LIFE19 NAT/IT/000264

Seagrass transplantation for transitional Ecosystem Recovery

(LIFE- TRANSFER)

Action D2: Monitoring of C2 action

SubAction D.2.2 Monitoring biodiversity and the environmental quality status

Third monitoring progress report

July 2024

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Executive Summary

The D.2.1 Sub-action concerns the monitoring of the growth of transplanted angiosperms. The D.2.2 Sub-action concerns the analysis of physico-chemical parameters in water samples, sediments and particulate matter, and the collection of macrophytes, benthic macroinvertebrates and fish fauna (biological elements) for the application of ecological quality indexes at the stations monitored at Comacchio (Fattibello) and Goro (Seganda, Bassunsin) lagoons.

This **Third Monitoring Progress Report** is divided in four sections: the first two sections, edited by DAIS-UNIVE, concern angiosperms growth and water and sediment analyses, the other two sections, edited by UNIFE, concerns the benthic and the fish fauna, and the ecological quality.

Regarding transplanted angiosperms rooting and growth, during the first year of transplants (2022-2023) we have not found significant results, due to high turbidity (Fattibello) or excessive algal growth episodes (Goro). During 2024, the transplants have also be done considering different lagoon sub-areas where we expect more rooting success. In addition, in Goro the transplants of *Ruppia cirrhosa*, but also of *Nanozostera noltei*, *Zostera marina* and *Cymodocea nodosa* in the most suitable areas for each species will be intensified.

The monthly sampling of the environmental parameters of water and sediments and macrophytes to determine the ecological status started in May (**Figure 1**, **Table 1**) and the analysis of the samples is in progress.

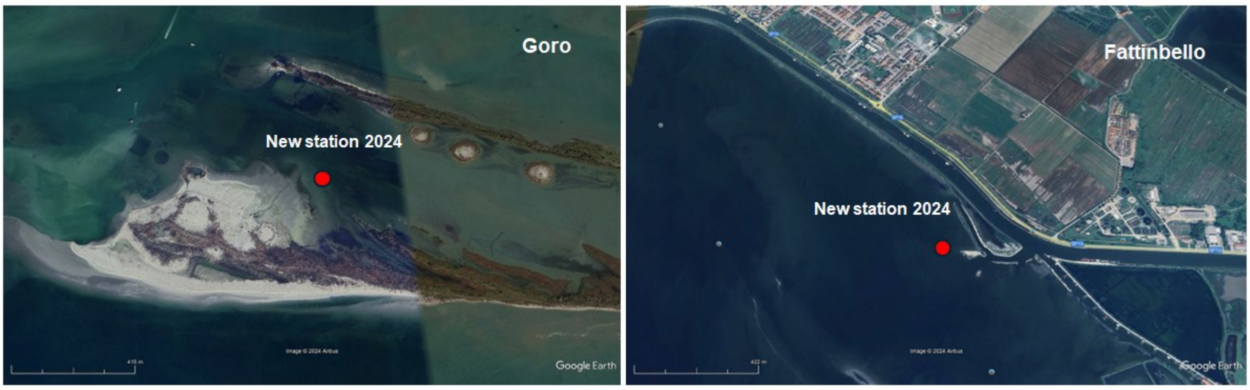

Figure 1. *New stations at Goro and Fattibello*

Goro		Fattibello	
Sexagesimal coordinates	Sampling date	Sexagesimal coordinates	Sampling date
44°47'29".56N 12°19'41".18E	13/05/2023	44°40'40".83N 12°11'57".21E	13/05/2023
	17/06/2023		17/06/2023
	09/07/2023		09/07/2023

Table 1. *Sexagesimal coordinates and sampling dates in 2024.*

Concerning the benthic fauna, 29 macrobenthic taxa were found in the Sacca di Goro, and 20 in Valle Fattibello. The ecological quality status through M-AMBI was Good for one transplant site and Poor and Bad at the other transplant and the control site, respectively, at Goro (High, Moderate, Poor, respectively, through BITS). It resulted moderate at the two sites (transplant and control) at Fattibello. The majority of the macrobenthic taxa present at all the sites belongs to the indifferent (EG-II) and tolerant (EG-III) group at Goro, and tolerant and opportunistic (EG-IV) group at Fattibello.

Concerning the fish fauna, the fish community was richer in species and abundance at Goro respect to Fattibello. The application of the HFBI index resulted in a quality judgement of high at Goro, and sufficient at Fattibello.

SubAction D.2.1 Monitoring angiosperm growth

Aquatic angiosperms at the beginning of the project were absent in both the lagoons. The only species present in the past was *Ruppia cirrhosa*, but it disappeared in the last three decades of the last century with the increasing of eutrophication (Sfriso et al., 2016; Munari et al., 2023).

This project aims to reintroduce this species and/or others aquatic angiosperms present in similar environments to reconstruct, where possible at least in part, the ancient prairies.

Table 1 shows the number of transplants foreseen in each lagoon in the Proposal for a total of 648 sods equivalent approx. to 6480 rhizomes.

Table 2. *Number of planned transplants in each lagoon.*

Year	2021		2022		2023		2024		2025		Total
Season	---	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	
Stations	---	8	8	8	8	8	8	8	8	8	72
N° of sods	---	72	72	72	72	72	72	72	72	72	648
Equivalent rhizomes	---	720	720	720	720	720	720	720	720	720	6480

Between autumn 2021 and spring 2024 the number of transplants was higher than anticipated (**Table 2, Figure 2**).

Indeed, the transplants in Goro were 623 sods of *Ruppia cirrhosa* (approx. 10591 equivalent rhizomes) (**Table 2**). The donor sites were Valle Campo and Valle Bertuzzi. In this lagoon, in suitable areas, 100 rhizomes of *Cymodocea nodosa* (approx. 7 equivalent sods), 450 rhizomes of *Zostera marina* (approx. 45 equivalent sods) and 950 rhizomes of *Nanozostera noltei* (approx. 63 equivalent sods) coming from the Venice Lagoon were also transplanted. Therefore, the total transplants were 738 sods equivalent to approx. 12091 rhizomes.

At Fattibello the number of transplants was 314 (approx. 5338 equivalent rhizomes). No other species were transplanted because the ecological conditions were not suitable.

Table 2. *Number of effective transplants*

N° of transplanted sods and rhizomes

	Year	Species	Sods (diameter 15 cm)	Equivalent rhizomes	Donor	Rhizomes	Equivalent Sods	TOTAL Sods	TOTAL Rhizomes
Goro	2021	*R. cirrhosa*	207	3519	Valle Campo	-	-		
	2022	*R. cirrhosa*	212	3604	Valle Bertuzzi	-	-		
		C. nodosa	-	-	Laguna di Venezia	100	7		
		Z. marina	-	-	Laguna di Venezia	300	30		
		Z. noltei	-	-	Laguna di Venezia	600	40		
	2023	*Z. marina*	-	-	Laguna di Venezia	150	15		
		Z. noltei	-	-	Laguna di Venezia	350	23		
		R. cirrhosa	72	1224	Valle Bertuzzi	-	-		
		R. cirrhosa	72	1224	Valle Bertuzzi	-	-		
		R. cirrhosa	10	170	Valle Bertuzzi	-	-		
	2024	*R. cirrhosa*	50	850	Valle Bertuzzi	-	-		
	Total		623	10591		1500	115	738	12091
Fattibello	2021	*R. cirrhosa*	80	1360	Valle Bertuzzi	-	-	-	
	2022	*R. cirrhosa*	140	2380	Valle Bertuzzi	-	-	-	
	2023	*R. cirrhosa*	44	748	Valle Bertuzzi	-	-	-	
	2024	*R. cirrhosa*	50	850	Valle Bertuzzi	-	-	-	
	Total		314	5338				314	5338

The monitoring of the angiosperm transplants occurred in late spring (31 May) and autumn (10 October) 2022, in late spring (30 May) and Autumn (13 October) 2023 and late spring 2024 (17 June).

At each angiosperm monitoring we have not recorded significant plant attachment but only some sods which then disappeared and were not recorded in the subsequent surveys because the excessive growth of macroalgae (Goro) or the high water turbidity due to phytoplankton blooms (Fattibello).

In 2024 in both lagoons, transplants occurred in different areas and during the year their number will be intensified.

Figure 2. *Transplant activities at Goro and Fattibello*

SubAction D.2.2 Monitoring biodiversity and the environmental quality status

SECTION 1 – WATER, SEDIMENTS, MACROALGAE AND EQ

Field sampling

Once the ecologically suitable sites had been selected for the transplantation of aquatic angiosperms, the sampling of the environmental matrices of water and sediments started. In each station some environmental parameters were monitored by means of portable instruments in accordance with what was reported in the sampling forms.

In field the following parameters and macrophyte variables were recorded:

- Date and time of the surveys;
- Air and water temperature;
- Water depth and transparency by Secchi disk;
- Dissolved oxygen;
- pH and Eh in the water column by dedicated probe for water measures;
- pH and Eh in the surface sediments by dedicated probe for sediment measures;
- Water samples for salinity determination;
- Water samples for nutrient determination;
- Sediment samples for physico-chemical and nutrients determination;
- Macroalgal coverage, macroalgal biomass, taxa dominance, samples to determine the complete macroalgal check list.

Water samples (250-500 ml) were manually collected at a depth of approx. 20-30 cm and immediately filtered throughout glass fiber filters GF/F (porosity 0.7µm). Filters were retained in filter-holder boxes until the determination of Chlorophyll-*a* (Chl-*a*) and Phaeopigments (Pheo-*a*). Water samples of 250 ml were retained in polyethylene bottles for the determination of nutrients and transported in laboratory by a fridge bag. Both filters and water samples were refrigerated until the determination.

Surface sediment samples (5 cm top layer) were collected by a manual Plexiglas corer (Ø=10cm). They were carefully mixed together and pH and Eh were immediately measured on the total homogenized sample. Then two subsamples were retained, one for the analysis of nutrients and the other for the determination of the sediment characteristics. Sediment samples were transported by fridge bag to the laboratory where they were frozen and lyophilized for the determination of fines (fraction <63µm), density, moisture, porosity and the total, inorganic, organic phosphorus; total, inorganic, organic carbon and total nitrogen.

Measures in water column and surface sediments

Temperature

The determination of the temperature in the water column at a depth of approx. 30 cm was obtained by means of a thermocouple probe (precision 0.1° C) combined with a portable pH-meter model Delta Ohm HD8705.

Dissolved oxygen

The determination of dissolved oxygen (OD) at about 20-30 cm depth was carried out using an Oximeter (OXI 196) from Wissenschaftlich-Technische Werkstätten GmbH (Germany). The data expressed instrumentally in mg L^{-1} were then converted into saturation percentage (%OD) taking into account the temperature and salinity values. The instrument was calibrated before each series of measurements in its wet container.

pH determination

The determination of the pH (acidity or basicity or neutrality) in the water column was carried out using the Delta Ohm HD8705 portable pH-meter, equipped with a combined electrode (accuracy 0.01 pH units). The instrument was calibrated before each sampling campaign with a pH 7.0 solution.

Redox potential determination

The determination of the red-ox potential in the water and in the surface sediment was carried out by means of a Delta Ohm HD8705 portable pH-meter equipped with a combined Ag (AgCl) electrode (precision 1 mV). The measurement in water was carried out at a depth of 20-30 cm while in the sediment it was carried out on a sample of 3 sub-samples (5 cm top layer), carefully homogenized, collected by means of a Plexiglas corer (Ø=10cm). The measurement on the homogenized sample avoids the enormous variations that occur depending on very small variations in the insertion of the electrode into the superficial sediment.

Salinity determination

Salinity was determined in laboratory as chlorinity by means of Oxner (1962) argentometric titration. The chlorinity values corrected with a standard solution of sea water of known chlorinity were converted into salinity by means of the relationship: Salinity = Cl^- x 1.805 + 0.03.

Suspended solids (filtered particulate matter) determination

Samples of the water column (250-500 ml) were filtered, in duplicate, throughout glass fiber filters GF/F (0.7µm) pre-dried at 105 ° C for 1 hour and weighed for the measurement of the total suspended solids (TSS). After filtration by a Millipore Swinnex manual apparatus the samples were washed with 2-3 aliquots of distilled water (20 ml) to remove the salts. Filters were placed in filter-holder boxes and refrigerated until the moment of the determination which took place by drying in an oven at 70 ° C for one night. The coefficient of variation as a measure of reproducibility of the analysis was kept below 5%.

Nutrients and chlorophylls in water

The filtered seawater was analyzed for nutrient concentrations following the methods described in Strickland & Parsons (1972) whereas chlorophylls and phaeopigments were determined according to the Lorenzen (1967) method.

Briefly, phytoplankton concentration was determined as Chl-*a* and Pheo-*a* by extraction with acetone 90% in ultrasonic bath for 30 min. Reactive phosphorus (RP) was measured as in Murphy & Riley (1962) and reactive silicate (Si) was quantified using the reaction of Mullin & Riley (1965). Ammonium was measured with the phenol-hypochlorite reaction of Riley (1953) modified by Solarzano (1969). The simultaneous determination of nitrite and nitrate concentrations was obtained using the cadmium reduction method as in Wood et al. (1967). The results were expressed as µg L^{-1} for chlorophylls and as µM for nutrients.

Sediment grain-size determination

Sediments were sieved with a 1 mm mesh sieve to remove the coarser part mainly represented by shell residues. Then the fine fraction (Pelite) and the sands were separated with a 63 µm mesh sieve.

Sediment density

The sediment density was determined on wet and dry basis. In particular the values on dry basis (g/cm^3) allow to calculate the concentration of nutrients or pollutants per volume unit.

The density determination was performed in duplicate by using porcelain crucibles of known volume comparing the sediment weight before and after drying at 110 °C for one night.

Sediment Moisture and Porosity

The same porcelain crucibles of known volume were also used to determine the sediment moisture (ml of water/ weight of wet sediment) and porosity (ml of water/ volume of wet). All data are reported as a percentage.

Elemental Analysis of C, N and P

In the laboratory, sediments were freeze-dried and pulverized using a sediment mill (Fritsch Pulverisette, Germany). The concentration of total nitrogen (TN) and total carbon (TC) were measured in duplicate by a CHNS Analyzer (Vario-MICRO, Elementar CHNS by Elementar Italia S.r.l.) after an accurate sample powdering of ca. 0.3 g of sample. The standard used for nitrogen determination was the "low level N- and S-contents" with N = 0.74%, art. no. 05 000 959 (Elementar Italia S.r.l.) and the standard used for carbon determination was "C2*", with C = 2.00%,* art. no. S05 005 343 (Elementar Italia S.r.l.). Organic carbon was measured as carbon loss on ignition after ashing at 430 °C for 2h taking into account the weight loss of the sample following the ashing.

Total phosphorus (TP) was determined following Aspila et al. (1976) after sample combustion in the muffle at 550 °C for at least 2 h of 0.3–0.4 g of sample. Subsequently, the residue thus obtained was suspended in 50 mL of 1 N HCl and sonicated for ca. 30 min. After allowing the sample to settle for at least 1 h, 0.5 mL of the supernatant were taken with a graduated gaschromatographic syringe and brought to exactly 10 mL using volumetric flasks for a final dilution of 1 L, with the result expressed directly in μM. At this point, the phosphorus concentration was determined spectrophotometrically by the molybdenum blue method adding the mixed reagent and reading the absorbance at 885 nm after ca. 10–15 min according to Murphy et Riley (1962) and Strickland et Parsons (1972). Inorganic phosphorus (IP) was obtained with the same procedure used for TP but without combustion at 550 °C. Organic phosphorus (OP) was determined by difference.

All samples were analysed in duplicate and the analyses were replicated on two different days to obtain an accuracy > 95. Otherwise, the analyses were repeated until the coefficient of variation (standard deviation/mean) between two replicates was <5%. Carbon and nitrogen content were expressed as mg g^{-1} and phosphorus as µg g^{-1}.

Macrophyte variables

Macrophyte coverage and taxa determination.

Macroalgae samples were collected in accordance with the method for the determination of the Macrophyte Quality Index (MaQI, ISPRA, 2011; Sfriso et al., 2014, **Figure 3**) in order to determine the ecological status as required by Water Framework Directive (2000/60/EC).

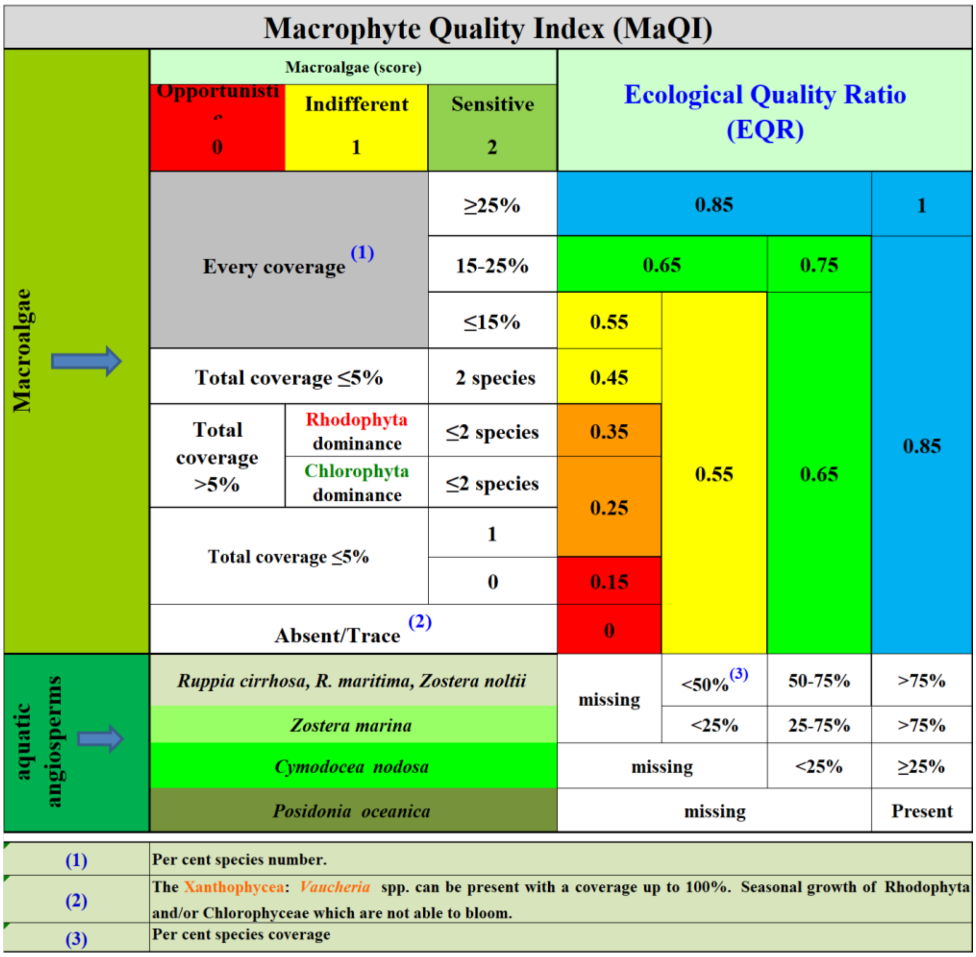

***Figure 3**. MaQI Scheme*

At each station, the relative coverage of macroalgae was assessed by using the Visual Census Technique in clear waters, or touching the bottom 20 times with a rake in turbid waters, in order to discriminate a coverage ≥5%, as required by the application of the index. Subsequently 5-6 macroalgal samples were collected reporting the percentage of

Chlorophyta and Rhodophyta. Representative samples of all the species present in the stations were stored in 4% formaldehyde for the taxonomic determination.

Results

First year of sampling

At present we have one year of monthly samples both at Goro and Fattibello. The sampling period was between 29 March 2022 and 07 March 2023.

Figure 4. *On the left lagoon of Goro with reeds indicating the transplant points of Ruppia cirrhosa. On the right trap for the collection of the particulate matter.*

Figure 5. *On the left, sampling operation on the lagoon of Fattibello. On the right, equipment and materials for sampling operations.*

Currently, all the physico-chemical analyses of the water column and surface sediments and the macrophyte determination collected during the first year (**Figures 4, 5**) have been carried out.

Water Column

Figure 6 shows the variations of Temperature, Salinity, Oxygen Saturation, pH, Eh, Total Suspended Solids, Settled Particulate Matter, Silicates, Reactive Phosphorus and Total Dissolved Nitrogen (sum of ammonium, nitrite, nitrate) in the water column.

The mean water temperature at Fattibello (20.4±8.6 °C) was slightly higher than at Goro (18.5±8.5 °C) with the minimum value recorded at Goro (6.6 °C) and the highest (31.0 °C) at Fattibello. Salinity on average was higher at Goro (26.7±3.6 psu) than at Fattibello (20.6±7.4 psu) where it fluctuated in a higher range (5.0-29.5 psu) with the lowest value in November. The oxygen saturation was slightly higher at Fattibello (210±69%) than at Goro (199±63) with the minimum values in November and December. At Goro the values of pH (8.30±0.37), on average, were higher than at Fattibello (8.10±0.37), with the highest values in winter. Similarly, the redox potential (Eh) was higher at Goro (291±56 mV) than at Fattibello (264±100 mV) where in July values close to 0 mV were recorded.

At Goro the mean amount of Total Suspended Solids (TSS) was quite twice higher (40.2±11.4 mg L^{-1}) than at Fattibello (20.6±7.4 mg L^{-1}) whereas the particulate collected by sedimentation traps at Goro was slighly lower (199±63 mg L^{-1} at Goro; 210±69 mg L^{-1} at Fattibello).

Silicates at Fattibello (33.8±27.7 μM) were significantly higher than at Goro (23.8±12.4 μM). The mean concentrations of the Reactive Phosphorus (RP) in the two lagoons was a bit lower at Goro (0.36±0.22 μM) than at Fattibello (0.43±0.23) with the highest values recorded in June and July. Conversely, the Dissolved Inorganic Nitrogen (DIN) monitored at Fattibello (35.8±52.7 μM) was on average almost 4 times higher than at Goro (9.45±8.36 μM). In addition, at Fattibello in winter values up to 154.5 μM were found.

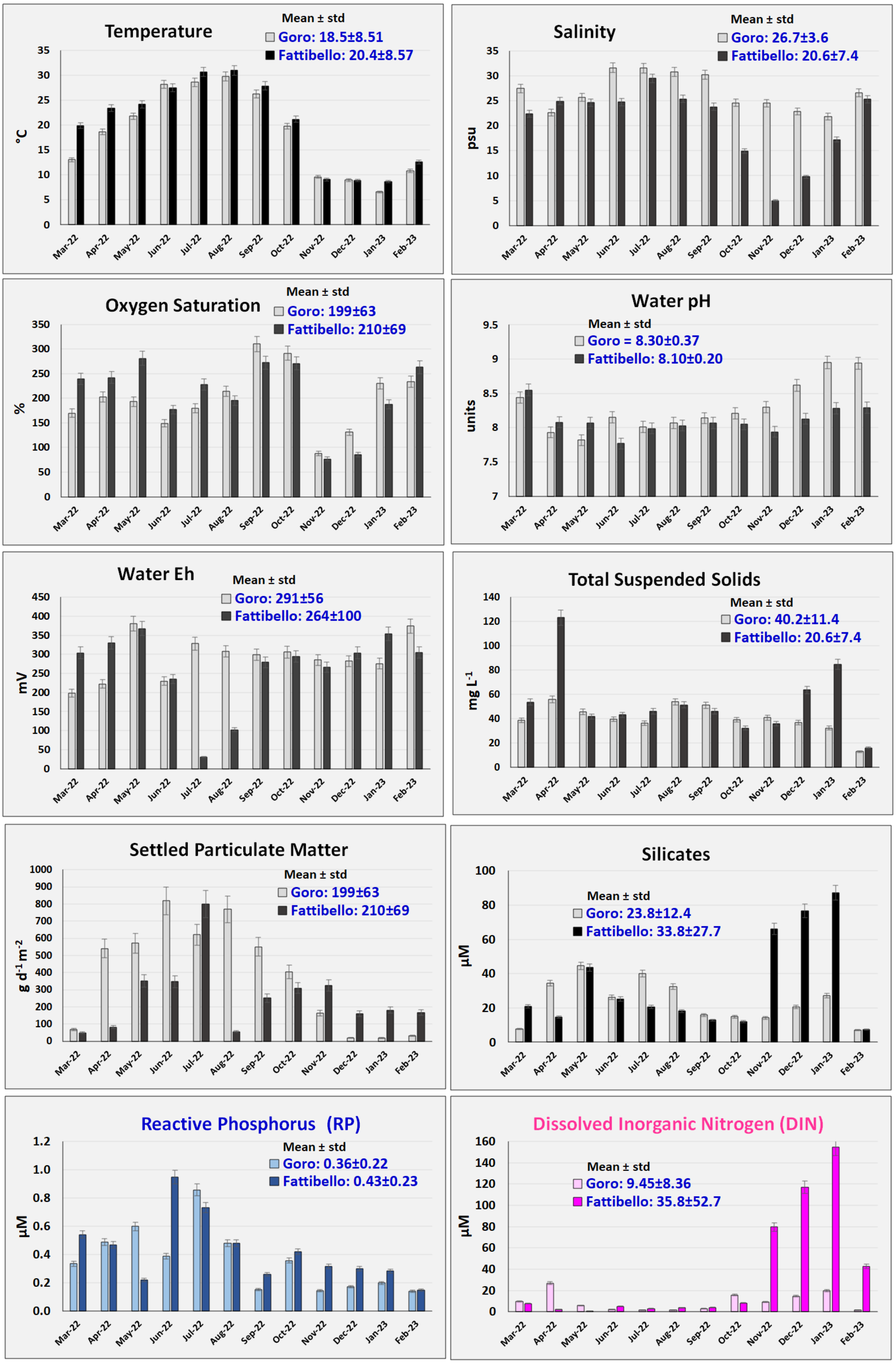

Figure 6. *Variation of some environmental parameters in the Water Column in the Goro and Fattibello stations.*

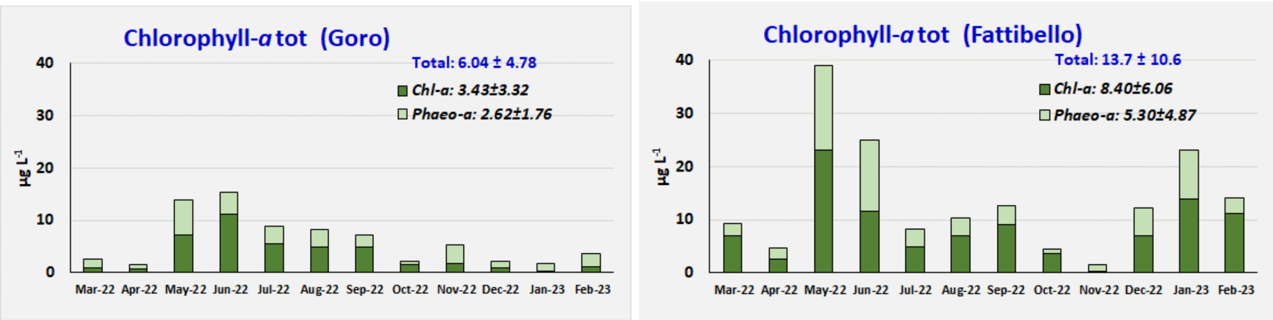

Figure 7. *Variation of the total Chlorophyll-a at Goro and Fattibello.*

If we consider the water transparency this mainly depends on the amount of TSS (**Figure 6**) and the concentration of Chlorophyll-*a* (Chl-*a*) (**Figure 7**). Both these parameters were twice higher at Fattibello than at Goro. As above reported, the mean TSS ranged from 20.6 mg L^{-1} at Goro to 40.2 mg L^{-1} at Fattibello where in April a peak of 123 mg L^{-1} was recorded. Similarly, the mean total Chl-*a* was 6.04±4.78 µg L^{-1} at Goro and 13.7±10.6 µg L^{-1} at Fattibello where a first peak was recorded in May-June (up to 38.9 µg L^{-1}) and a second peak in January-February. In both stations the concentration of the active pigment (Chl-*a*) was greater than the degraded one (Phaeo-*a*). The high values of TSS and Chl-*a* recorded mostly at Fattibello, with a water transparency of approx. 30-40 cm, are prohibitive both for the presence of macroalgae and the rooting of aquatic phanerogams.

Surface sediments

Some physico-chemical characteristics of the 5 cm sediment top layer in the two stations are reported in **Figure 8.**

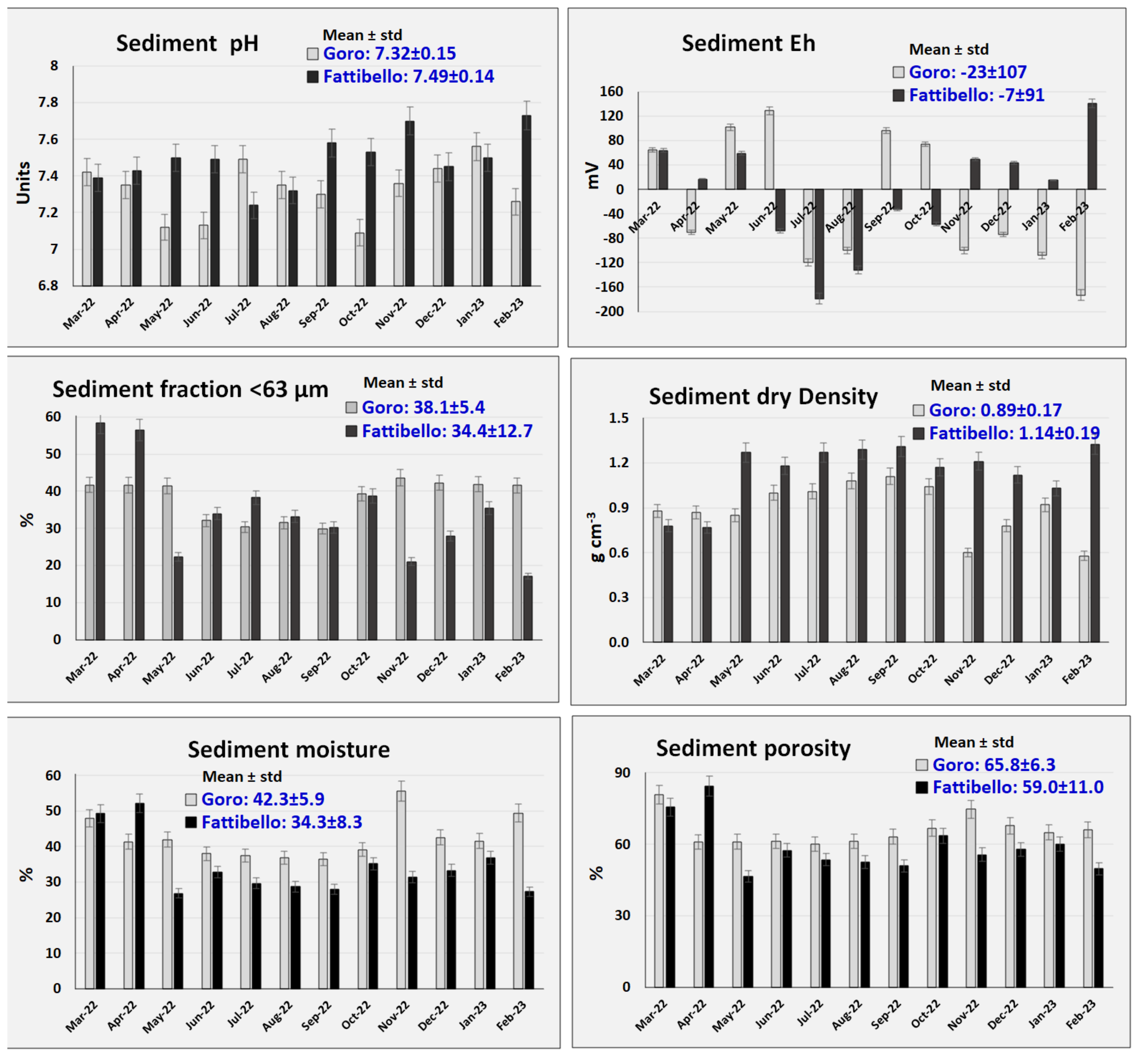

Figure 8. *Variation of some physico-chemical characteristics of surface sediments*

The pH of surface sediments in the two lagoons was slightly lower at Goro (7.32 ±0.15 units) than at Fattibello (7.49±0.14 units). Similarly, the value of Eh was lower at Goro (-23±107 mV) than at Fattibello (-7±91 mV). The amount of Fines (fraction <63 µm) in the two stations was quite similar ranging from 34.4±12.7% at Fattibello to 38.1±5.4% at Goro. The highest amount of Fines was coupled with the lower dry density recorded al Goro (0.89±0.17 g DW cm^{-3}) in comparison to Fattibello (1.14±0.19 g DW cm^{-3}). Instead, higher values of moisture and porosity were recorded at Goro (42.3±5.9% and 65.8±8.3%, respectively).

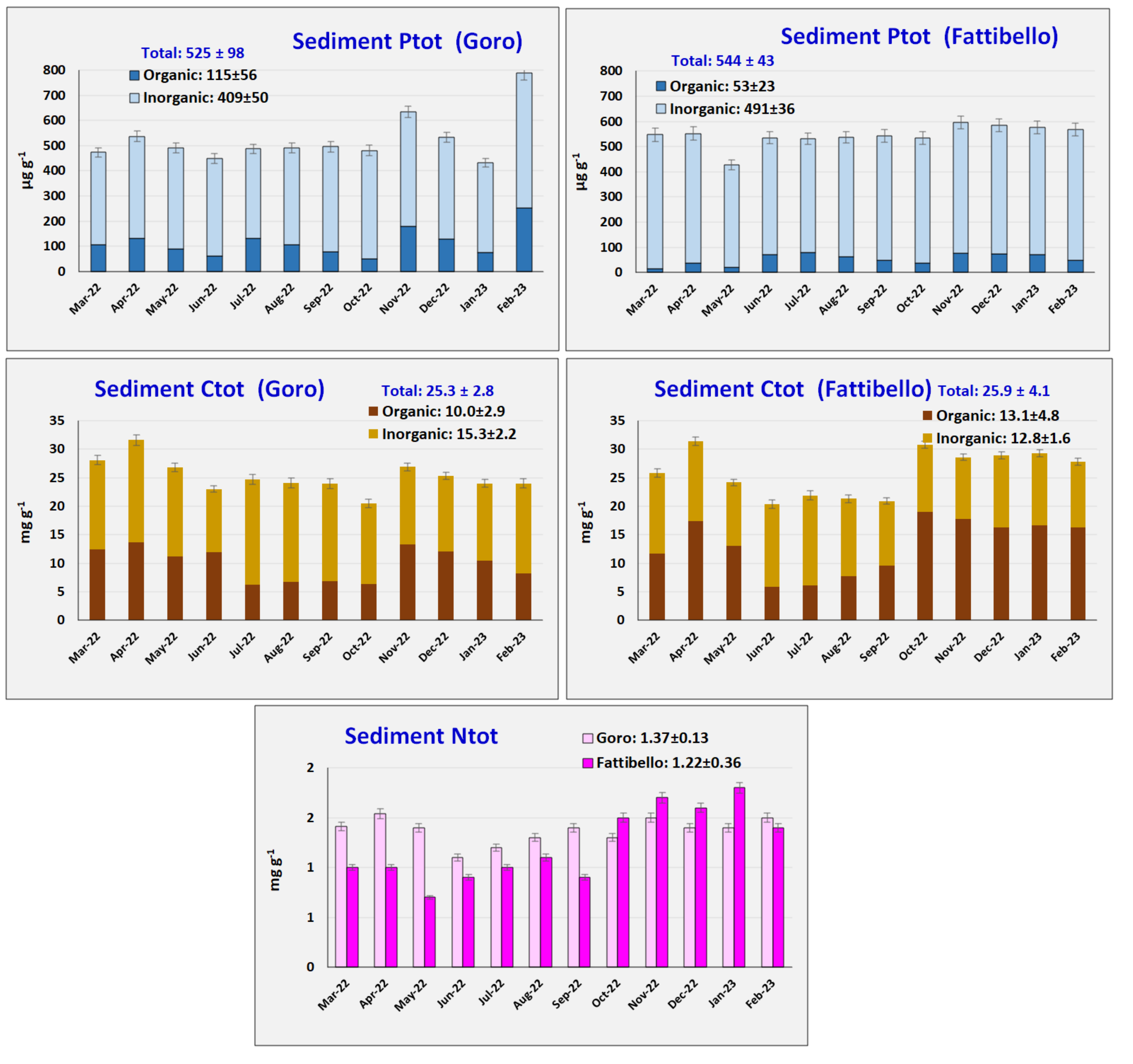

Figure 9. *Variation of nutrient concentrations in surface sediments.*

Regarding the trophic status, the nutrient and carbon concentrations were quite similar (**Figure 9**). The Total Phosphorus ranged from 525±98 µg g^{-1} at Goro to 544±43 µg g^{-1} at Fattibello. However, the concentration of the organic fraction (Porg) at Goro was twice higher (115±56 µg g^{-1}) than at Fattibello (53±23 µg g^{-1}). Total Nitrogen (Ntot) ranged from 1.37±0.13 to 1.22± 0.36 mg g^{-1} at Goro and Fattibello, respectively. The concentrations of Total Carbon (Ctot) was basically the same (25.3 and 25.9) with minor differences between the organic and organic fractions.

Macrophytes

Macroalgae and MaQI determination (First year)

The quantitative and qualitative consistency of macroalgae present in the two stations is reported in **Figure 10.**

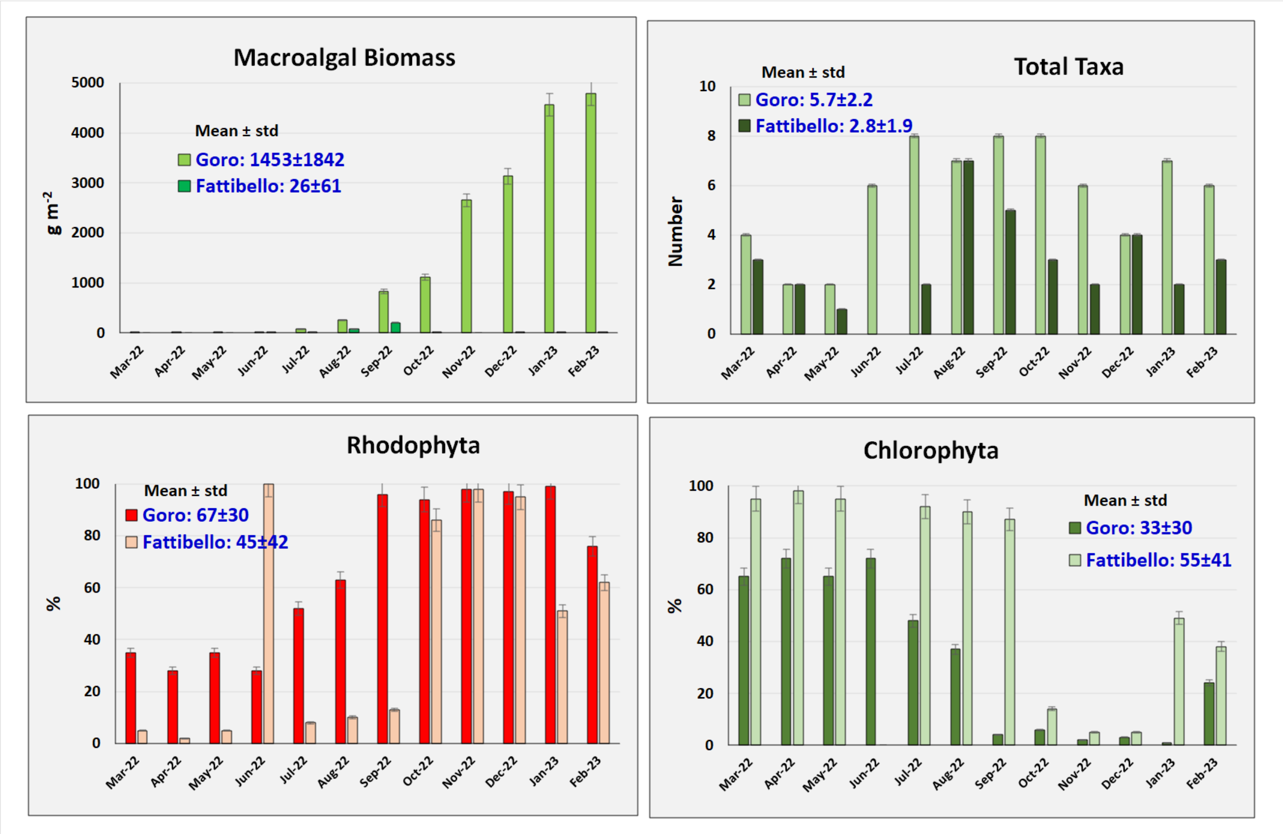

Figure 10. *Variation of macroalgae in the two stations.*

The mean biomass on fresh weight basis was very high at Goro (1453±1842 g m^{-2}) and negligible at Fattibello where the main producer was phytoplankton (**Figure 7**). At Goro the highest values (up to 4787 g m^{-2}) were recorded in the cold seasons whereas at Fattibello it was zero or close to zero most to the year with a maximum in July (79 g m^{-2}). In both the lagoons the dominant species were the Rhodophyceae: *Gracilariopsis vermiculophylla* and *Gracilariopsis longissima* and the Chlorophycea *Ulva australis* species that characterize degraded environments. No taxa of high ecological value were recorded.

On the basis of the recorded species the ecological conditions obtained by the application of the index MaQI were Poor for Goro (**Table 3**) and Bad for Fattibello (**Table 4**).

Table 3. *Macrophytes sampled at Goro.*

Taxonomic list first year														
Goro 2022-2023														
N°	N°	Chlorophyceae	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dic	Gen	Feb
1	1	***Blidingia dowsonii*** (Hollenberg & I.A.Abbott) S.C.Lindstrom, L.A.Hanic & L.Golden	x			x	x	x	x	x			x	x
2	2	***Cladophora glomerata*** (Linnaeus) Kützing					x			x				
3	3	***Cladophora lehmanniana*** (Lindenberg) Kützing						x						
4	4	***Ulva australis*** Areschoug	x	x	x	x	x	x	x	x	x			x
5	5	***Ulva rigida*** C. Agardh										x	x	
6	6	***Ulva intestinalis*** Linnaeus								x				
7	7	***Ulva polyclada*** Kraft					x		x					
8	8	***Uronema marinum*** Womersley				x	x		x	x	x		x	
		Rhodophyceae												
9	1	***Agardhiella subulata*** (C. Agardh) Kraft et M. J. Wynne					x	x	x	x	x		x	x
10	2	***Hypnea cervicornis*** J Agardh								x	x	x		
11	3	***Gracilariopsis longissima*** (S. G. Gmelin) Steentoft et al.				x	x	x	x		x	x	x	x
12	4	***Gracilariopsis vermiculophylla*** Ohmi	x	x	x	x	x	x	x		x	x	x	x
13	5	***Melanothamnus harveyi*** (Bailey) Diaz-Tapia & Maggs				x								
14	6	***Polysiphonia morrowii*** Harvey	x											
15	7	***Sahlingia subintegra*** (Rosenvinge) Kornmann								x				
16	8	***Solieria filiformis*** (Kützing) P. W. Gabrielson						x	x				x	x
		Phaeophyceae												
		Total Taxa	4	2	2	6	8	7	8	8	6	4	7	6
		Chlorophyceae N°	2	1	1	3	5	3	4	5	2	1	3	2
		Rhodophyceae N°	2	1	1	3	3	4	4	3	4	3	4	4
		Phaeophyceae N°	0	0	0	0	0	0	0	0	0	0	0	0
		Cover %	5	10	0.01	5	25	30	75	60	60	70	80	100
		Biomassa g/m^2	1.6	3.4	0.4	1.8	83	254	831	1114	2653	3138	4565	4787
		Rhodophyceae%	65	72	65	72	48	24	37	6	2	3	1	24
		Chlorophyceae%	35	28	35	28	52	63	4	94	98	97	99	76
		Chlorophyceae abundance%	3.3	7.2	0.007	3.6	12	7.2	27.8	3.6	1.2	2.1	0.8	24.0
		Rhodophyceae abundance%	1.8	2.8	0.004	1.4	13	18.9	3.0	56.4	58.8	67.9	79.2	76.0
		MaQI	0.25	0.25	0.25	0.35	0.25	0.25	0.25	0.35	0.35	0.35	0.35	0.35
			Poor											

Table 4. *Macrophytes sampled at Fattibello.*

Taxonomic list first year														
Fattibello 2022-23														
N°	N°	Chlorophyceae	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
1	1	***Blidingia dowsonii*** (Hollenberg & I.A.Abbott) S.C.Lindstrom, L.A.Hanic & L.Golden	x					x	x			x		
2	2	***Blidingia ramifera*** (Bliding) Garbary & L.B.Barkhouse												x
3	3	***Cladophora albida*** (Nees) Kützing						x						
4	4	***Cladophora glomerata*** (Linnaeus) Kützing						x	x					
5	5	***Cladophora sericea*** (Hudson) Kützing								x		x	x	
6	6	***Rhizoclonium* sp**						x						
7	7	***Ulva australis*** Areschoug	x	x	x		x	x	x	x	x	x		x
8	8	***Ulva compressa*** Linnaeus	x	x										
9	9	***Ulva flexuosa*** Wulfen							x	x				
10	10	***Ulva linza*** Linnaeus						x						
11	11	***Ulva polyclada*** Kraft					x		x					
12	12	***Ulva prolifera*** O. F. Müller						x			x	x	x	
13	13	***Uronema marinum*** Womersley												x
		Rhodophyceae												
14	14	***Agardhiella subulata*** (C. Agardh) Kraft et M. J. Wynne						x	x	x				
15	15	***Bostrychia scorpioides*** (Hudson) Montagne	x											
16	16	***Catenella caespitosa*** (Withering) L.M.Irvine	x											
17	17	***Dasya baillouviana*** (S. G. Gmelin) Montagne	x			x			x					
18	18	***Gracilariopsis longissima*** (S. G. Gmelin) Steentoft et al.					x	x						
19	19	***Gracilariopsis vermiculophylla*** Ohmi		x			x	x	x	x	x	x	x	x
20	20	***Melanothamnus harveyi*** (Bailey) Diaz-Tapia & Maggs					x			x				x
21	21	***Polysiphonia morrowii*** Harvey						x			x		x	
22	22	***Solieria filiformis*** (Kützing) P. W. Gabrielson						x	x			x	x	
		Phaeophyceae												
23	1	***Kuckuckia spinosa*** (Kützing) Kornmann	x	x										
24	1	***Myrionema* sp.**	x	x										
		Total Taxa	8	5	1	1	5	12	9	6	4	6	5	5
		Chlorophyceae N°	3	2	1	0	2	7	5	3	2	4	2	3
		Rhodophyceae N°	3	1	0	1	3	5	4	3	2	2	3	2
		Phaeophyceae N°	2	2	0	0	0	0	0	0	0	0	0	0
		Cover %	0.05	0.05	0.05	0.05	30	0.05	0.05	70	0.05	0.1	0.1	0.05
		Biomassa g/m^2	0	0	0	0	19.2	0	1.2	207	17	4	13	1.3
		Chlorophyceae %	0	98	100	0	92	14	7	87	5	16	49	38
		Rhodophyceae %	0	2	0	100	8	86	93	13	95	84	51	62
		Chlorophyceae abundance %	0	0.049	0.05	0	27.6	0.007	0.004	61	0.003	0.02	0.05	0.02
		Rhodophyceae abundance %	0	0.001	0	0.05	2.4	0.043	0.047	9	0.05	0.08	0.05	0.03
		MaQI	0	0	0	0	0.25	0	0	0.25	0	0	0	0
			Bad											

Statistical analyses

The relationship between environmental parameters of the water column and surface sediments and macrophyte variables was determined by the application of the Principal Component Analysis (PCA) which showed a variance of 74.5% with 5 components. The combination of the first two components is plotted in **Figure 11**.

Two main groups of parameters/variables were detected. One with Chl-*a*, Phaeo-*a* and TSS responsible of water turbidity which were associated with the nitrogen species (ammonium, nitrite, nitrate), silicate, Ehs, Corg and Pinorg. The other with the algal biomass and cover which were associated with Salinity, some sediment characteristics (Fines, Moisture, Porosity), pH of the water column (pHw), Porg and Cinorg. Among the macroalgae Chlorophyceae were associated with total nitrogen (Ntot) and the redox potential of the water column (Ehw), whereas Rhodophyceae with reactive phosphorus (RP), the sediment collected by sedimentation traps (SPM) and water temperature (Temp)Temperature.

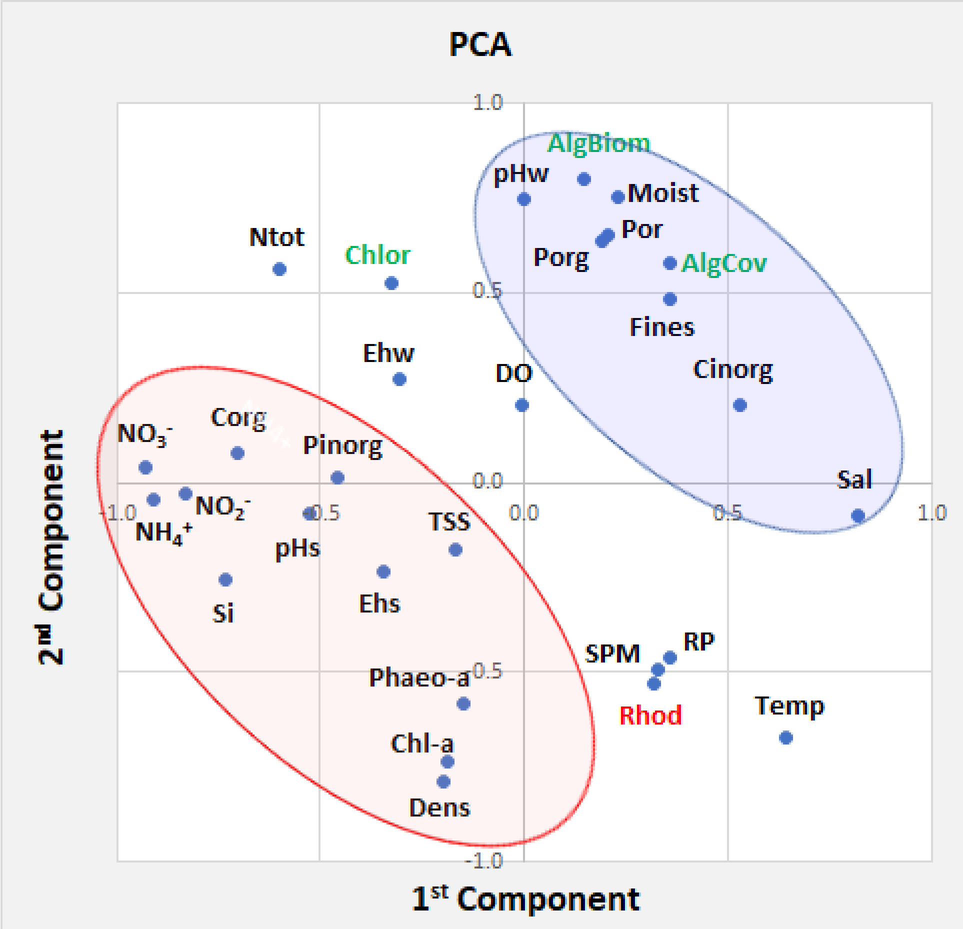

Figure 11. PCA analysis between environmental parameters and macrophyte variables recorded at Goro and Fattibello.

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SECTION 2 – MACROBENTHOS AND EQ

The macrobenthic community analysis (composition, structure and dynamics) is the best approach for assessing the ecological status for a given water body. The DL 260 / 10 explicitly requests the analysis of the "macrobenthos" as biological quality element for the definition of the ecological status of transition and marine-coastal waters. The monitoring of the macrobenthic community on a spatio-temporal scale enables the evaluation of the effectiveness of activities carried out for environmental improvement and it provides an adequate tool for a rigorous assessment of the quality of the environmental conditions.

The macrobenthos monitoring actions are carried out at 2 sites of the Natura 2000 Network, characterized by the presence of the priority habitat 1150 - coastal lagoons, and affected by the conservation activity of this habitat by transplanting marine phanerogams; at each of the 4 sites (Sacca di Goro, Valle Fattibello,), the monitoring action is carried out at several stations. Initially the Seganda station was included in Goro, but following the unsatisfactory results obtained during the first 2 years of experimentation it was decided to abandon it as the turbidity of the water is excessive all year round for the development of macrophytes; in Goro the experimentation is therefore continued in Bassunsin plus xx (always with 5 replicates per station to infer the intra-site variability). The same negative conditions also manifested themselves in the station initially chosen in fattibello; here, after a short time, a colony of flamingos settled, whose activity makes the water constantly cloudy. for this reason the transplant site, after 2 years, was moved to another area of the lagoon, away from the flamingos.

At each station, macrobenthos is sampled following a BACI (Before-After, Control-Impact) design, that is sampling in a control site and in a site subjected to impact (specifically the transplant operation), before and after impact (intervention) (**Figure 1**).

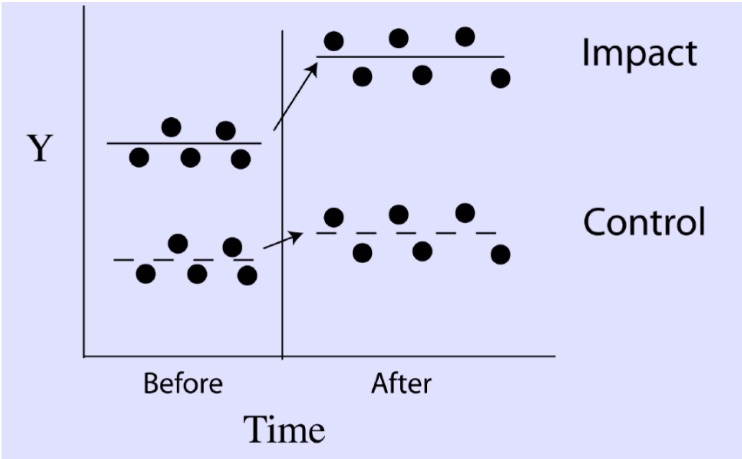

Fig. 1. Before-after-control-impact (BACI) design

At each station 5 replicates of samples are collected in order to achieve for each site (i.e. lagoon) 5 Control replicates, i.e. in areas not directly interested by the phanerogam transplant; 5 Impact replicates, i.e. in areas directly interested by the phanerogam transplant.

For the assessment of environmental quality, an indicator specifically required by Legislative Decree 260 / 2010 for transitional waters is used, the M-AMBI index (Muxika et al., 2007).

After the ex-ante campaign (May 2021), and the beginning of phanerogams transplant operations (autumn 2021), sampling of macrobenthos was carried out twice a year, i.e. in April and October 2022, May and November 2023, and the most recent April 2024. Samples from April 2024 are under analyses, so will be not included in this report.

Structural indices describing the macrobenthic community were calculated on species/abundance data at each replicate of each station.

The ecological quality at each station has been assessed by applying the macrobenthic index M-AMBI (Muxika et al., 2007) on the species/abundance data set. The M-AMBI index is based on a multivariate analysis in which factor analysis combines the values of AMBI, with those of Shannon-Wiener diversity (H') and number of species (S). The M-AMBI is calculated by means a user-friendly software (www.azti.es) to be applied with the latest update of the species list already available.

The index is based on the classification of macrobenthic species into 5 ecological groups (EG) which correspond to different levels of disturbance-sensitivity (Borja et al., 2000). The

EGI group includes the most sensitive species; following a tolerance gradient we arrive at the EGV group, which includes strongly opportunistic species, characteristic of heavily polluted environments. The AMBI index is calculated as:

AMBI = [(0*%EGI)+(1,5*%EGII)+(3*%EGIII)+(4,5*%EGIV)+(6*%EGV)]/100

The ecological value (EG) of benthic taxa is reported in the AMBI library. If some species are not assigned an ecological value, as such species are not present in the AMBI library, the accuracy of the result may be compromised if: a) the percentage of unassigned taxa is > 20%, b) the taxa not belonging to some groups have a large number of individuals. Thanks to the calculation method, the M-AMBI Index is able to summarize the complexity of soft bottom communities, enabling the ecological reading of the ecosystem in question. M-AMBI corrects the quality values provided by AMBI through the integration of diversity and specific richness. M-AMBI is an extremely flexible tool for the derivation of the EQR, as it requires the operator to enter the limit values (equivalent to the reference values) for H ', S and AMBI. If this step is omitted, the reference values for the "High" quality class are taken as the highest values of S and H '(and lowest of AMBI) present within the numeric matrix for which the operator is running the calculation. This omission leads to extreme errors in the evaluation of the EQ (ecological quality).

The value of the M-AMBI varies between 0 and 1. Below (**Figure 2**) are reported (i) the type-specific reference values for each metric that makes up the M-AMBI, the M-AMBI class limits, expressed in terms of the ecological quality ratio (RQE), between the High status and the Good status, and between the Good status and the Moderate status as required by current legislation. The values of the reference conditions and the relative Good / Moderate and High / Good limits considered for the calculation are those relating to macrotypes 1 and 2 (M-AT-1, M-AT-2), to which Fattibello and the Sacca di Goro respectively belong.

Valori di riferimento e limiti di classe

Tab. 4.4.1/c – Limiti di classe in termini di RQE per l'M-AMBI

Rapporto di Qualità Ecologica			
Elevato/Buono	*Buono/Sufficiente*	*Sufficiente/Scarso*	*Scarso/Cattivo*
0,96	0,71	0,57	0,46

Le condizioni di riferimento sono state definite sulla base di un criterio misto statistico/geografico. L'indice M-AMBI è un indice multivariato, pertanto le condizioni di riferimento vanno indicate per i tre indici che lo compongono: AMBI, Indice di Diversità di Shannon-Wiener e numero di specie (S).

Tab. 4.4.1/d - Valori di riferimento tipo-specifiche per l'applicazione dell'M-AMBI

Macrotipo	Geomorfologia	Escursione marea	Salinità	AMBI	Diversità di Shannon-Wiener	Numero di Specie (S)
M-AT-1	Laguna costiera	Non tidale	-	1,85	3,3	25
M-AT-2	Laguna costiera	microtidale	Oligo/meso/poli	2,14	3,40	28
M-AT-3	Laguna costiera	microtidale	Eu/iper	0,63	4,23	46

Fig. 2. Reference values for the M-AMBI calculation (from the DL260/10).

The BITS index (Mistri & Munari, 2008) was also applied. BITS is written:

$$BITS = \log[(6fI+fII) / (fIII+1)+1] + \log[nI/(nII+1) + nI/(nIII+1) + 0{,}5nII/(nIII+1) +1]$$

where *fI* is the sensitive families frequency (ratio of the total number of individuals belonging to sensitive families to the total number of individuals in the sample), *fII* is the tolerant families frequency (ratio of the total number of individuals belonging to tolerant families to the total number of individuals in the sample), and *fIII* is the opportunistic families frequency (ratio of the total number of individuals belonging to opportunistic families to the total number of individuals in the sample). The +1 terms in the equation are needed in order to allow the division operation to be completed even when *fIII* is null, and to prevent the eventuality of a log of zero if *fI* and *fII* are null. The second term of the BITS model allows to weight the number of sensitive families respect the tolerant and the opportunistic ones: *nI* is the number of sensitive families, *nII* is the number of tolerant and *nIII* is the number of opportunistic families. Again, the +1 terms in the equation are needed in order to allow the division operation to be completed. The BITS index is null when there are no sensitive and tolerant families, indicating a very high amount of organic matter in the sediments, and, in lagoonal ecosystems, a very poor water exchange. BITS is high when the environment is good, with few opportunistic families, and it decreases as the environment degrades.

The following scheme (from DL260/10) reports the BITS class limits, expressed in terms of the ecological quality ratio (RQE), between the High status and the Good status, and between the Good status and the Moderate status as required by current legislation, and the type-specific reference values for BITS.

Limiti di classe in termini di RQE per il BITS			
Elevato/Buono	Buono/Sufficiente	Sufficiente/Scarso	Scarso/Cattivo
0,87	0,68	0,44	0,25

Valori di riferimento tipo-specifiche per l'applicazione del BITS	
M-AT-1	2,8
M-AT-2	3,4
M-AT-3	3,4

Sacca di Goro

Overall, a total of 29 macrobenthic taxa were found in the Sacca di Goro. **Table 1** shows the faunal list of the macrobenthic taxa collected during all the monitoring campaigns. Relative abundances vary according to season and site, and the variations are better highlighted below in the analysis of community structural indices

Polydora cornuta	*Caprella scaura*
Streblospio shrubsolii	*Monocorophium acherusicum*
Streblospio eridani	*Cyathura carinata*
Hediste diversicolor	*Idotea balthica*
Caulleriella alata	*Gammarus aequicauda*
Serpula concharum	*Melita palmata*
Ficopomatus enigmaticus	*Grandidierella japonica*
Hydroides nigra	*Microdeutopus gryllotalpa*
Pileolaria militaris	*Monocorophium insidiosum*
Hydroides dianthus	*Actiniaria ind.*
Hydroides elegans	*Cerastoderma glaucum*
Alitta succinea	*Lentidium mediterraneum*
Capitella minima	*Arcuatula senhousia*
Prionospio cirrifera	*Platyhelminthes ind.*
Corophium orientale	

Tab. 1. Taxonomic list of the macrobenthic taxa identified in the Sacca di Goro

In **Table 2** the values of community descriptors (diversity, H’, and species richness, S), together with AMBI/M-AMBI values and ES are reported for all the sampling dates. The laboratory processing of the samples collected during the last sampling campaign (May 2024) is still underway. In the Table also the reference parameters are shown (in grey).

Date	*Stations*	*AMBI*	*H'*	*S*	*M-AMBI*	*Status*
	Bad	6	0	0	0	Bad
	High	2.14	3.4	28	1	High
June 2021	Gor-C	2.98	2.71	15	0.71	Moderate
	GorS	2.90	2.47	23	0.78	Good
April 2022	Gor-C	3.13	2.25	20	0.71	Moderate
	GorS-Tr	3.31	2.64	16	0.68	Moderate
	GorB-Tr	2.9	2.18	19	0.71	Moderate
October 2022	Gor-C	4.24	1.41	14	0.46	Bad
	GorS-Tr	3.13	1.47	7	0.48	Poor
	GorB-Tr	2.63	3.11	21	0.85	Good

May 2023	Gor-C	3.08	2.67	15	0.68	Moderate
	GorS-Tr	3.54	2.70	18	0.69	Moderate
	GorB-Tr	1.73	1.49	21	0.76	Good
November 2023	Gor-C	2.98	1.96	9	0.56	Poor
	GorS-Tr	3.08	2.10	13	0.61	Moderate
	GorB-Tr	4.94	2.01	25	0.59	Moderate

Tab. 2. Community parameters and AMBI/M-AMBI values in the Sacca di Goro (Gor-C. Control; GorS-Tr: Seganda; GorB: Bassunsin transplant sites)

In general it is evident that the ES is often better at the GorB transplant site compared to the control and GorS sites.

The temporal trend of the M-AMBI index is represented in Fig. 3, where, for each sampling date, the M-AMBI values found at the control site and at the transplant sites are compared.

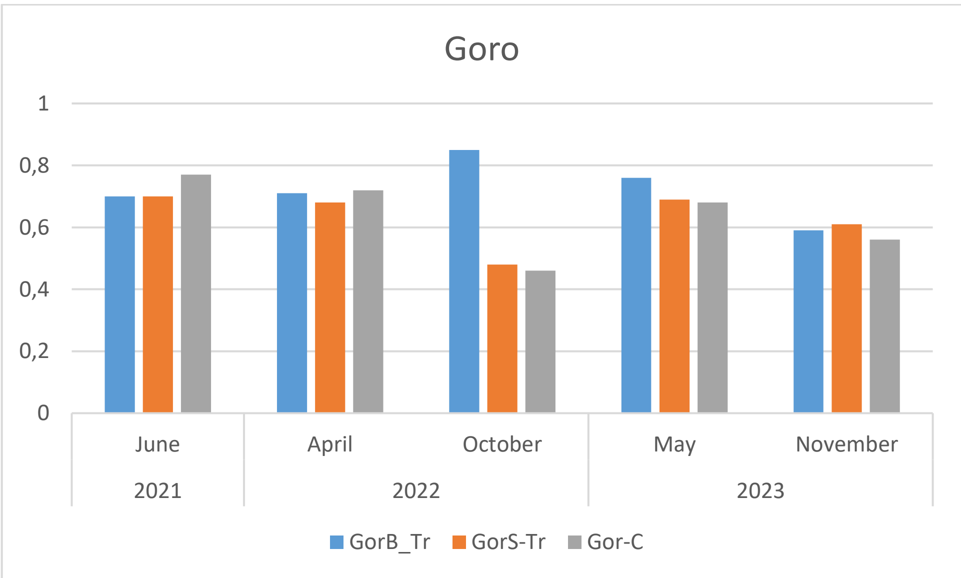

Fig. 3. M-AMBI values at Goro (Gor-C. Control; GorS-Tr: Seganda; GorB: Bassunsin transplant sites)

Table 3 shows the percentage of invertebrates belonging to the five sensitivity-tolerance groups: EG-I sensitive, EG-II indifferent, EG-III tolerant, EG-IV and EG-V opportunistic of second and first order respectively; the higher the percentage of EG-I (or the lower the percentage of EG-IV and EG-V), the better the ecological quality.

Date	*Stations*	Ecological Groups				
		I(%)	*II(%)*	*III(%)*	*IV(%)*	*V(%)*

June 2021	Gor-C	4.34	1.19	92.71	0.39	1.38
	GorS	0.23	1.41	97.66	0.70	0
April 2022	Gor-C	1.29	0.39	87.61	9.68	1.03
	GorS-Tr	1.45	0	79.42	14.78	4.35
	GorB-Tr	3.18	1.96	93.39	1.47	0.00
October 2022	Gor-C	0	0.90	14.60	84.30	0.10
	GorS-Tr	0	0	91.70	8.00	0.40
	GorB-Tr	4.60	16.20	74.90	4.00	0.20
May 2023	Gor-C	29.80	13.10	16.20	4.00	36.90
	GorS-Tr	0.80	0.30	61.50	37.00	0.40
	GorB-Tr	5.60	79.40	9.10	5.90	0.10
November 2023	Gor-C	0	9.50	84.10	4.80	1.60
	GorS-Tr	0	0.0	97.0	0.40	2.60
	GorB-Tr	4.0	2.90	21.70	2.30	69.0

Tab. 3. Sensitivity-tolerance distribution of macrobenthos in the Sacca di Goro (Gor-C. Control; GorS-Tr: Seganda; GorB: Bassunsin transplant sites).

The majority of the taxa present at the two transplant sites belongs to the “tolerant” group (EG-III), while at the control site to the opportunist group (EG-IV). At BAS, however, are present also sensitive (EG-I) and indifferent (EG-II) species. It is also evident how, in the transplant sites, the benthic community is better structured, in terms of ecological groups, than in the control site.

The application of the BITS index (**Table 4**) gave a higher value at the Bassunsin transplant site, where the ecological status was High. Both transplant sites exhibited, however, a better ecological status than the control site.

Date	*Stations*	*EQR BITS*	*Status*
June 2021	Gor-C	0.44	Moderate
	GorS	0.52	Moderate
April 2022	Gor-C	0.22	Poor
	GorS-Tr	0.50	Moderate
	GorB-Tr	0.80	High
October 2022	Gor-C	0.25	Poor
	GorS-Tr	0.52	Moderate
	GorB-Tr	0.92	High
May 2023	Gor-C	0.35	Moderate
	GorS-Tr	0.52	Moderate
	GorB-Tr	0.69	Good
November	Gor-C	0.40	Moderate

2023	GorS-Tr	0.54	Moderate
	GorB-Tr	0.89	High

Tab. 4. BITS EQR values in the Sacca di Goro (Gor-C. Control; GorS-Tr: Seganda; GorB: Bassunsin transplant sites).

Valle Fattibello

Overall, 20 macrobenthic taxa were found in the Valle Fattibello. **Table 5** shows the faunal list of the macrobenthic taxa collected during the monitoring campaign.

Polydora cornuta	*Caprella scaura*
Streblospio shrubsolii	*Monocorophium acherusicum*
Prionospio lighti	*Cyathura carinata*
Hediste diversicolor	*Grandidierella japonica*
Caulleriella alata	*Microdeutopus gryllotalpa*
Alitta succinea	*Monocorophium insidiosum*
Capitella capitata	*Lentidium mediterraneum*
Capitella minima	*Arcuatula senhousia*
Prionospio cirrifera	*Ceratoderma glaucum*
Corophium orientale	*Platyhelminthes sp.*

Tab. 5. Taxonomic list of the macrobenthic taxa identified in the Valle Fattibello

In **Table 6** the values of community descriptors (diversity and species richness), together with AMBI/M-AMBI values and ES are reported. In the Table also the reference parameters are shown (in grey).

Date	*Stations*	*AMBI*	*H'*	*S*	*M-AMBI*	*Status*
	Bad	6	0	0	0	Bad
	High	1.85	3.3	25	1	High
June 2021	Fat-C	2.78	2.19	30	0.84	Good
	Fat	3.33	1.55	13	0.54	Poor
April 2022	Fat-C	2.78	2.19	29	0.84	Good
	Fat-Tr	2.89	2.93	24	0.86	Good
October 2022	Fat-C	3.64	2.29	17	0.65	Moderate
	Fat-Tr	3.64	2.12	16	0.62	Moderate
May 2023	Fat-C	3.35	2.68	18	0.7	Moderate
	Fat-Tr	3.05	2.66	15	0.69	Moderate
November 2023	Fat-C	3.05	3.04	13.00	0.71	Good
	Fat-Tr	2.92	2.21	18.00	0.71	Good

Tab. 6. Community parameters and AMBI/M-AMBI values at Fattibello (Fat-C: control; Fat-Tr: transplant site)

The temporal trend of the M-AMBI index is represented in **Fig. 4**, where, for each sampling date, the M-AMBI values found at the control site and at the transplant site are compared.

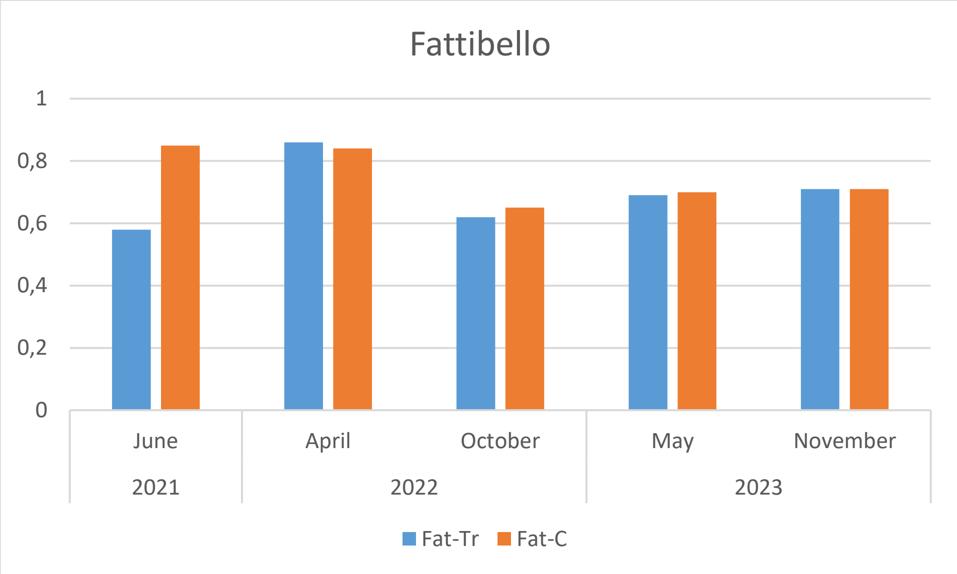

Fig. 4. Ecological quality through M-AMBI at Fattibello (Fat-C: control; Fat-Tr: transplant site).

Table 7 shows the percentage of invertebrates belonging to the five sensitivity-tolerance groups: EG-I sensitive, EG-II indifferent, EG-III tolerant, EG-IV and EG-V opportunistic of second and first order respectively; the higher the percentage of EG-I (or the lower the percentage of EG-IV and EG-V), the better the ecological quality.

Date	*Stations*	Ecological Groups				
		I(%)	*II(%)*	*III(%)*	*IV(%)*	*V(%)*
June 2021	Fat-C	9.00	3.20	82.90	3.20	1.70
	Fat	0.10	0.10	87.80	1.50	10.50
April 2022	Fat-C	9,00	3,20	82,90	3,20	1,70
	Fat-Tr	5,54	3,97	82,84	7,66	0
October 2022	Fat-C	0	7,7	43,8	46,5	1,9
	Fat-Tr	0	7,8	42,7	48,5	0,9
May 2023	Fat-C	5.7	1.4	58.7	32.4	1.7
	Fat-Tr	0.3	21.2	53.8	24.3	0.3
November 2023	Fat-C	2.4	15.3	69.4	2.4	10.6
	Fat-Tr	6	0	90.7	0.2	3.2

Tab. 7. Sensitivity-tolerance distribution of macrobenthos at Fattibello (Fat-C: control; Fat-Tr: transplant site)

The majority of taxa present at the two sites belongs to the "tolerant" (EG-III), however there are very strong fluctuations in the composition of the community between the various periods and the 2 sites. Data for November 2023 refers to the new transplant site (see **Fig. 5**).

The application of the BITS index (**Table 8**) generally gave the similar ES values at both sites.

Date	*Stations*	*EQR BITS*	*Status*
June 2021	Fat-C	0.85	Good
	Fat	0.64	Moderate
April 2022	Fat-C	0.70	Good
	Fat-Tr	0.77	Good
October 2022	Fat-C	0.63	Moderate
	Fat-Tr	0.60	Moderate
May 2023	Fat-C	0.55	Moderate
	Fat-Tr	0.57	Moderate
November 2023	Fat-C	0.79	Good
	Fat-Tr	0.81	Good

Tab. 8. BITS EQR values at Fattibello (Fat-C: control; Fat-Tr: transplant site)

Fig. 5. New transplant site at Fattibello

References

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Section 3 - Fish fauna monitoring

The HFBI (Habitat Fish Bio Indicator) index

The HFBI is an empirically derived multi-metric index, composed of six metrics expressed as ecological quality reports. The index is calculated by combining various ecological descriptors including species richness and biomass, but also characteristics related to the belonging of each species to the different functional groups. They contribute to the calculation of the metrics that describe the characteristics of the functional groups, exclusively species belonging to the following ecological guilds: estuarine residents (ES), diadromes (Di) and marine migratory (MM). These groups were included due to their high susceptibility to environmental degradation, being highly dependent on the integrity of the habitats for the purposes of reproduction, nourishment and growth.

The fishing tool we adopted has such a selectivity as to allow a representative sampling of the communities fish present in the sampled area and associated with the particular type of habitat to be monitored. The mesh size (internode equal to 2 mm) of the tool allow to capture even small species such as *Aphanius fasciatus* and *Syngnathus abaster,* often associated with environments in good health. Furthermore, since in the lagoon environments the distribution of fish species is strongly influenced by some environmental variables, such as water temperature, salinity, oxygen dissolved as well as vegetation cover, and has a strong seasonal variability, the index was designed in such a way as to be able to evaluate the structure of the fishing communities according to the type of water body, seasonality (spring and autumn) and habitats (vegetated or non-vegetated environment).

Sampling was carried out in Goro at July and November 2022, May and November 2023, and May 2024. In Fattibello fishing campaigns were carried out at June and November 2022, then at May and November 2023, and finally May 2024.

Results

Table 9 shows the taxonomic list of fish species captured in the Sacca di Goro, while **Table 10** is referred to Fattibello fish community. At Goro the fish community is richer (both in species number and abundance) and more diversified respect to Fattibello, probably reflecting the different level of confinement respect to the sea of the 2 lagoons. In general, in Goro the fish community is dominated in weight and abundance by mullets, while in Fattibello by sandsmelts and gobies.

Anguilla anguilla	*Pomatoschistus canestrini*
Atherina boyeri	*Zosterisessor ophiocephalus*
Sardina pilchardus	*Dicentrarchus labrax*
Alosa fallax	*Chelon auratus*
Sprattus sprattus	*Liza ramada*
Aphanius fasciatus	*Solea solea*
Engraulis encrasicolus	*Syngnathus abaster*
Knipowitschia panizzae	*Mullus barbatus*
Gobius niger	*Chelon saliens*

Table 9. Fish species at Goro

Atherina boyeri	*Knipowitschia panizzae*
Sardina pilchardus	*Gobius niger*
Sprattus sprattus	*Pomatoschistus canestrini*
Aphanius fasciatus	*Zosterisessor ophiocephalus*
Engraulis encrasicolus	*Solea solea*

Table 10. Fish species at Fattibello

The application of the HFBI index is shown in **Tables 11 and 12.** At both lagoons, at the transplant sites the value of the index was slightly higher respect to the control site.

Date	*Stations*	*HBFI*	*Status*
July 2022	Gor-C	0.85	Good
	GorB-Tr	1.0	High
November 2022	Gor-C	0.8	Good
	GorB-Tr	1.0	High
May 2023	Gor-C	0.23	Poor
	GorB-Tr	0.28	Poor
November 2023	Gor-C	0.85	Good
	GorB-Tr	0.99	High
May 2024	Gor-C	0.79	Good
	GorB-Tr	0.80	Good

Table 11. HBFI at Goro

Date	*Stations*	*HBFI*	*Status*
June 2022	Fat-C	0.38	Moderate
	Fat-Tr	0.30	Poor
November	Fat-C	0.49	Moderate

2022	Fat-Tr	0.40	Moderate
May	Fat-C	0.15	Poor
2023	Fat-Tr	0.14	Poor
November	Fat-C	0.25	Poor
2023	Fat-Tr	0.36	Moderate
May	Fat-C	0.25	Poor
2024	Fat-Tr	0.87	High

Table 12. HBFI at Fattibello

Figure 6 shows some phases of the fishing activity.

Fig. 6 Fish samples from Goro and Fattibello