:10:16.395+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	5.355096	6.520292	24,649	59,024	Odontocete click	gdubus	2022–07–17T07:10:14.355+00:00	2022–07–17T07:10:15.520+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	4.093375	5.120678	26,524	59,493	Odontocete click	gdubus	2022–07–17T07:10:13.093+00:00	2022–07–17T07:10:14.120+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	0.170319	1.176938	26,055	57,930	Odontocete click	mjannic	2022–07–17T07:10:09.170+00:00	2022–07–17T07:10:10.176+00:00	1	sure
TP_annotation_HF_CETIROISE (10_128,000)	channelA_2022_07_17_09_10_09_seg272.wav	2.776497	3.376332	25,899	59,493	Odontocete click	mjannic	2022–07–17T07:10:11.776+00:00	2022–07–17T07:10:12.376+00:00	1	sure

Table A3
Table from (Darras, et al. 2023) filled with APLOSE's information and features.

Software tools	URL	Scope			Data Management					1.Signal Processing			
		Taxonomic	Regional	Ecological	Backup and retrieval	Indexing/ organizing/ labeling	Archival/long-term storage (>10 years)	Geographic management	Temporal management	Amplification	Snippet extraction	Noise reduction/ addition	Resampling
APLOSE	https://osmose.ifremer.fr/app	all	all	all	yes	In progress	In progress	Not yet	Not yet	no	no	no	yes
Audio navigation						4. Recording annotation			5. Acoustic analysis				
Spectograms	Waveforms	Frequency filtering	Playback	Playback rate/ pitch control	Manual annotation	Automated sound detection	Reference recordings	Acoustic indices	Frequency spectrum	Frequency-time measurements	Sound level measurements	SPL calibration	
yes	No	no	yes	yes	yes	no	no	yes	no	yes	no	yes	
6. Dissemination / Collaboration	Product information												
Public projects	Collaborative projects	Discussion platform/ forum	Form to contact contributors	Research indices	User access	Code access	Link to code	License	Software type	Interaction	Execution	Last update	Manual
Not yet	yes	Not yet	yes	Not yet	free	open	https://github.com/Project-OSmOSE/osmose-app	GPL-3	online	graphical user interface	web browser	01/09/2024	https://github.com/Project-OSmOSE/osmose-app/wiki

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