APPENDIX 3

TA PROJECT REPORT (TEMPLATE)

(see following pages)

TA PROJECT REPORT PACKAGE

- The completed and signed forms included in this package should be sent by email to jerico.ta@marine.ie and **jerico**-s3**@ifremer.fr** within **one month after the completion of the TA project** by the User Group Leader.
- **Refunding of the TA reimbursement to the user group will be processed as soon as these forms will be submitted**.
- The TA project report will be published in the JERICO-S3 website. The report, as well as other information collected with the attached forms, will be used to report to the European Commission.
- **Please note that any publication resulting from work carried out under the JERICO-S3 TA activity must acknowledge the support of the European Commission – H2020 Framework Programme, JERICO-S3 under grant agreement No.871153.**

1. Project Information

Proposal reference number	23/1003404
Project Acronym (ID)	ACMaREMAS
Title of the project	Acoustic Characterisation of a Marine Renewable Energy test site using Marine Autonomous Systems
Host Research Infrastructure	Marine Institute, SmartBay and glider
Starting date - End date	13/02/2023 - 07/03/2023
Name of Principal Investigator **Home Laboratory** **Address** **E-mail address** **Telephone**	Ivia Closset Finnish Meteorological Institute Erik Palménin Aukio 1, FI-00560, Helsinki ; postal: PO BOX 503, 00101 Helsinki, Finland ivia.closset@fmi.fi +35850 4421329

2. Project objectives (250 words max.)

This project aimed to study the applications and advantages of using Marine Autonomous Systems to characterise the underwater soundscape at a Marine Renewable Energy Test Site in Galway Bay, Ireland. It benefited from the unique SmartBay facility that is designed to undertake low-cost sea trials and validation of devices and components at various technology readiness levels. The unique co-location of glider deployment and the SmartBay facility allowed us to address the following objectives:

(i) At a short term, configure and deploy a Slocum S3 glider with an attached hydrophone to determine the acoustic characteristics of the renewable energy test site.

(ii) At a medium term, analyse and compare acoustic data from an existing fixed point acoustic sensor lander that provides an acoustically quiet and stable monitoring station with the Glider acoustic dataset to investigate noise propagation in the test site area.

(iii) At a longer term, determine the sound propagation of noise generated on the site by a test renewable energy device and a sound projector device generating noise of known frequency and intensity, and validate the use of gliders as a suitable platform for future acoustic monitoring studies.

Additional objectives are: (iv) Transfer knowledge and technical expertise on glider operations, best practices and mission strategy planning between Smartbay Glider Team and FMI project team to enable similar glider acoustic monitoring missions in the future.

3. Main achievements and difficulties encountered (250 words max.)

Despite some technical difficulties encountered regarding the synchronization of the hydrophone recording and the sound projector, the project successfully fulfilled most of the objectives.

The glider and hydrophone were successfully configured (see figure 1) and deployed in the vicinity of the SmartBay Test site with both FMI and MI teams operating together (Objective i). This effort led to the successful implementation of a comparable device at FMI with the ambition of similarly monitoring the acoustic landscape in the Baltic Sea (Objective iv).

Figure 1: The soundtrap pointing forward and attached under the hull of the G3 Slocum glider.

The early termination of the mission by the glider itself due to a technical problem with the engine led to the unanticipated recovery of the device after only five days and therefore had strongly narrowed down our sampling strategy. Our ability to fully investigate sound propagation at the Test site has been seriously limited since we were not able to perform the second round of tests with the sound projector planned later during the glider mission. However, preliminary results from the shortened mission show a good coherence when comparing recordings between of both hydrophones (Objective ii).

With regards to data analysis, noises produced by the glider seemed to be easily identified from the hydrophone dataset and FMI team is currently working on developing a statistical method that will filter out glider’s noise and allow better analysis of the underwater soundscape and sound propagation at the Test site (Objective iii).

4. Dissemination of the results

Data analysis is still in progress, FMI team will present the main results of this project during the International Underwater Glider Conference (part of the 9th EGO meeting supported by OceanGlider and the EuroGOOS Glider Task Team) scheduled from June 10th to June 14th, 2024, in Gothenburg (Sweden).
After the completion of further hydrophone testing in the Baltic Sea area, datasets from the ACMaREMAS project and from the Baltic Sea will be combined and compared with the ambition of being published in a scientific paper investigating the sound propagation in shallow coastal waters (estimated submission by the end of 2024-early 2025).

5. Technical and Scientific preliminary Outcomes (2 pages max.)

One of the main purposes of the project was to investigate the characteristics of the self-noise produced by the glider and to preliminary verify the ability of the glider to serve as a platform to study underwater noise using a set of tests performing with a sound-projector and by comparing acoustic data collected from the glider with those collected from a fixed point (broadband 0-200 KHz) iClisten hydrophone. Despite the shorter than expected observation period and the mismatch between the glider-mounted hydrophone and the sound-projector system used at the Test site, several interesting preliminary findings have emerged from this project.

(1) Identification of glider self-noise

Before studying the underwater ambient noise and signal detection capability, the self-noise of the glider needs to be analysed. The self-noise of a SLOCUM G3 glider is expected to come mainly from the piston and the pitch-battery motors which controls the buoyancy and barycentre of the glider respectively. The SLOCUM G3 glider is also equipped with a rudder which will steer the platform during the dive when it deviates from the preset heading. These self-noises can be easily identified on the spectrogram (figure 2).

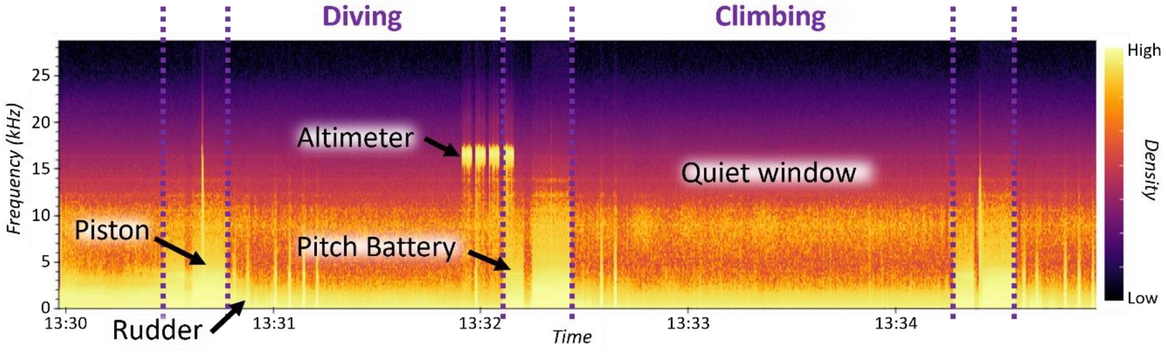

Figure 2: Spectrogram of the glider self-noises during and full yo (diving and climbing phases).

The piston-motor and pitch-battery have the highest noise level and the main energy of the noise is concentrated below 5000Hz. The rudder noise can happen randomly during the dive but seems to occur mostly right after the turning phase (both at depth and on surface). A feature that is different from deep gliders operating in open ocean is the altimeter that has a clear signature (centred around 16kHz) at the end of the diving phase and that is triggering the turning. All those noises will interfere with the acoustic environment acquisition and signal detection ability of the glider. However, in between these periods, the self-noise of the glider is negligible, validating its use as a recording platform.

(2) Intercomparison between the glider Soundtrap and Smartbay iCListen datasets

Shortly after the glider deployment, an acoustic source was deployed at the SmartBay Test site and three sets of acoustic signals were transmitted corresponding to the low, medium, and high frequency range of the sound-projector. Unfortunately, a mismatch between the sampling window of the glider hydrophone and the time of emission from the sound-projector prevented us to examine the low and medium sets.

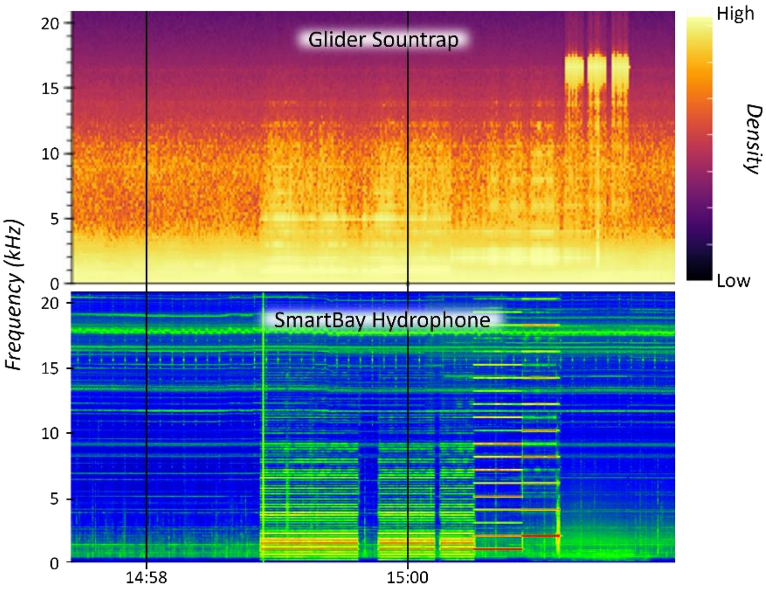

Figure 3: Spectrograms showing the acoustic signals emitted by the sound-projector (from 2 to 10 KHz) recorded simultaneously by the glider Soundtrap (top panel) and SmartBay hydrophone (bottom panel).

The raw spectrograms of the high frequency set recorded by the glider Soundtrap and the SmartBay iCListen presented in figure 3 show similar patterns between 2 and 10 KHz (the sound-projector ran out of power after 10KHz), confirming that both hydrophones recorded the acoustic signals. As anticipated, the intensity of the signal recorded by the glider is lower and partly diluted in background noises. Surprisingly, the signal recorded by both hydrophone display several “bands” distributed over different frequencies, although the sound-projector should have emitted sequentially at a single known frequency from 2 to 10 KHz. This observation requires further analysis but might result from the reverberation or echo associated with shallow bathymetry that would affect signal propagation and would be missing from deep environment datasets.

(3) Next steps and other outcomes

The project has served to train staff from FMI in the use of a glider as a passive acoustic platform in shallow environment. The experience acquired during the project has been essential to understand how the sensor is implemented on the glider as well as how acoustic data is managed, quality controlled and analysed. A substantial effort is ongoing at FMI to translate this effort into a comprehensive glider acoustic data processing interface which will serve to generate visualization plots and quality controlled acoustic datasets. For example, glider acoustic data acquired during this project is currently quality controlled and will be compared to data collected from a similar testing experiment performed in the Baltic Sea in September 2023. Preliminary results from the latter reveal a good consistency of self-noise between the SmartBay and Baltic gliders and proved the ability of the system to track nearby environmental sound source such as those produced by surface vessel.

Helsinki, 02/10/2023
Location and date

Signature of principal investigator