Equipment acquisition

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Activity Number	3.2
Activity Title	Setting up of the monitoring network of underwater noise measurement
Partner in Charge	IOF
Partners Involved	CNR, BWI, ARPA FVG
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Summary

1   Abstract

The document describes processes of procurement of instruments for measuring underwater noise, accessories and spare parts by the five project partners involved in measurements.

2   Introduction

Main objective of the SOUNDSCAPE project is assessment of influence of anthropogenic sources on marine fauna and in general on the ecosystem in the Northern Adriatic Sea (NAS) by creating a cross-border technical, scientific and institutional cooperation. It is known that the NAS is an area highly impacted by increasing maritime traffic, tourism and resource exploitation, whilst having a very vulnerable biodiversity. Most of the region is considered to be an ecologically and Biologically Significant Area (EBSA, Convention on Biological Diversity), as well as hosting varied Natura 2000 sites and marine and coastal protected areas (MPAs). This cooperation aims to ensure an efficient protection of marine biodiversity and to develop a sustainable use of marine and coastal ecosystems and resources. Descriptor D11 of EU Marine Strategy Framework Directive (MSFD) points out to the need to monitor and manage underwater noise to achieve Good Environmental Status (GES) of EU marine waters by 2020.

The fact is, there are no extensive data on underwater noise in the area and our knowledge on noise pollution and its impact on biodiversity is very limited. SOUNDSCAPE aims to fill this knowledge gap by implementing a substantial technological upgrade in noise measurements and modelling in the area and informing MSP in the region. The project will make possible the transition from an almost "no-data-available" situation to a modern network of continuous noise measurements and an advanced sound modelling in the full NAS area taking into account the seasonality, the spatial distribution of noise and its impact on biodiversity and on marine fauna including endangered species (e.g. bottlenose dolphins, sea turtles).

Therefore, according to the project work plan, the network of the nine underwater noise monitoring stations is to be set up in the wide area of the NAS continuously twelve months (one year).

The crucial element in implementing underwater acoustic monitoring system and performing accurate and reliable measurements is the equipment operator's skill and the ability to work with the equipment in a proper and correct manner. Therefore, the training of the operators was considered very important and treated accordingly.

To be able to do that, partners involved in noise measurement acquired, through the bidding process, the equipment needed.

3. Bidding processes

For preparation bidding processes all partners made contract with outsourcing firm. Besides that, LP contracted external expert for preparation of technical specification, which has to meet the purchased equipment having in mind environmental conditions at the measuring sites and objective of the measurements. After a quite long discussion project partners decided to locate measuring stations at nine very specific stations as shown at the Table 1 and Figure 1.

It is important to take in mind that there is a quite high sound reflection at shallow sea (less than 10 meters) and noise cannot be measured.

Monitoring station reference	Monitoring station name	Depth (m)
MS1	Aqua alta	17
MS2	Azalea	18
MS3	Ancona	15
MS4	Paloma	25
MS5	Susak	37
MS6	Losinj	38
MS7	Žirje	53
MS8	Split	40
MS9	Ivana	42

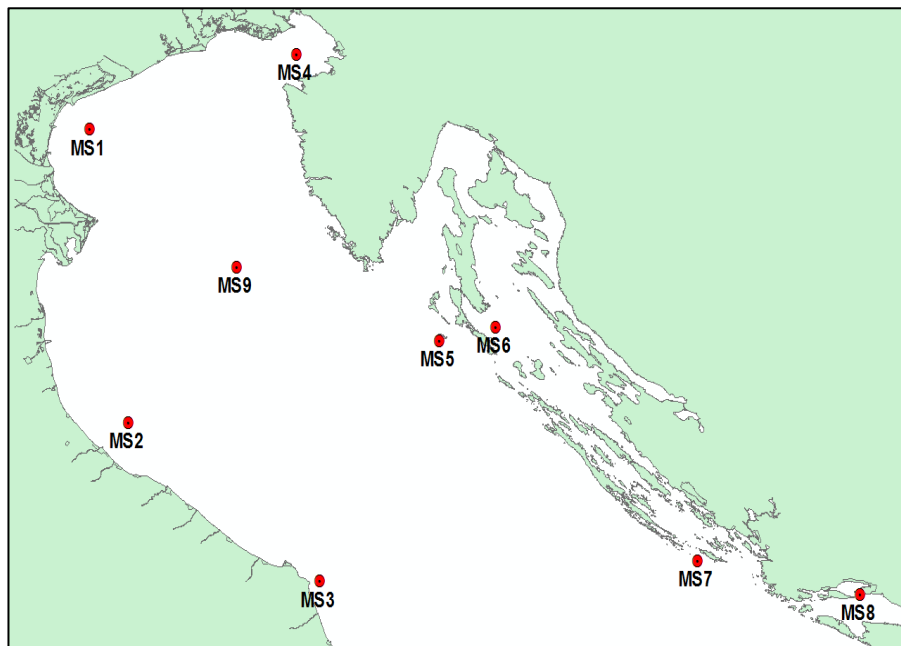Table 1. Depth and location of the monitoring stations

Figure 1. Spatial distribution of the monitoring stations

Based on advices of external expert the equipment specifications were agreed upon and defined are shown at Table 2, and fully described in Deliverable D3.2.1.

Table 2. Autonomous passive acoustic recorder (APAR) – mandatory or minimum technical requirements technical specification

Ref.	Technical requirement
1	Recording file format:
2	Sensitivity: -165 to -185 dB re 1 V/µPa
3	Dynamic range: Minimum 16 bit
4	Frequency response: 10 Hz – 10 kHz flat within ±2 dB, 10 Hz – 20kHz flat within ±3 dB
5	Directionality: Omnidirectional to within +/- 1 dB up to 20 kHz horizontal, and to within +/- 2 dB in vertical
6	Sampling rate: Minimum 44 kHz at dynamic range requested
7	Data storage: Minimum 512 GB (SD cards or SSD only)
8	System self-noise: Better than 58 dB re 1 µPa2/Hz at 63 Hz; Better than 53 dB re 1 µPa2/Hz at 125 Hz
9	Battery life: Alkaline: not less than 25 days Lithium: not less than 75 days Continuous recording 16 bit resolution, 24 kHz sampling
10	Calibration: The system has to be fully calibrated (hydrophone sensitivity and directivity, gain and self-noise and the calibration documented for each instrument (no generic data)
11	Programmable or switchable Input gain (has to enable various sensitivities within range required)
12	Power up/down without opening of housing
13	Start/stop recording without opening of housing
14	Maximum operating depth:
15	Temperature range:-5°C to +40°C
16	Communication interface for control and setting up of system parameters
17	Mooring frame: Frame to enable attachment of deployment equipment (flotations, acoustic releasers, moorings etc.) to the instrument
18	Hydrophone protection: Mechanical protection of hydrophone against physical damage (e.g. cage)
19	Possibility of start stop recording (duty cycling, on/off scheduling)
20	Dimensions (with mooring frame and batteries): Diameter no more than mm Weight in water no more than 20 kg
21	Possibility to use both alkaline and lithium batteries Note: If any additional hardware, software or accessories are needed to fulfil this requirement, this should be included in the proposal
22	Delivery time: Not more than 8 weeks
23	Warranty: Not less than 12 months
24	Pistonophone: Grass 42AC or similar with coupler for the hydrophone quoted
Value added technical requirements	
1	Dynamic range 16 and 24 bit …..
2	Additional sampling rate …
3	Additional data storage
4	Increased battery life (210 days)
5	High pass filter with cut-off frequency in 3-10 Hz range

Table 2 Automatic passive acoustic recorder (APAR) - overview

Producer/type	SonoVault	Porpoise	Orca	RESEA
Recording file format:	OK	OK	OK	OK
Sensitivity: -165 to -185 dB re 1 V/µPa	Neptune sonar D60 -198 dB Reson TC 4037 -193 dB Gain do +48 dB OK	Sensor Tech SQ91 -192 dB Gain up to +40 dB OK	OK They offer more hydrophones Eg. GTI M36 -195 dB Gain up +45 dB	OK They offer more hydrophones (including zero state HTI and Colmar) and sensitivity is OK and with only 15 dB amplification
Dynamic range: Minimum 16 bit	16 & 24 bit	24 bits	16 bit; 24 bit on request	For low power mode only 16 bit
Frequency response: 10 Hz – 10 kHz flat within ±2 dB, 10 Hz – 20kHz flat within	Neptune sonar D60 OK Reson TC 4037 OK	NO data	OK Depending of hydrophone	OK Depending of hydrophone (all included)
Directionality: Omnidirectional to within +/- 1 dB up to 20 kHz horizontal, and to within +/- 2 dB in vertical	D60 OK TC 4037 OK	NO data	OK Depending of hydrophone	OK Depending of hydrophone (all included)
Sampling rate: Minimum 44 kHz	96 kHz max for 24 bits, the remaining 96 is divided by the integer eg 96/12 = 8 kHz; for 16 bits max 220 kHz	24 kHz, 48 kHz, 96 kHz, 192 kHz, 384 khz (12 kHz on request)	24 kHz, 48 kHz, 96 kHz, 192 kHz, 384 khz (12 kHz on request)	192 kS/s, 96 kS/s,48 kS/s, 32 kS/s, 16 kS/s, 8 kS/s, 4 kS/s, 2 kS/s, 1 kS/s (za low power mode) For normal mode 1.25 MS/s, 625 kS/s, 312.5 kS/s,156.25 kS/s, 78.125 kS/s, 39.0625 kS/s
Data storage: Minimum 512 GB (SD cards or SSD	Up to 18 TB (Up to 3,5 TB no extra charge)	Up to 2 TB	2 Slots, 256 GB default, up to 1 TB	256 GB SD card+600 GB SSD
System self-noise: Better than 58 dB re 1 µPa2/Hz at 63 Hz; Better than 53 dB re 1 µPa2/Hz at 125 Hz	OK	OK	OK	OK?

Table 2 Automatic passive acoustic recorder (APAR) – overview (continued)

Producer/type	SonoVault	Porpoise	Orca	RESEA
Battery life: **Alkaline: X days** **Lithium: y days** Continuous recording 16 bit resolution, 24 kHz sampling	**Alkaline: 40 days (with 36 batteries)** **Lithium: 500 days (with 42 batteries; 350 days with 28 batteries, minimum 70 days with 14 batteries)** Continuous recording 16 bit resolution, 96 kHz sampling	**Alkaline:** 105 days **Lithium:** 315 days Continuous recording 24 bit resolution, 24 kHz sampling	**Alkaline:** 25 days **Lithium:** 75 days	**Alkaline:** 13 days **Lithium:** 45 days Continuous recording 16 bit resolution, 24 kHz sampling
Calibration: The system has to be fully calibrated (hydrophone sensitivity and directivity, gain and self-noise and the calibration documented for each instrument (no generic data)	OK	OK	OK	OK
Programmable or switchable Input gain (has to enable various sensitivities within range required)	OK, 6 – 45 dB i - 20 dB att	OK Configurable Gain: 0 dB-40 dB	OK Programmable in software (0 dB, 15 db, 30 dB, 45 dB)	There are no, but there are 4 channels each of which can have different amplification, so connecting the hydrophone to different inputs can get different gains. But the "low power" mode can only be 2channels and the amplification can either be 0 or 15 dB. They have a programmable attenuator if used with a hydrophone amplifier.
Power up/down without opening of housing	OK	OK	OK	OK
Start/stop recording without opening of housing	OK	OK	OK	OK

Table 2 Automatic passive acoustic recorder (APAR) – overview (continued)

Producer/type	SonoVault	Porpoise	Orca	RESEA
Maximum operating depth: 500 m	6000 m (1500 m hydrophone D60, 900 m TC 4037)	2000 m (500 m in manual)	200 m or 3500 m	200 m or 700 m
Temperature range: -5°C to +40°C	-5°C to +40°C	-10°C to +-50°C	-10°C to +-50°C	-
Communication interface for control and setting up of system parameters	RS 232	Real Time Ethernet Streaming	Ethernet programming and live streaming; High speed USB for download RS 422 on request	Ethernet
High pass filter: Cut of frequency In 3-10 Hz range	OK	NO (only 400 Hz)	NO (only 400 Hz)	OK
Mooring frame, hydrophone protection	OK	OK	OK	OK
Possibility of start stop recording (duty cycling, on/off scheduling)	OK	OK Configurable recording, schedule and duty cycling	OK Configurable recording, scheduling and duty cycling	OK
Dimensions (with mooring frame and batteries): Diameter no more Length no more Weight in water no more	138 mm (200 mm frame) 598 mm (1100 mm frame) 9 kg in air (no batteries) Batteries approx. 4 kg	70 mm Without container for batteries (232 mm, 1,2 kg)	180 mm 280 mm (without additional container for batteries) 6,7 kg in air	120 mm 550 mm, 5 kg in water
Possibility to use both alkaline and lithium batteries	YES but SPS has to be re-programmed	YES	YES	NO
Delivery time 8 weeks	12-14	-	-	-
Pistonphone: Grass 42AC with coupler for the hydrophone delivered (up to 3 pieces should be delivered – tbd later)				
Notice		User friendly software (simple, intuitive) There is software for data processing It has real time Ethernet for audio	There are 5 channels (unnecessary), the same software as Porpoise	There are 4 channels that are not needed but can be used for the above-mentioned CHANGE OF amplification

Notice: It was discussion about KIWi instruments produced by Ocean Instruments NZ. Unfortunately, instruments cannot meet our requirements. At this time, they are unable to provide individually fully calibrated hydrophones. At the moment they are only able to provide individual piston phone calibration, and a guaranty of flat response +/- 3dB. Meanwhile they are constructing a new calibration facility in order to provide full calibration as an option for customers whom require it. They will be able to offer this in ~12 months' time (source Pre

Figure 4 Acoustic releasers overview

Producer		Tip	Operating depth	Release load	Dimensions	Price*
Teledyne Benthos		R500 Shallow Water Acoustic Release AR-955-LS1-NFC	500 m	180 kg	41" X 9" X 13" (?) 13 kg in air	5.300 USD
		Top Side Deck Unit RLSIT-LH1				7.500 USD
iXblue		Oceano 500 KAA00074	400 m	200 kg	565 x 140 mm 6,5 kg in air	5.985 Eur
		Oceano TT701-15m Deck set unit KA00226				8.845 Eur
Edgetech		PORT LF-SD	3.500 m	250 kg		6.825 USD
		Works with existing PACS command unit				
Sonardyne		Lightweight Release Transponder (LRT) 7986-000-01	500 m	125 kg	490 X 63 mm 1.77 kg in air	2.342 GBP
		Lightweight Release Command Unit (HF) 7967-000-02				6.260 P

* All prices are Ex works (without transport and insurance)

Based on that, the bidding process was launched, proposals from various manufacturers received and processed. After the assessment of instruments offered by more producers (technical specifications, prices, software, maintenance, warranty period, training course, and deliverable time), SonoVault acoustic recorder manufactured by company Develogic from Hamburg, Germany was chosen by all project partners as the best option and ordered.

According Applications Form it was planned to procure eleven pieces of instruments for measurements underwater noise including spare parts and consumables by six project partners, which are involved in field measurements:

1. Institute of oceanography and fisheries (IOF) – 4 pcs
2. National research council (CNR) - 2 pcs
3. Blue world institute of marine research and conservation (BWI) - 2 pcs
4. Environmental protection agency of Friuli Venezia Giulia (ARPA-FVG) - 1 pc
5. Cetacea foundation (CF) - 1 pc
6. Marche region (REM) - 1 pc

Based on adopted methods of anchoring of the instrument three different types of anchoring system are used depends of depth of sea at the measuring stations. Dependent of used anchoring system different accessories has to be purchased.

As measuring devices will monitor underwater noise at all stations twelve months it is planned to visit sites and recover instruments not at least four times in twelve months (approximately every three months or more often), data must be download, battery replaced and instrument clean and calibrated.

According to partners' agreement during each visit to measuring stations temperature and salinity profile in water column are measured.

I want point that no one partner did not buy CTD probe. Partner who has CTD probe lend them to partner who does not have.

No.	Name of institutions	Type of instrument and SN
1	Institute of oceanography and fisheries (IOF)	Device for measurement of underwater noise SonoVault: 4 pcs ; SN1095, 1096,1097,1099 With accessories and consumables Network accessible device (NAS): 1pc Notebook: 1 working station for data processing
2	National research council (CNR)	Device for measurement of underwater noise SonoVault: 2 pcs, SN: 1092,1093
3	Blue world institute of marine research and conservation (BWI)	Device for measurement of underwater noise SonoVault: 2pcs; SN: 1101, 1012
4	Environmental protection agency of Friuli Venezia Giulia (ARPA-FVG)	Device for measurement of underwater noise SonoVault: 1 pc; SN: 1095
5	Cetacea foundation (CF)	Device for measurement of underwater noise SonoVault: 1 pc; SN: 1094
6	Marche region (REM)	Device for measurement of underwater noise SonoVault: 1 pc; SN: 1091

Figure 2   Autonomous passive underwater acoustic recorder SonoVault

Figure 3   Four of eleven bought SonoVault acoustic recorders on a ship deck
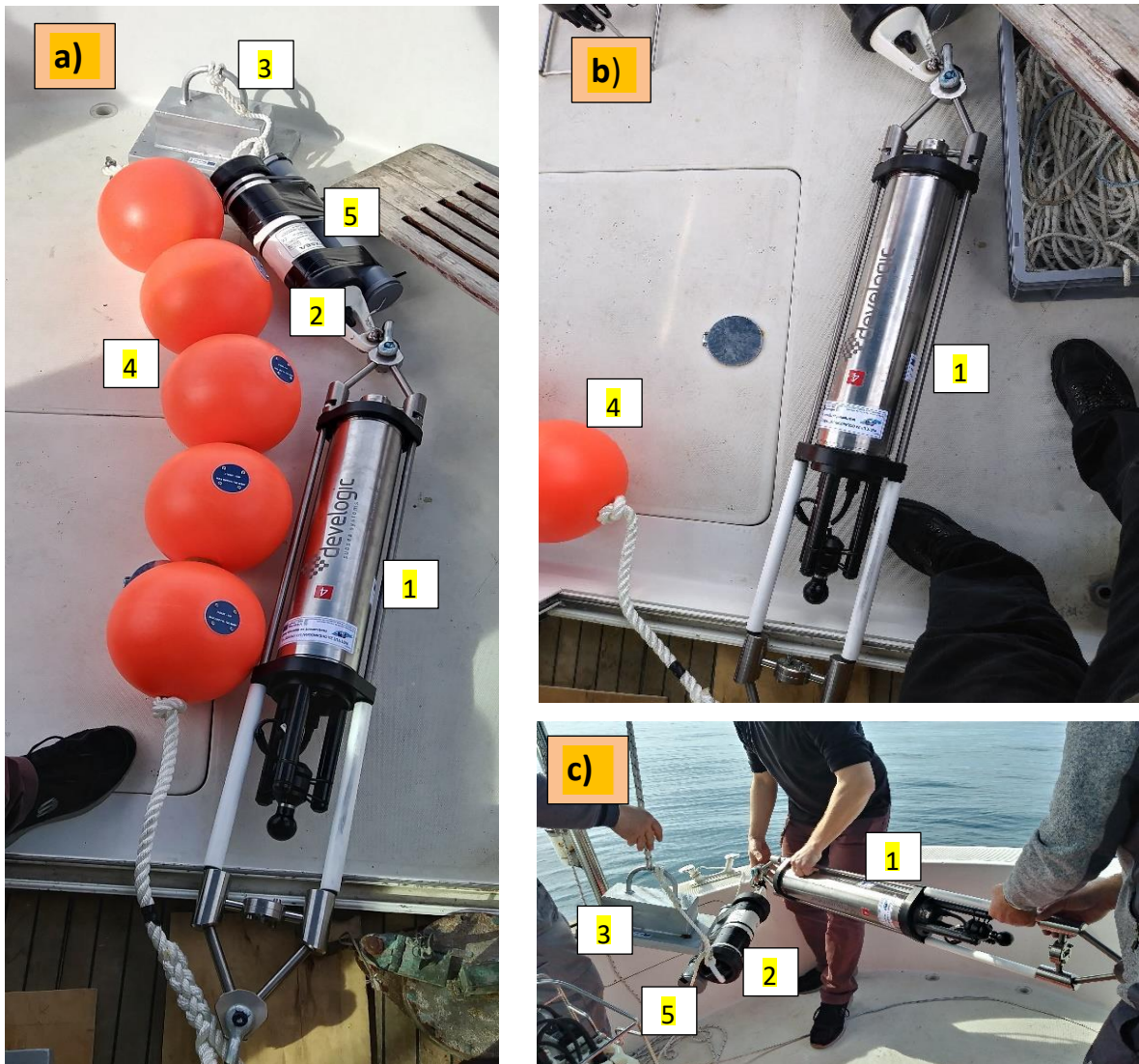
(1 – SonoVault passive recorder, 2 - acoustic releaser, 3 - heavy anchoring block, 4 - floating buoys, 5 - container with recovering rope)

Figure 4. Preparation of measuring assemble for deployment at the station MS-8 (Split): a) assemble ready for deployment: including SonoVault recorder, acoustic releaser, anchoring weight and container with recovering rope and floating buoys), b) instrument with recovering rope, c) deployment of the assemble
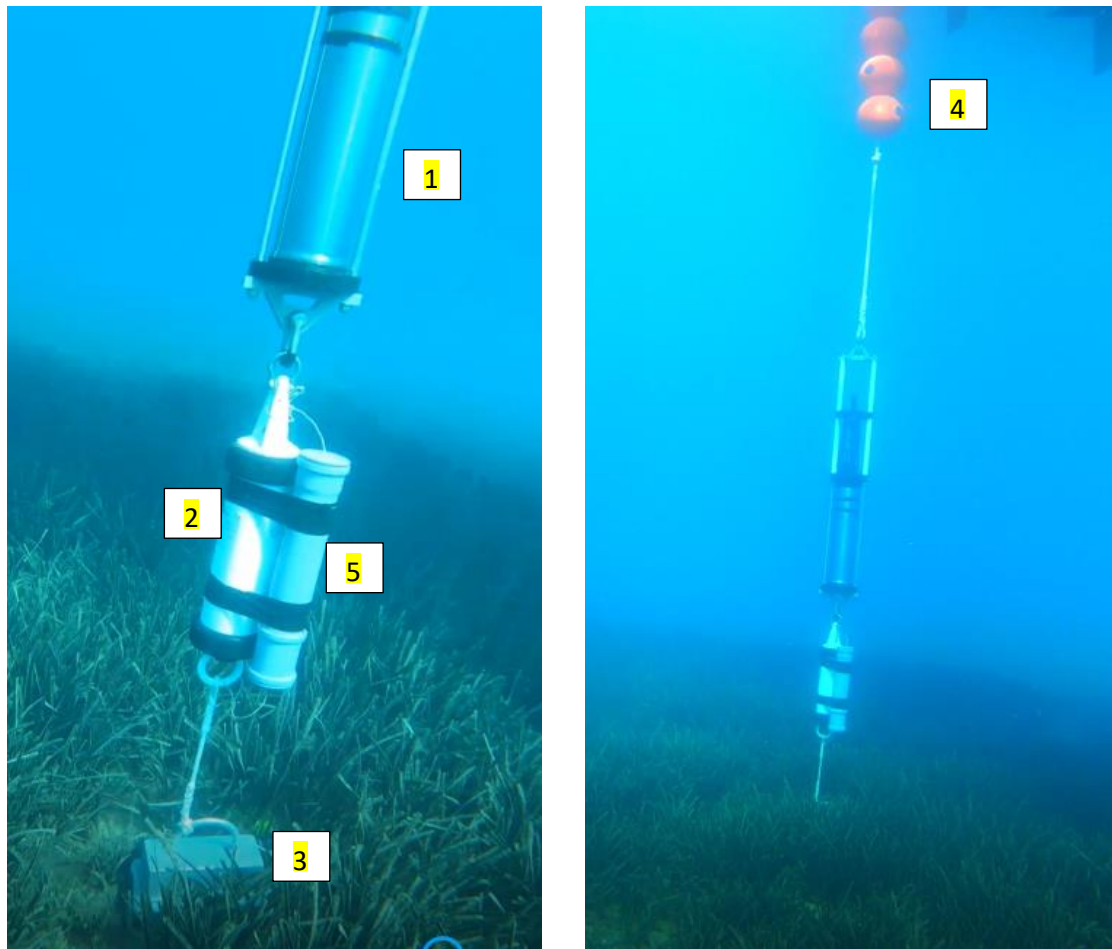
Figure 5   Anchored measuring assemble in work at the testing site: 1 – SonoVault measuring instrument, 2 - acoustic releaser, 3 - heavy anchoring block, 4 - floating buoys, 5 - container with recovering rope