Reports on deployment of the underwater noise monitoring network

Final Version of 15/10/2021

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Summary

1 Abstract

Document describes implementation of the underwater noise monitoring in the whole project period (2020-02-21 till 2021-08-06).

All deployments/recovery/redeployments details of monitoring equipment on all locations are described and documented with notes of success/failure of each redeployment.

2 Introduction

The main objective of the project is to create a cross-border technical, scientific and institutional cooperation to face together the challenge of assessing the impact of underwater environmental noise on the marine fauna and in general on the Northern Adriatic Sea ecosystem.

Therefore, according to the project work plan, the network of the underwater noise monitoring was set up in the Northern Adriatic Sea (Activity 3.2). The continuous underwater noise produced by anthropogenic activities such as marine traffic (both commercial and recreational) and hydrocarbon exploitation is monitored within a seventeen months' period (Activity 3.3).

Underwater noise monitoring system set up and specifications for the system components (D3.2.1) as well as recommendations for the underwater noise monitoring procedure (D3.2.2) were defined. According to that, time schedule for the implementation of the underwater noise monitoring system was agreed upon by partners. The beginning of the deployment of measurement equipment on defined measurement sites was scheduled for mid-February 2020. The first recovery was scheduled shortly after e.g. approx. one month. These first results were used for the purposes of verification of parameters set up, deployment gear, method and procedure as well as assessment of the suitability of the measurement site location to the threat for the equipment loss or damage and biofouling rate. After eventual corrections, the equipment was deployed for the period of approx. two or three months depending of the specific measurement site.

All measurement sites were deployed more or less by the schedule, by the end of February 2020, except MS9 (beginning of March) which is in the middle of the sea and outside the territorial waters which imposed much logistic and legal challenges.

The further course of planned actions was severely influenced by the coronavirus (Covid-19) pandemia. It hit hard in March 2020, especially Italian partners and resulted in business lockdowns, restricted mobility and inability of all partners to proceed with the planned activities. Most of the partners were not able to recover the equipment on time which resulted in data loss due to the lack of memory and/or battery power which was planned for the much shorter deployment period. In spite of that, partners decided to press on and manage to recover the equipment mostly during May and beginning of June. The serviced equipment was re-deployed with more memory and batteries to accommodate for the longer deployment period. As there were no further lockdowns, partners managed to keep the planned course of deployments in spite of numerous restrictions imposed on staff involved. The measurement period was planned until the end of February 2021, but was prolonged to June 2021, with some partners last recoveries in mid and late July, even early August.

The monitoring site specific details of the deployment/recovery actions throughout measurement period are given in Section 3.

3 Implementation of the underwater noise monitoring network

3.1 Description of the implemented underwater noise monitoring network

To achieve objectives of the project mentioned earlier, the network of the underwater noise monitoring stations is developed, designed and implemented. The network for the monitoring of underwater noise is set up by implementing 9 monitoring stations.

The locations of monitoring stations were determined after analysis, considering expected noise pressures, categorization of the monitoring according to TG Noise recommendations, deployment and servicing complexity, soundscape modelling requirements and cost. The locations of the implemented monitoring stations somewhat differ from the ones that were planned and defined in D3.2.1. Monitoring station MS3 Ancona was moved towards deeper sea to allow for the better reception of low frequencies, while MS5 Susak and MS9 Ivana were relocated to avoid areas which has been assessed as the threat for the equipment loss or damage by the trawling activities.

The locations of the implemented monitoring stations are displayed in Table 3-1 and in Figure 3-1

Monitoring station reference	Monitoring station name	Position		Depth (m)
		Longitude (E)	Latitude (N)	
MS1	Aqua alta	12°30,883	45° 19,383	17
MS2	Azalea	12°42,656	44°10,254	18
MS3	Ancona	13°40,932	43°31,954	15
MS4	Paloma	13°33,917	45°37,095	25
MS5	Susak	14°17,293	44°29,545	37
MS6	Lošnj	14°34,51	44°32,747	38
MS7	Žirje	15°35,984	43°37,776	53
MS8	Split	16°25,336	43°29,885	40
MS9	Ivana D	13°15,720	44°46,953	42
MS9*	Ivana E	13°14,65'	44°44,66'	42

Table 3-1 Locations of the implemented monitoring stations

After the Ivana D gas production platform, close to the monitoring site MS9, collapsed in December 2020 and the whole area was closed and access restricted, monitoring site was moved close to Ivana E platform and the site was marked as MS9*. These two positions are only few miles apart and the differences in the data collected are regarded not relevant.

On all monitoring stations autonomous passive underwater acoustic recorder Sono.Vault with Neptune Sonar D60 hydrophone, as displayed on Figure 3-2, was used. The autonomous passive underwater acoustic recorders were setup as shown in Table 3-2. More information about SonoVault underwater passive recorder there is in Deliverable D3.2.4.

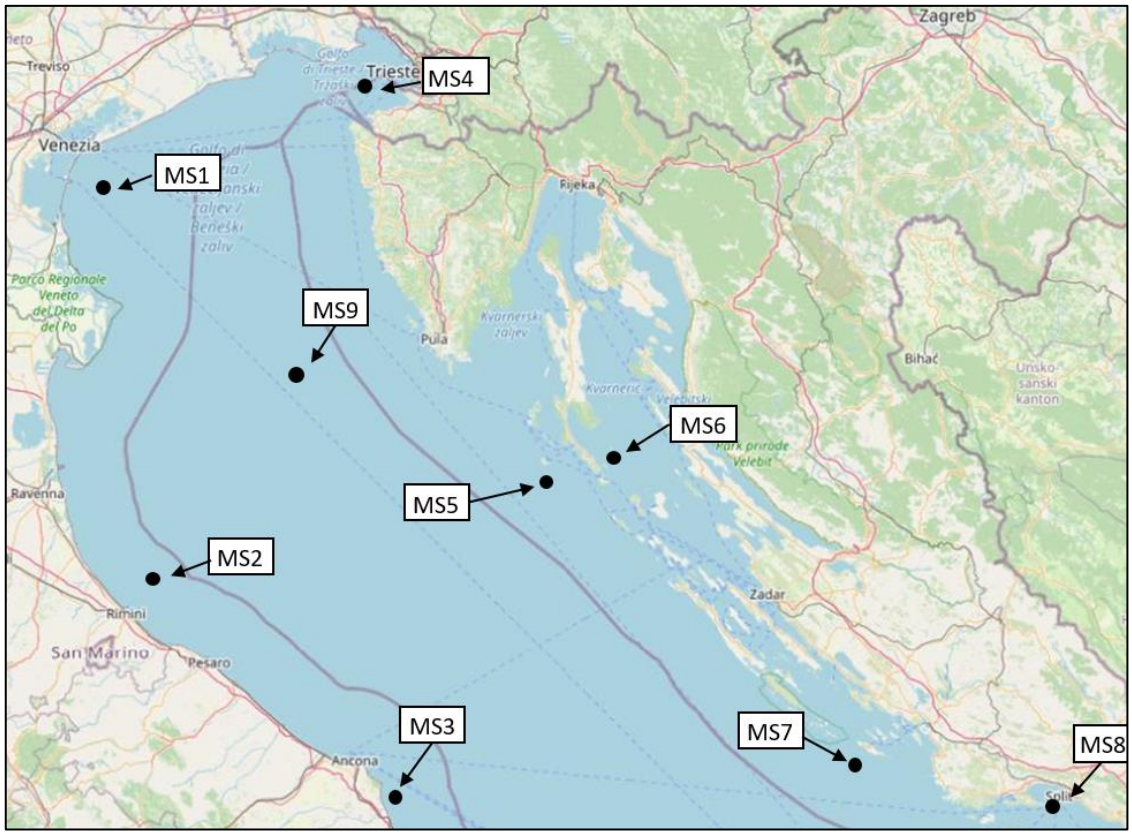

Figure 3-1 Locations of the implemented monitoring stations

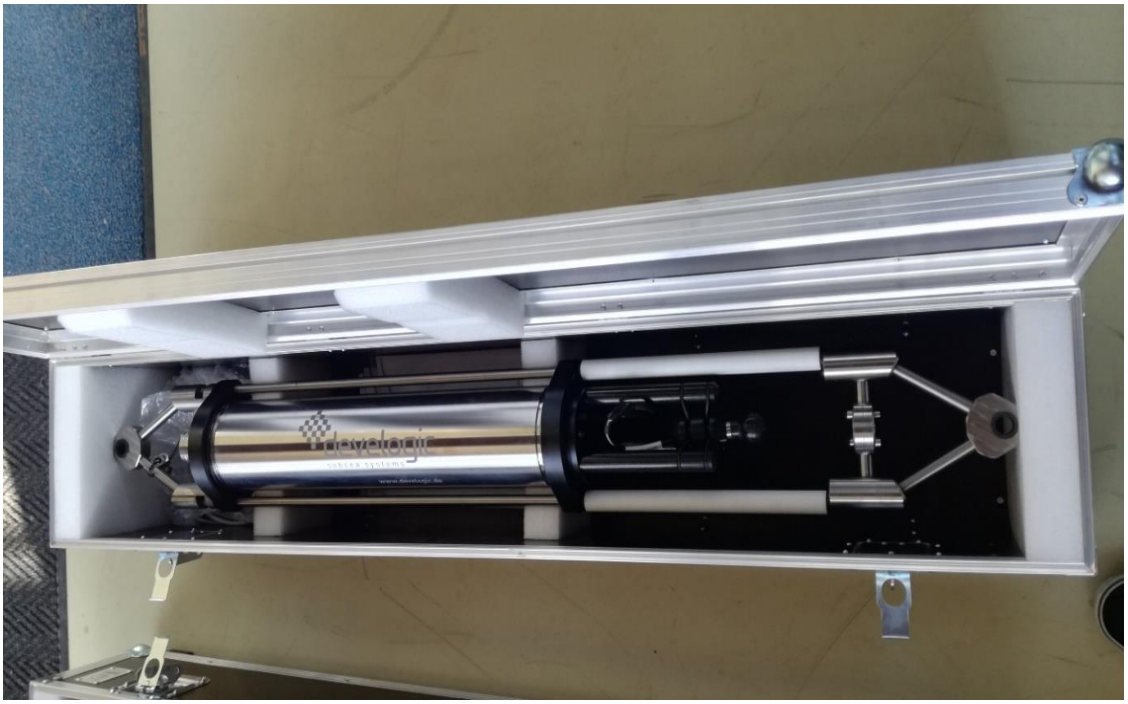

Figure 3-2 Autonomous passive underwater acoustic recorder Sono.Vault

Table 3-2 The autonomous passive underwater acoustic recorders setup

Dynamic range	16 bit	
Sampling rate:	48 kHz	
Type of recording	Continuous	
Sensitivity	**Monitoring station**	**Gain setting**
	MS1	6
	MS2	6
	MS3	6 (1st deployment)
		7 (other deployments)
	MS4	7 (1st deployment)
		6 (other deployments)
	MS5	6
	MS6	6
	MS7	6
	MS8	5
	MS9	5

The time course of the implementation of the underwater noise monitoring network (deployment/recovery actions for each monitoring station) is described in detail in sections 2.2 to 2.10. The overview of deployment/recovery actions for each monitoring station is given in Tables 3-3 I to 3.3 IV. The deployment period is in black letters, data recording period in red letters.

The overall graphic overview of deployment/recovery actions for each monitoring station is given in Table 3-4. The deployment period is shown with black line, data recording period with red line. The performance of CTD measurement required for modelling data is also shown, where green square represent that CTD was carried out, while red square represents that CTD measurements were not performed.

The digital copies of original deployment/recovery sheets are stored in data bases on both IOF and CNR ISMAR servers and are accessible to the authorized staff.

Table 3-3 I The overview of deployment/recovery actions for monitoring station MS1 Aqua Alta and MS2 Azalea

Measurement site	Deployment. No.	Deployment period	Total days	Deployment. Days	Summary				
					Total Deployment days per station	Data recording days	Total operate days per station	Deployment/ total days ratio	Recording / total days ratio
MS1 AQUA ALTA	1	2020/02/21 - 2020/04/03 2020/02/21 - 2020/03/11	533	43	502	19	448	94,18	84,05
	2	2020/04/09 - 2020/06/11 2020/04/09 - 2020/06/11		64		64			
	3	2020/06/15 – 2020/08/12 2020/06/15 – 2020/08/12		59		59			
	4	2020/08/12 – 2020/11/18 2020/08/12 – 2020/11/18		99		99			
	5	2020/11/18 – 2021/03/03 2020/11/18 – 2021/03/03		106		106			
	6	2021/03/11 – 2021/04/15 2021/03/11 – 2021/03/16		36		6			
	7	2021/05/04 – 2021/08/06 2021/05/04 – 2021/08/06		95		95			
MS2 AZALEA	1	2020/02/29 – 2020/05/09 2020/02/29 – 2020/04/30	492	71	384	62	375	78,05	76,22
	2	2020/05/31 – 2020/07/18 2020/05/31 – 2020/07/18		49		49			
	3	2020/08/01 – 2020/10/10 2020/08/01 – 2020/10/10		71		71			
	4	2020/10/24 – 2020/12/20 2020/10/24 – 2020/12/20		58		58			
	5	2021/01/30 – 2021/04/03 2021/01/30 – 2021/04/03		64		64			
	6	2021/04/25 – 2021/07/04 2021/04/25 – 2021/07/04		71		71			

Table 3-3 II The overview of deployment/recovery actions for monitoring station MS3 Ancona and MS4 Paloma

Measurement site	Deployment. No.	Deployment period	Total days	Deployment. Days	Summary				
					Total Deployment days per station	Data recording days	Total recording days per station	Deployment / total days ratio	Recording / total days ratio
MS3 ANCONA	1	2020/02/21 – 2020/05/28 2020/02/21 – 2020/04/22	494	98	445	62	387	90,08	78,34
	2	2020/06/10 – 2020/09/10 2020/06/10 – 2020/09/10		93		93			
	3	2020/09/29 – 2021/01/28 2020/09/29 – 2021/01/11		122		105			
	4	2021/02/17 – 2021/05/05 2021/02/17 – 2021/05/05		78		78			
	5	2021/05/14 – 2021/07/16 2021/05/14 – 2021/07/11		54		49			
MS 4 PALOMA	1	2020/02/21 – 2020/03/05 2020/02/21 – 2020/03/05	515	14	401	14	336	77,86	65,24
	2	2020/03/11 – 2020/04/27 2020/03/11 – 2020/04/27		48		48			
	3	2020/04/27 – 2020/06/10 2020/04/27 – 2020/06/10		45		45			
	4	2020/06/10 – 2020/08/13 2020/06/10 – 2020/08/13		65		65			
	5	2020/08/13 – 2020/10/14 2020/08/13 – 2020/10/14		63		63			
	6	2020/10/14 – 2020/11/27 2020/10/14 – 2020/10/14		45		0			
	7	2021/02/05 – 2021/03/16 2021/02/05 – 2021/03/01		40		24			
	8	2021/03/18 – 2021/04/08 2021/03/18 – 2021/04/04		22		18			
	9	2021/04/08 – 2021/04/23 2021/04/08 – 2021/04/23		16		16			
	10	2021/05/01 – 2021/05/10 2021/05/01 – 2021/05/10		10		10			
	11	2021/06/17 – 2021/07/19 2021/06/17 – 2021/07/19		33		33			

Table 3-3 III The overview of deployment/recovery actions for monitoring station MS5 Susak and MS6 Lošinj

Measurement site	Deployment. No.	Deployment period	Total days	Deployment. Days	Summary				
					Total Deployment days per station	Data recording days	Total recording days per station	Deployment / total days ratio	Recording / total days ratio
MS5 SUSAK	1	2020/03/05 – 2020/04/09 2020/03/05 – 2020/04/09	495	36	481	36	481	97,17	97,17
	2	2020/04/11 – 2020/06/11 2020/04/11 – 2020/06/11		62		62			
	3	2020/06/14 – 2020/08/09 2020/06/14 – 2020/08/09		57		57			
	4	2020/08/13 – 2020/10/18 2020/08/13 – 2020/10/18		67		67			
	5	2020/10/20 – 2021/01/15 2020/10/20 – 2021/01/15		88		88			
	6	2021/01/18 – 2021/03/17 2021/01/18 – 2021/03/17		59		59			
	7	2021/03/17 – 2021/06/01 2021/03/17 – 2021/06/01		73		73			
	8	2021/06/04 – 2021/07/12 2021/06/04 – 2021/07/12		39		39			
MS6 LOŠINJ	1	2020/02/22 – 2020/04/09 2020/02/22 – 2020/04/09	503	48	466	48	466	92,64	92,64
	2	2020/05/07 – 2020/06/11 2020/05/07 – 2020/06/11		36		36			
	3	2020/06/14 – 2020/08/09 2020/06/14 – 2020/08/09		57		57			
	4	2020/08/13 – 2020/10/18 2020/08/13 – 2020/10/18		67		67			
	5	2020/10/20 – 2021/01/15 2020/10/20 – 2021/01/15		88		88			
	6	2021/01/18 – 2021/03/17 2021/01/18 – 2021/03/17		59		59			
	7	2021/03/18 – 2021/06/01 2021/03/18 – 2021/06/01		76		76			
	8	2021/06/04 – 2021/07/08 2021/06/04 – 2021/07/08		35		35			

Table 3-3 IV The overview of deployment/recovery actions for monitoring station MS7 Žirje, MS8 Split and MS9 Ivana with average values for all monitoring stations

Measurement site	Deployment. No.	Deployment period	Total days	Deployment. Days	Summary				
					Total deployment days per station	Data recording days	Total recording days per station	Deployment/ total days ratio	Recording / total days ratio
MS7 ŽIRJE	1	2020/03/04 – 2020/05/05	495	63	495	0	383	100	77,37
	2	2020/05/05 – 2020/08/01 2020/05/05 – 2020/08/01		89		89			
	3	2020/08/01 – 2020/12/04 2020/08/01 – 2020/11/29		126		121			
	4	2020/12/04 – 2021/05/18 2020/12/04 – 2021/04/04		166		122			
	5	2021/05/19 – 2021/07/08 2021/05/19 – 2021/07/08		51		51			
MS8 SPLIT	1	2020/02/24 – 2020/05/06 2020/02/24 – 2020/05/06	499	73	488	73	397	97,80	79,56
	2	2020/05/06 – 2020/07/01 2020/05/06 – 2020/07/01		57		57			
	3	2020/07/01 – 2020/11/25 2020/07/01 – 2020/09/29		148		91			
	4	2020/11/25 – 2021/04/29 2020/11/25 – 2021/03/26		156		122			
	5	2021/05/14 – 2021/07/06 2021/05/14 – 2021/07/06		54		54			
MS9 IVANA D	1	2020/03/10 – 2020/05/08 2020/03/10 – 2020/05/08	493	60	352	60	351	71,40	71,20
	2	2020/05/08 – 2020/07/22 2020/05/08 – 2020/07/22		76		76			
MS9* IVANA E	3	2020/07/22- lost		1		0			
	4*	2020/12/14 – 2021/05/09 2020/12/14 – 2021/05/09		147		147			
	5*	2021/05/09 – 2021/07/15 2021/05/09 – 2021/07/15		68		68			
		Total averages	**496,1**		**440,0**		**397,2**	**88,66**	**80,03**

From Tables 3-3 I to 3-3 IV it is visible that overall efficiency of the monitoring process was very good. In spite of all problems encountered, (see sections 2.2 to 2.10) valid raw data on continuous underwater sound levels (wav. files) were recorded within 80,2% of time that was available to the partners involved (total days). The ratio of days within which valid data were recorded to total days within which equipment were deployed (total deployment days) is 88,8%.

In average, partners had 496 available days in total (days within which they were able to deploy equipment). Out of this, partners used, in average, 440 days to deploy equipment (88,7%). Out of total days available, valid data were recorded, in average, within 397 days (80%)

Monitoring stations with the greatest number of deployment days were MS1 Aqua Alta (502 days) and MS7 Žirje (495 days) and the shortest deployment periods were at and MS9 Ivana (352 days) and MS2 Azalea (384 days). The data were recorded for the longest period on MS5 Susak (481 days) and MS6 Lošinj (466 days) while the shortest periods with data were on MS4 Paloma (336 days), and MS7 Žirje (338) days. This all fits with the detailed courses of deployment described in sections 2.2. to 2.10.

Measurement site	Dply. No.	Deployment period	Total days	Dply. Days	Summary: Total Dply days per station	Summary: Recording days	Summary: Total recording days per station	Summary: Dply / total days ratio	Summary: Rec / total days ratio
MS1 AQUA ALTA	1	2020/02/21 - 2020/04/03 2020/02/21 - 2020/03/11	533	43	502	19	448	94,18	84,05
	2	2020/04/09 - 2020/06/11 2020/04/09 - 2020/06/11		64		64			
	3	2020/06/15 – 2020/08/12 2020/06/15 – 2020/08/12		59		59			
	4	2020/08/12 – 2020/11/18 2020/08/12 – 2020/11/18		99		99			
	5	2020/11/18 – 2021/03/03 2020/11/18 – 2021/03/03		106		106			
	6	2021/03/11 – 2021/04/15 2021/03/11 – 2021/03/16		36		6			
	7	2021/05/04 – 2021/08/06 2021/05/04 – 2021/08/06		95		95			
MS2 AZALEA	1	2020/02/29 – 2020/05/09 2020/02/29 – 2020/04/30	492	71	384	62	375	78,05	76,22
	2	2020/05/31 – 2020/07/18 2020/05/31 – 2020/07/18		49		49			
	3	2020/08/01 – 2020/10/10 2020/08/01 – 2020/10/10		71		71			
	4	2020/10/24 – 2020/12/20 2020/10/24 – 2020/12/20		58		58			
	5	2021/01/30 – 2021/04/03 2021/01/30 – 2021/04/03		64		64			
	6	2021/04/25 – 2021/07/04 2021/04/25 – 2021/07/04		71		71			
MS3 ANCONA	1	2020/02/21 – 2020/05/28 2020/02/21 – 2020/04/22	494	98	445	62	387	90,08	78,34
	2	2020/06/10 – 2020/09/10 2020/06/10 – 2020/09/10		93		93			
	3	2020/09/29 – 2021/01/28 2020/09/29 – 2021/01/11		122		105			
	4	2021/02/17 – 2021/05/05 2021/02/17 – 2021/05/05		78		78			
	5	2021/05/14 – 2021/07/16 2021/05/14 – 2021/07/11		54		49			
MS 4 PALOMA	1	2020/02/21 – 2020/03/05 2020/02/21 – 2020/03/05	515	14	401	14	336	77,86	65,24
	2	2020/03/11 – 2020/04/27 2020/03/11 – 2020/04/27		48		48			
	3	2020/04/27 – 2020/06/10 2020/04/27 – 2020/06/10		45		45			
	4	2020/06/10 – 2020/08/13 2020/06/10 – 2020/08/13		65		65			
	5	2020/08/13 – 2020/10/14 2020/08/13 – 2020/10/14		63		63			
	6	2020/10/14 – 2020/11/27 2020/10/14 – 2020/10/14		45		0			
	7	2021/02/05 – 2021/03/16 2021/02/05 – 2021/03/01		40		24			
	8	2021/03/18 – 2021/04/08 2021/03/18 – 2021/04/04		22		18			
	9	2021/04/08 – 2021/04/23 2021/04/08 – 2021/04/23		16		16			
	10	2021/05/01 – 2021/05/10 2021/05/01 – 2021/05/10		10		10			
	11	2021/06/17 – 2021/07/19 2021/06/17 – 2021/07/19		33		33			

Table 3-4 The overview of deployment/recovery actions for each monitoring station (deployment period - black line, data recording period – red line, green square – CTD performed, red square – CTD not performed)

Measurement site	Dply. No.	Deployment period	Total days	Dply. Days	Summary: Total Dply days per station	Summary: Recording days	Summary: Total recording days per station	Summary: Dply / total days ratio	Summary: Rec / total days ratio
MS5 SUSAK	1	2020/03/05 – 2020/04/09 2020/03/05 – 2020/04/09	495	36	481	36	481	97,17	97,17
	2	2020/04/11 – 2020/06/11 2020/04/11 – 2020/06/11		62		62			
	3	2020/06/14 – 2020/08/09 2020/06/14 – 2020/08/09		57		57			
	4	2020/08/13 – 2020/10/18 2020/08/13 – 2020/10/18		67		67			
	5	2020/10/20 – 2021/01/15 2020/10/20 – 2021/01/15		88		88			
	6	2021/01/18 – 2021/03/17 2021/01/18 – 2021/03/17		59		59			
	7	2021/03/17 – 2021/06/01 2021/03/17 – 2021/06/01		73		73			
	8	2021/06/04 – 2021/07/12 2021/06/04 – 2021/07/12		39		39			
MS6 LOŠINJ	1	2020/02/22 – 2020/04/09 2020/02/22 – 2020/04/09	503	48	466	48	466	92,64	92,64
	2	2020/05/07 – 2020/06/11 2020/05/07 – 2020/06/11		36		36			
	3	2020/06/14 – 2020/08/09 2020/06/14 – 2020/08/09		57		57			
	4	2020/08/13 – 2020/10/18 2020/08/13 – 2020/10/18		67		67			
	5	2020/10/20 – 2021/01/15 2020/10/20 – 2021/01/15		88		88			
	6	2021/01/18 – 2021/03/17 2021/01/18 – 2021/03/17		59		59			
	7	2021/03/18 – 2021/06/01 2021/03/18 – 2021/06/01		76		76			
	8	2021/06/04 – 2021/07/08 2021/06/04 – 2021/07/08		35		35			
MS7 ŽIRJE	1	2020/03/04 – 2020/05/05	495	**63**	495	0	383	100	77,37
	2	2020/05/05 – 2020/08/01 2020/05/05 – 2020/08/01		**89**		89			
	3	2020/08/01 – 2020/12/04 2020/08/01 – 2020/11/29		**126**		121			
	4	2020/12/04 – 2021/05/18 2020/12/04 – 2021/04/04		**166**		122			
	5	2021/05/19 – 2021/07/08 2021/05/19 – 2021/07/08		**51**		51			
MS8 SPLIT	1	2020/02/24 – 2020/05/06 2020/02/24 – 2020/05/06	499	73	488	73	397	97,80	79,56
	2	2020/05/06 – 2020/07/01 2020/05/06 – 2020/07/01		57		57			
	3	2020/07/01 – 2020/11/25 2020/07/01 – 2020/09/29		148		91			
	4	2020/11/25 – 2021/04/29 2020/11/25 – 2021/03/26		156		122			
	5	2021/05/14 – 2021/07/06 2021/05/14 – 2021/07/06		54		54			
MS9 IVANA A MS9* IVANA E	1	2020/03/10 – 2020/05/08 2020/03/10 – 2020/05/08	493	60	352	60	351	71,40	71,20
	2	2020/05/08 – 2020/07/22 2020/05/08 – 2020/07/22		76		76			
	3	2020/07/22- lost		1		0			
	4	2020/12/14 – 2021/05/09 2020/12/14 – 2021/05/09		147		147			
	5	2021/05/09 – 2021/07/15 2021/05/09 – 2021/07/15		68		68			
			Total averages	**502,11**	**446,00**		**402,67**	**88,80**	**80,20**

Table 3-4 (*Continue*) The overview of deployment/recovery actions for each monitoring station (deployment period - black line, data recording period – red line, green square – CTD performed, red square – CTD not performed)

a. MS1 Aqua Alta

The monitoring station MS1 Aqua Alta is located near the entrance to the Venice harbour.

The first deployment was made on 2020-02-21. The equipment was successfully recovered on 2020-04-03 (deployment period of 43 days). Data was recorded only until 2020-03-11 (25 days), after that instrument was turned off. The reason for that was the unclear manufacturer's guidelines for the usage of alkaline batteries. As explained before, deployment period planned was short and responsible partner (CNR ISMAR) decided to use alkaline batteries, but due to unclear manufacturer's guidelines the instrument was not set-up properly and it turned off itself automatically, although there was enough energy in the batteries left. This problem was communicated with manufacturer and among the partners and proper set up procedure was adopted.

The second deployment followed few days later (2020-04-11) and the successful recovery followed on 2020-06-11 (deployment period of 64 days). The data was recorded throughout the whole period (64 days).

The equipment was deployed for the third time on 2020-06-15 and recovered on 2020-08-12 (59 days). The data was recorded throughout the whole period (59 days).

The fourth deployment started on 2020-08-12 and the equipment was recovered after 99 days on 2020-11-18. The data was recorded throughout the whole period of 99 days.

The fifth deployment was made on 2020-11-12 and the equipment was recovered after 106 days on 2021-03-03. The data was recorded throughout the whole period of 106 days.

The sixth deployment was made on 2021-03-11 and the equipment was recovered on 2021-04-15 (36 days). The data was recorded until 2021-03-16, after that instrument was turned off due to unexpected battery discharge.

The seventh deployment started on 2021-05-04 and ended after 95 days on 2021-08-06. The data was recorded throughout the whole period of 95 days.

All deployments and recoveries were made with the aid of the divers.

b. MS2 Azalea

The monitoring station MS2 Azalea is located near dismissed gas platform which provide protection again equipment damage owing to the trawling.

The first deployment was made on 2020-02-29. The equipment was successfully recovered on 2020-05-09 (deployment period of 71 days). Data was recorded only until 2020-04-30 (62 days). The instrument was provided with 7 SD cards with 256 GB memory. The data was successfully recorded on first two cards but the third was found empty. Later, this memory card was inspected and found faulty.

The equipment was deployed for the second time on 2020-05-31 and recovered on 2020-07-18 (deployment period of 49 days). The data was recorded throughout the whole period (49 days).

The third deployment started 2020-08-01 and the equipment was recovered on 2020-12-20 (deployment period of 71 days). The data was recorded throughout the whole period (71 days).

The fourth deployment started 2020-10-24 and the equipment was recovered on 2020-10-10 (deployment period of 58 days). The data was recorded throughout the whole period (58 days).

The equipment was deployed for the fifth time on 2021-01-30 and recovered on 2021-04-03 (deployment period of 64 days). The data was recorded throughout the whole period (64 days).

The final sixth deployment started 2021-04-25 and the equipment was recovered on 2021-07-04 (deployment period of 71 days). The data was recorded throughout the whole period (71 days).

There are regular gaps between successive deployments. The reason for that was that boat used for deployment/recovery was hired from the outside provider, and servicing (downloading of data, battery replacement etc.) of the monitoring equipment was not possible on site. Therefore, equipment was brought back in the laboratory and redeployed when the combination of boat and staff availability and favourable weather conditions allowed.

All deployments and recoveries were made with the aid of the divers.

c. MS3 Ancona

MS3 station is located in shallow water not far from the coast, in front of Habitat Natura 2000 protected area of Monte Conero Regional Park. The equipment was positioned near a mussel farm to provide protection from fishing trawling and gillnets.

The first deployment was made on 2020-02-21. The equipment was successfully recovered on 2020-05-28 (deployment period of 98 days). Data was recorded only until 2020-04-22 (62 days), because the instrument was provided with only 2 SD cards with 512 GB of total memory and data was successfully recorded until memory was full. As explained before (*in the earlier document section*), deployment period planned was short and this was considered sufficient, but due to COVID-19 pandemic lockdown restrictions it was not possible to recover the instrument as planned, so recovery operations were delayed. The recovery was carried out by scuba divers. The Antifouling paint on the buoys was applied. Missing data gap from 2020-04-22 to 2020-06-10.

The equipment was deployed for the second time on 2020-06-10, and successfully recovered on 2020-09-10 (deployment period of 93 days). The data was recorded throughout the whole period (93 days). During recovery operations instrument was found under a line of the near mussel farm, because a new mussel line was deployed right on the location of the equipment (any new weights or chains were deployed, only a floating mussel line). Instrument was recovered with acoustic releaser, but when the equipment was released, it got stuck on the mussel line ropes, and it was necessary to extricate it. No damage on the equipment was recorded. Data collected was good and complete, any effect is visible in the WAV files. After the recovery, some technical problems occurred with calibration procedure. Consequently, the calibration has been postponed by few days and equipment reboot has been necessary. Equipment was then deployed again on 2020-09-29. Missing data gap from 2020-09-10 to 2020-09-29.

Third leg of data collection was from 2020-09-29 (deployment) to 2021-01-28 (recovery), 122 days in total. Data was recorded only until 2021-01-11, (data recorded period 105 days) due to low battery voltage. Planned recovery was delayed due to two failed recovery attempts. The failed attempts were

carried out on dates 2021-01-07 and 2021-01-19 respectively, and they were caused first by severe biofouling that blocked acoustic releaser hook, and then by bad sea condition that didn't allow scuba diver to locate the instrument. To recover the hydrophone, it was at last necessary to design a specific „trawling“ rope system, used from the boat (2020-01-28). Equipment was not damaged by using this equipment. Afterward equipment management operations were carried out, including battery replacement, both for the recorder and acoustic releaser. Deployment was also postponed by several days due to bad weather conditions and equipment was deployed again on 2021-02-17. Missing data gap from 2021-01-11 to 2021-02-17.

The fourth deployment was from 2021-02-17 to 2021-05-05, covering 78 days of deployment period. Instrument was successfully recovered with acoustic releaser and data collected were good. The data was recorded throughout the whole period (78 days)

The successive deployment was on date 2021-05-14. Unfortunately, at recovery planned date, on 2021-07-16 it was not found. Research operations were carried out with on-board echosounder, but with negative results. Successively, on date 2021-07-21 an additional mini-survey with a Multibeam system was performed, covering about a 180x700 m area, but the instrument was not found. The recorder and the releaser were found on 2021-12-14 by nearby mussel farm operators stuck in the ropes and returned. Probably, it was accidentally hooked by the farm rope during their working operations and was shifted from its original position. The data was recorded until 2021-10-15 when the memory reached its maximum available capacity. The recorder was inspected and found to be fully operational and calibration as it should be. The data recorded was analysed for their integrity and validity and it was found that they are valid until 2021-07-11. After that SPL's recorded show higher levels and different spectra than previous ones. It was concluded that this was the date when accident, in which the recorder was moved from its original position to the mussel farm, occurred. Therefore, based on the aforementioned dates and events, a deployment period from 2021-05-14 to the originally planned recovery date of 2021-07-16. was considered. Valid data in this fifth leg cover 49 recording days

During every deployment and recovery operation a CTD profile was carried out, except for the 2021-05-05 recovery, due to unavailability of the probe. After each recovery some days were dedicated on hydrophone and mooring management, as cleaning operations, data download, calibration, and equipment preparation for the successive deployment. Hydrophone and Acoustic Releaser worked properly during entire monitoring period, and all data recorded was good and complete. Issues occurred were caused by external factors.

d. MS4 Paloma

The monitoring station MS4 Paloma is located in the centre of Trieste Gulf, near the entrance to the Trieste and Koper harbours.

The first deployment was made on 2020-02-21. The equipment was successfully recovered on 2020-03-05 (deployment period of 14 days). The data was recorded throughout the whole period (14 days).

The second deployment followed few days later (2020-03-11) and the successful recovery followed on 2020-04-27 (deployment period of 47 days). The data was recorded throughout the whole period (47 days).

The equipment was deployed for the third time on the same day (2020-04-27) and recovered on 2020-06-10 (deployment period of 45 days). The data was recorded throughout the whole period (45 days).

The equipment was deployed for the fourth time on 2020-06-10 and recovered on 2020-08-13 (deployment period of 65 days). Data were recorder throughout the whole period (65 days).

The fifth deployment was made on 2020-08-13. The equipment was successfully recovered on 2020-10-14 (deployment period of 63 days). The data was recorded throughout the whole period (63 days).

The sixth deployment started on 2020-10-14.

In the night between 27th and 28th November 2020, the mast of Paloma oceanographic station sank and disappeared from radar, but fortunately the equipment was recovered on the afternoon of November 27. Unfortunately, the SD cards were empty, and all data of the last 14 days were lost.

Further deployments had to be postponed due to the restricted access while the area was secured.

The seventh deployment started on 2021-02-05 when the access to the area was allowed. The equipment was successfully recovered on 2021-03-16 (deployment period of 40 days). Data were recorded till the 2021-03-01, due to battery failure.

The eight deployment started on 2021-03-18 and was successfully recovered 2021-04-08 (deployment period of 22 days). Data were recorded only till the 2021-04-04 (18 days).

The ninth deployment started on 2021-04-08 and was successfully recovered 2021-04-23 (deployment period of 16 days). The data was recorded throughout the whole period (16 days).

The equipment was deployed for the tenth time on 2021-04-23 and recovered on 2021-05-10 (deployment period of 17 days). Unfortunately, data were recorded only from 2021-05-01 till the recovery time. The total amount of days of recording available for analysis were 10.

The eleventh deployment started on 2021-06-17 and successfully recovered on 2021-07-19. The data was recorded throughout the whole period (34 days).

The first five recoveries were made with the acoustic releaser. From the sixth deployment onwards, the recovery has been made by hand, using a signalling surface buoy.

Deployment and recovery of the monitoring equipment will continue as a normal monitoring procedure of ARPA FVG.

e. MS5 Susak

The monitoring station MS5 Susak is located away from the shore and islands towards the open sea.

The first deployment was made on 2020-03-05. The equipment was successfully recovered on 2020-04-09 (deployment period of 36 days). The data was recorded throughout the whole period (36 days).

The second deployment followed few days later (2020-04-11) and the successful recovery followed on 2020-06-11 (deployment period of 62 days). The data was recorded throughout the whole period (62 days).

As the first two deployments, all further deployments (third to eight) was successful and without any problems. Data were recorded throughout all deployment periods. There are regularly small gaps (one to four days) between successive deployments. The reason for that was small rubber inflatable boat

used for deployment/recovery which made servicing (downloading of data, battery replacement etc.) of the monitoring equipment not possible on site. Therefore, equipment was brought back in the laboratory and redeployed in one of the next days depending on the weather conditions and the availability of the staff.

All deployments and recoveries were made with the aid of the divers.

f. MS6 Lošinj

The monitoring station MS6 Lošinj is located in the core of Natura 2000 SCI (Cres-Lošinj, HR3000161) of high relevance for the resident bottlenose dolphin community as their important feeding and nursery ground.

The first deployment was made on 2020-02-22. The equipment was successfully recovered on 2020-04-09 (deployment period of 48 days). The data was recorded throughout the whole period (48 days). When the calibration was performed after the recovery, faulty results were recorded. The event was closely scrutinized and it was found out that the instrument broke down between the switch off after recovery and switch on for calibration. The data recorded was compared with the ones recorded previously and found correct. The instrument was sent to the manufacturer for the repair.

After the repair and testing, the second deployment was made on 2020-05-07 and the successful recovery followed on 2020-06-11 (deployment period of 36 days). The data was recorded throughout the whole period (36 days).

All further deployments (third to eight) was successful and without any problems. Data were recorded throughout all deployment periods. As for MS5 Susak, there are regularly small gaps (one to four days) between successive deployments, for the same reason.

All deployments and recoveries were made with the aid of the divers.

g. MS7 Žirje

The monitoring station MS7 Žirje is located on the edge of Jabuka Pit which is very important fishing and spawning area and near Kornati National park which is also Natura 2000 area (HR 4000001).

The first deployment was made on 2020-03-04. The equipment was successfully recovered on 2020-05-05 (deployment period of 63 days). Regretfully, due to unexplainable human error no data was recorded throughout the whole period. The instrument was inspected in the laboratory and found out to be fully operational, both calibrations (before the deployment and after recovery) were correct but no data was recorded.

The second deployment was made with the spare instrument the same day (2020-05-05) and the equipment was successfully recovered on 2020-08-01 (deployment period of 89 days). The data was recorded throughout the whole period (89 days).

The third deployment was made on 2020-08-01. The equipment was successfully recovered on 2020-12-04 (deployment period of 126 day). The data was recorded until 2020-11-29 (121 days). The data gap is due to the exceedance of the maximum available memory (1024 GByte). The equipment should be recovered earlier but was prevented by very bad weather conditions.

The fourth deployment was made on 2020-12-04. The equipment was successfully recovered on 2021-05-18 (deployment period of 166 day). The data was recorded until 2021-04-04 (122 days). The data gap is due to the exceedance of the maximum available memory (1024 GByte). The equipment should be recovered earlier but, due to prolonged remount and overhauling, the service vessel was out of duty and unavailable.

The fifth deployment was made on 2021-05-18. The equipment was successfully recovered on 2021-17-08 (deployment period of 51 day). The data was recorded throughout the whole period (51 days).

All recoveries were made with the acoustic releaser.

h. MS8 Split

The monitoring station MS8 Split is located near the entrance to Split port.

The first deployment was made on 2020-02-24. The equipment was successfully recovered on 2020-05-06 (deployment period of 64 days). The data was recorded throughout the whole period (64 days).

The second deployment followed the same day (2020-05-06) and the successful recovery followed on 2020-06-30 (deployment period of 55 days). The data was recorded throughout the whole period (55 days).

The equipment was deployed for the third time on 2020-07-01 and was successfully recovered on 2020-11-25 (deployment period of 148 days). The data was recorded until 2020-09-29 (91 days). The data gap is due to the exceedance of the maximum available memory (1024 GByte).

The forth deployment was made on 2020-11-25 and the equipment was successfully recovered on 2021-04-29 (deployment period of 156 days). The data was recorded until 2021-03-26 (122 days) The equipment should be recovered earlier but, due to prolonged remount and overhauling, the service vessel was out of duty and unavailable.

The fifth deployment was made on 2021-05-14 and the successful recovery followed on 2021-07-06 (deployment period of 54 days). The data was recorded throughout the whole period (54 days).

All recoveries were made with the acoustic releaser.

i. MS9 Ivana

The monitoring station MS9 Ivana is located near Ivana-D gas production platform in the middle of the Northern Adriatic Sea very close to the main shipping lanes to Venice, Trieste and Koper ports.

The first deployment was made on 2020-03-10. The equipment was successfully recovered on 2020-05-08 (deployment period of 59 days). The data was recorded throughout the whole period (59 days).

The second deployment followed the same day (2020-05-08) and the equipment was successfully recovered on 2020-07-22 (deployment period of 76 days). The data was recorded throughout the whole period (76 days).

The equipment was deployed for the third time on 2020-07-22. At the beginning of December 2020, Ivana-A gas production platform collapsed in the heavy storm and the whole area was closed with restricted access. Therefore, the equipment was not available for recovery until the spring of 2021. After that the recovery was tried twice. First time it was found out that there was no response from acoustic releaser. The reason may be flat batteries or the equipment was removed from the position in the process of platform inspection and recovery. The second time the equipment was searched after with remote operated vehicle (ROV), but was not found. For the time being, the equipment and the data are considered lost.

The replacement equipment was deployed close to Ivana-E platform (the new location is just couple of miles apart and was marked as MS9*) on 2020-12-14. The equipment was successfully recovered on 2021-05-09 (deployment period of 147 days). The data was recorded throughout the whole period (147 days

The fifth deployment was made on 2021-05-09 and the successful recovery followed on 2021-07-15 (deployment period of 68 days). The data was recorded throughout the whole period (68 days).

All recoveries were made with the acoustic releaser.