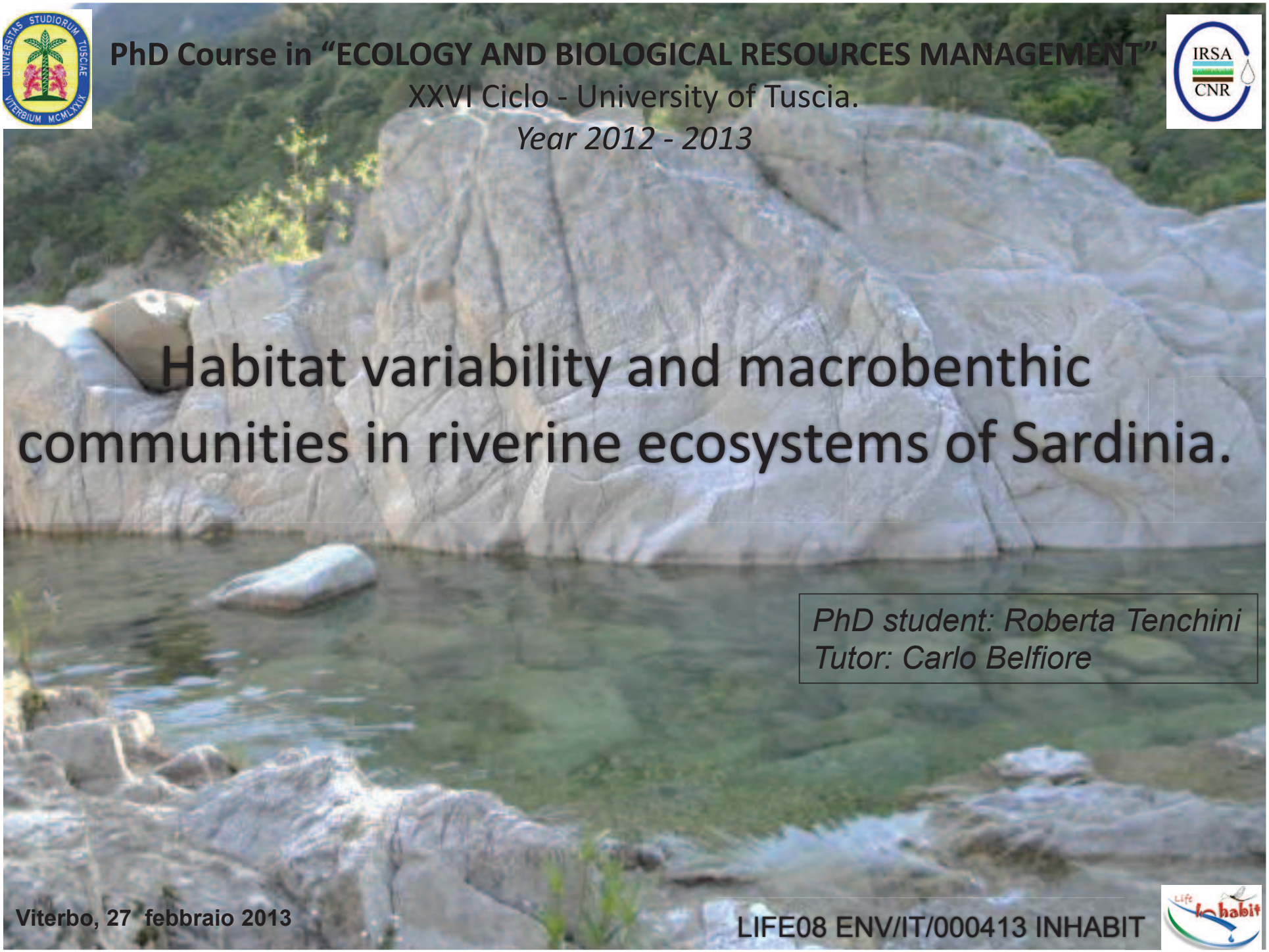


PhD Course in "ECOLOGY AND BIOLOGICAL RESOURCES MANAGEMENT"

XXVI Ciclo - University of Tuscia.

Year 2012 - 2013

Habitat variability and macrobenthic communities in riverine ecosystems of Sardinia.

PhD student: Roberta Tenchini
Tutor: Carlo Belfiore

Viterbo, 27 febbraio 2013

LIFE08 ENV/IT/000413 INHABIT

INHABIT project objectives

- To improve the efficacy of PdG (local scale) *sensu* WFD
- To improve the reliability of Ecological Status classification

The main focus is the study of the relationship between biota, hydromorphological characteristics and habitats in rivers

The main aspects of PhD:

Ecological aspects:

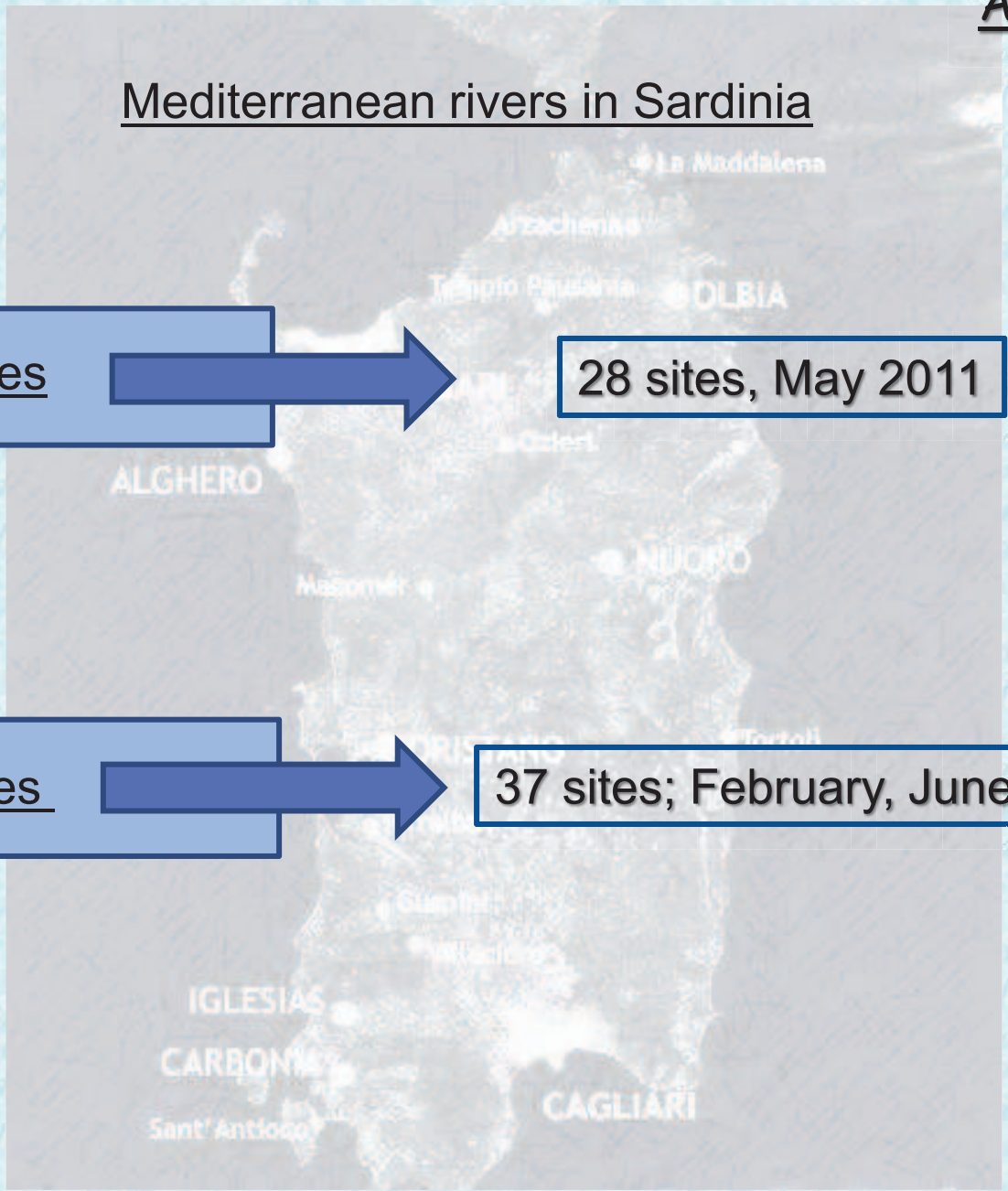
- to explore the ecological preferences of endemic species of Ephemeroptera
- to characterize their habitats and investigate their distribution at the micro and meso-scale
- to observe biological and environmental variability in natural sites and along the quality gradient
- to propose measures for their protection.

Taxonomic aspects:

- Morphological description of a probably-new endemic species of "*Caenis*" genus
- Definition of taxonomic status of species belonging to Baetidae and Heptageniidae

Areas and sites

Mediterranean rivers in Sardinia



INHABIT Sites → 28 sites, May 2011

MICARI Sites → 37 sites; February, June, August 2004

Materials & methods

- Sampling of aquatic communities (multi-habitat, proportional)
- Collection of water samples for physio-chemical analysis
- Recording of hydromorphological characteristics and habitat (Caravaggio)

Biological and Hydromorphological indices:

. **STAR_ICMi** : macrobenthos
. **HQA**: Habitat Quality
. **HMS**: Habitat Modification
. **LUI**: alteration in Land Use
. **IQH**: Habitat Quality Index
. **LRD:** Lentic-lotic River descriptor
. **LIMeco** :Level of pollution from macro-descriptors related to ecological status

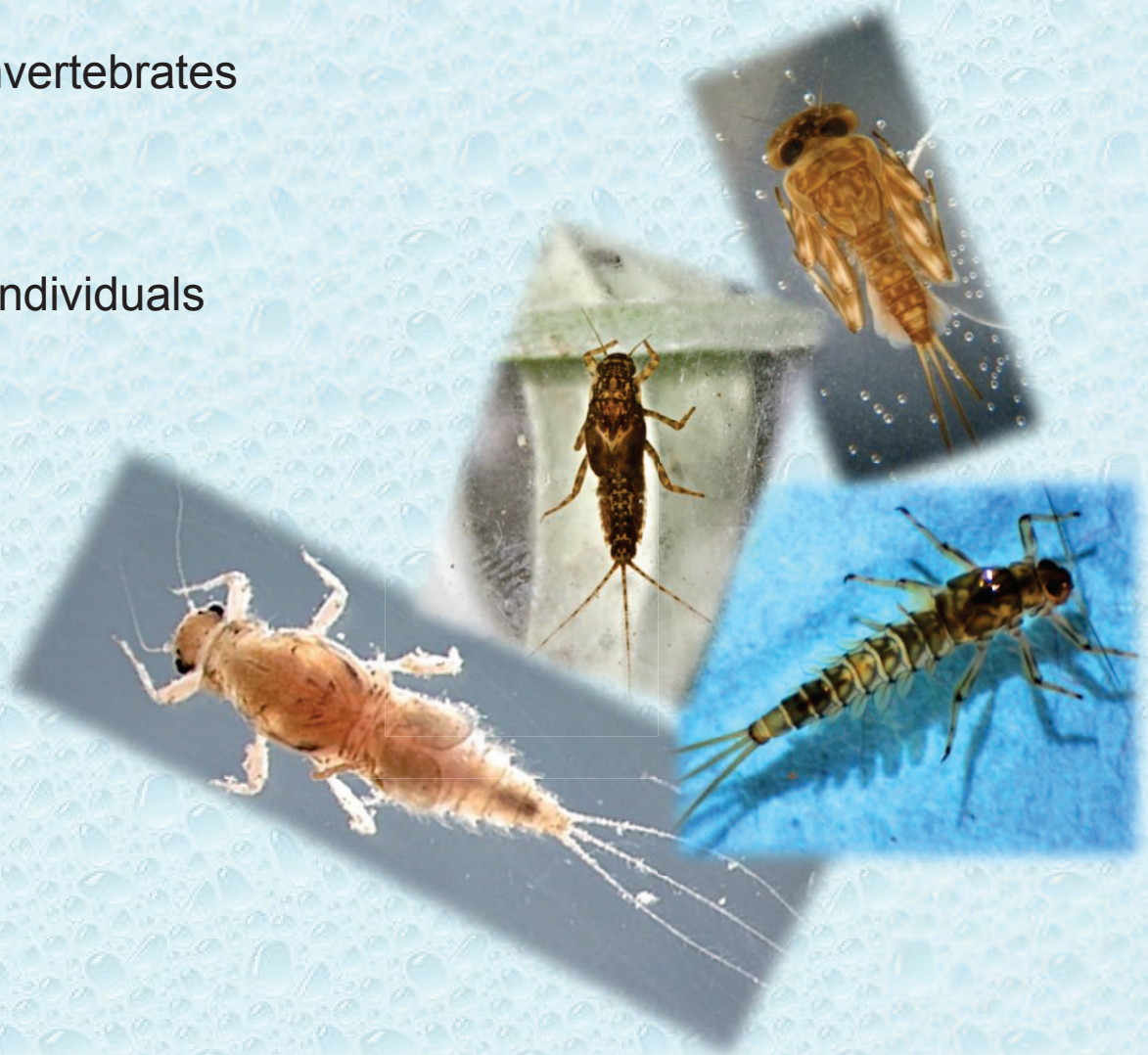
Physio-chemical variables:

O2 %
Cl mg/l
BOD5
O2 mg/l
N-NH4 µg/l
N-NO3 mg/l
TP mg/l
temp °C
Cond. µS/cm
pH

Aquatic invertebrate community

- 1300 samples of macroinvertebrates
- 257019 individuals

Ephemeroptera: 121067 individuals
10 genera:
Baetis
Caenis
Habrophlebia
Electrogena
Ecdyonurus
Siphlonurus
Serratella
Procloeon
Cloeon
Centroptilum



Results

INHABIT project

indices

		HMS			HQA			LUI			IQH		LIMeco	
Cod	Sito	valore	EQR	CL	valore	EQR	CL	valore	EQR	CL	EQR	CL	EQR	CL
S1	Barrastoni	2	0.980	1	50	0.830	1	0.501	0.987	1	0.932	1	0.688	1
S2	Liscia	2	0.980	1	55	0.936	1	0.890	0.977	1	0.964	1	1.000	1
S3	Cialdeniddu	7	0.930	2	57	0.979	1	2.086	0.947	2	0.952	1	0.625	2
S4	Safaa Aglientu REF	0	1.000	1	70	1.255	1	0	1.000	1	1.085	1	1.000	1
S5	Sperandeu REF	3	0.970	1	49	0.809	1	0	1.000	1	0.926	1	1.000	1
S6	Baldu Monte Culvert	9	0.910	2	57	0.979	1	1.034	0.974	1	0.954	1	0.875	1
S7	Baldu Down Culvert	17	0.830	2	54	0.915	1	3.005	0.923	2	0.889	1	0.875	1
S8	Sud Limbara Terra Mala Valle Ponte	11	0.890	2	58	1.000	1	2.848	0.927	2	0.939	1	0.750*	1*
S9	Sud Limbara Terra Mala Ref REF	1	0.990	1	56	0.957	1	0.139	0.996	1	0.981	1	0.750*	1*
S10	Saserra REF	0	1.000	1	46	0.745	1	0	1.000	1	0.915	1	1.000	1
S11	Posada Valle Guado REF	0	1.000	1	62	1.085	1	0	1.000	1	1.028	1	1.000	1
S12	Lorana Monte	0	1.000	1	52	0.872	1	0	1.000	1	0.957	1	0.656	2
S13	Posada Affluente REF	0	1.000	1	50	0.830	1	0	1.000	1	0.943	1	1.000	1
S14	Rio San Giuseppe	51	0.490	4	29	0.383	3	4.373	0.888	2	0.587	3	1.000	1
S15	Lorana Multiculvert	43	0.570	4	46	0.745	1	1.450	0.963	1	0.759	2	0.656	2
S16	Cedrino Irgoli Affluente	42	0.580	3	44	0.702	1	9.832	0.749	2	0.677	2	0.750	1
S17	Flumineddu REF	0	1.000	1	61	1.087	1	0	1.000	1	1.029	1	1.000	1
S18	Corr'e Pruna Monte	51	0.490	4	34	0.489	2	11.015	0.719	3	0.566	3	0.688	1
S19	Corr'e Pruna Valle	45	0.550	4	36	0.532	2	8.923	0.772	2	0.618	2	0.688	1
S20	Corr'e Pruna Ponte	79	0.210	5	26	0.319	3	13.072	0.667	3	0.399	4	1.000	1
S21	Solanas	11	0.890	2	47	0.766	1	3.362	0.914	2	0.857	1	0.875	1
S22	Picocca REF	7	0.930	2	60	1.043	1	0.140	0.996	1	0.990	1	0.750*	1*
S23	Foddeddu	60	0.400	4	30	0.404	3	10.284	0.738	2	0.514	3	0.625	2
S24	Porceddu	28	0.720	3	42	0.660	1	4.353	0.889	2	0.756	2	1.000	1
S25	Museddu	57	0.430	4	32	0.447	3	4.480	0.886	2	0.588	3	0.813	1
S26	Canale Monte Depuratore	88	0.120	5	34	0.489	2	11.652	0.703	3	0.437	3	0.625	2
S27	E Gurue	21	0.790	3	56	0.978	1	1.035	0.974	1	0.914	1	0.875	1
S28	Tirso REF	0	1.000	1	52	0.891	1	0.150	0.996	1	0.962	1	1.000	1

Results

MICARI project

indices

			HMS			HQA			LUI			IQH		LIMeco	
Cod	Sito	mese/anno	valore	EQR	CL	valore	EQR	CL	valore	EQR	CL	EQR	CL	EQR	CL
M1	Girasole Foce	02/04	44	0.560	4	40	0.617	2	1.780	0.955	1	0.711	2	1.000	1
M2	Girasole Foce	06/04	63	0.370	4	40	0.617	2	0.535	0.986	1	0.658	2	0.875	1
M3	Girasole Foce	08/04	67	0.330	4	43	0.681	1	0.773	0.980	1	0.664	2	0.656	2
M4	Mannu Valle	08/04	23	0.770	3	39	0.609	2	9.786	0.750	2	0.710	2	0.469	3
M5	Mannu Villamar	06/04	24	0.760	3	41	0.652	2	4.592	0.883	2	0.765	2	0.469	3
M6	Mirenu Condotta	02/04	45	0.550	4	45	0.723	1	2.626	0.933	2	0.735	2	0.750	1
M7	Mirenu Condotta Briglia	08/04	46	0.540	4	48	0.787	1	1.897	0.952	1	0.760	2	1.000	1
M8	Mirenu Monte Condotta	06/04	44	0.560	4	62	1.085	1	0.734	0.981	1	0.875	1	0.750	1
M9	Mulargia B - Autocampionatore	02/04	57	0.430	4	44	0.717	2	7.951	0.800	2	0.648	3	0.094	5
M10	Mulargia B - Autocampionatore	06/04	23	0.770	3	47	0.783	1	3.326	0.920	2	0.823	1	0.531	2
M11	Mulargia B - Autocampionatore	08/04	45	0.550	4	33	0.478	3	11.639	0.700	3	0.577	3	0.563	2
M12	Mulargia C - Guado Intermedio	08/04	13	0.870	2	55	0.957	1	2.323	0.940	2	0.923	1	0.781	1
M13	Mulargia C - Guado Monte	02/04	18	0.820	2	46	0.761	2	4.481	0.886	2	0.822	1	0.156	5
M14	Mulargia C - Guado Valle	06/04	0	1.000	1	50	0.848	1	0	1.000	1	0.949	1	0.375	3
M15	Mulargia D - Foce	02/04	11	0.890	2	61	1.087	1	1.578	0.960	1	0.979	1	0.219	4
M16	Mulargia D - Valle	08/04	9	0.910	2	53	0.913	1	0.247	0.994	1	0.939	1	0.813	1
M17	Mulargia D - Ponte Centralina	06/04	8	0.920	2	42	0.674	2	0.375	0.990	1	0.861	1	0.594	2
M18	Mulargia ref	02/04	0	1.000	1	58	1.022	1	0	1.000	1	1.007	1	0.438	3
M19	Mulargia ref	06/04	0	1.000	1	48	0.804	1	0	1.000	1	0.935	1	0.656	2
M20	Mulargia ref	08/04	0	1.000	1	29	0.391	3	0	1.000	1	0.797	2	0.875	1
M21	Oleandro ref	02/04	0	1.000	1	57	0.979	1	0	1.000	1	0.993	1	1.000	1
M22	Oleandro ref	06/04	0	1.000	1	57	0.979	1	0	1.000	1	0.993	1	1.000	1
M23	Oleandro ref	08/04	0	1.000	1	56	0.957	1	0	1.000	1	0.986	1	0.750	1
M24	Leni ref	06/04	1	0.990	1	69	1.234	1	0.145	1.000	1	1.073	1	1.000	1
M25	Pelau Ponte	08/04	10	0.900	2	55	0.957	1	4.323	0.890	2	0.916	1	0.781	1
M26	Su Corongiu Monte	06/04	0	1.000	1	50	0.830	1	0.467	0.988	1	0.939	1	0.406	3
M27	Su Corongiu Ponte	08/04	12	0.880	2	60	1.043	1	3.986	0.898	2	0.940	1	0.469	3
M28	Su Corongiu Valle	02/04	63	0.370	4	51	0.851	1	2.277	0.942	2	0.721	2	0.219	4
M29	Su Lernu Castagna	08/04	5	0.950	1	49	0.826	1	0.580	0.985	1	0.920	1	1.000	1
M30	Su Lernu Monte Padru	06/04	21	0.790	3	65	1.174	1	1.090	0.972	1	0.979	1	0.688	1
M31	Su Lernu ref	02/04	0	1.000	1	67	1.217	1	0	1.000	1	1.072	1	1.000	1
M32	Su Lernu ref	08/04	0	1.000	1	56	0.978	1	0	1.000	1	0.993	1	0.781	1
M33	Su Lernu ref	06/04	0	1.000	1	59	1.043	1	0	1.000	1	1.014	1	1.000	1
M34	Su Lernu Valle Padru	02/04	31	0.690	3	60	1.065	1	3.939	0.900	2	0.885	1	0.688	1
M35	S. Lucia Confluenza	02/04	14	0.860	2	57	1.000	1	3.360	0.914	2	0.925	1	0.688	1
M36	S. Lucia Ponte	08/04	26	0.740	3	58	1.022	1	0.878	0.978	1	0.913	1	0.875	1
M37	S. Lucia FFSS	06/04	14	0.860	2	62	1.109	1	1.615	0.959	1	0.976	1	0.750	1

LRD

MICARI project

Results

INHABIT project

Sito	Data	LRD	Classe LRD
Mulargia B	24/02/2004	-12.75	2
Mulargia B	09/06/2004	3.75	3
Mulargia B	23/08/2004	38.5	5
Mulargia Reference	23/02/2004	-30.54	2
Mulargia Reference	11/06/2004	18.39	4
Mulargia Reference	24/08/2004	85.5	5+
Mulargia D	23/02/2004	-25.1	2
Mulargia D	10/06/2004	-6.57	3
Mulargia D	22/08/2004	64.5	5+
Mulargia C	24/02/2004	-9.33	3
Su Lernu Padru	05/06/2004	-32.25	1
Mulargia C	09/06/2004	-10.91	3
Mulargia C	23/08/2004	35.5	5
Rio Leni Reference	09/06/2004	-23.92	2
Su Lernu Reference	20/02/2004	-12.54	2
Su Lernu Reference	05/06/2004	-26.83	2
Su Lernu Reference	18/08/2004	37	5
Mirenu Condotta	06/06/2004	-21.43	2
Su Lernu valle Padru	20/02/2004	-12.25	2
Castagna Castagna	18/08/2004	53.14	5+
Gorbini Reference	21/02/2004	-23.5	2
Gorbini Reference	07/06/2004	-27.39	2
Gorbini Reference	19/08/2004	49.75	5+
Mannu Villamar	10/06/2004	33.31	5
Mannu valle Villamar	22/08/2004	55.75	5+
Su Corongiu Valle	07/06/2004	-15.37	2
Su Corongiu Valle	19/08/2004	25.99	4
Su Corongiu Valle	21/02/2004	6.61	3
Tricarai S.Lucia	22/02/2004	-8.94	3
Tricarai ponte F.S.	06/06/2004	-10.21	3
Tricarai valle ponte	20/08/2204	27.85	4
Girasole Foce	21/02/2004	-0.65	3
Girasole Foce	08/06/2004	13.64	4
Girasole Foce	21/08/2004	55.84	5+
Rio Pelau Ponte	25/08/2004	87.7	5+
Mirenu Condotta	22/02/2004	-32.05	1
Mirenu Condotta	20/08/2004	8.45	3

Sito	Data	LRD	Classe LRD
Barrastoni	10/05/2011	0	3
Liscia Valle Lago	10/05/2011	45.83	5
Cialdeniddu	11/05/2011	59.50	5+
Safaa Alientu	12/05/2011	25.34	4
Sperandeu	12/05/2011	2.33	3
Baldu Monte Culvert	13/05/2011	11.25	4
Baldu Down Culvert	13/05/2011	-1.70	3
Sud Limbara - Terra Mala Valle	14/05/2011	0.04	3
Sud Limbara - Terra Mala Ref	14/05/2011	13.56	4
Saserra Ref	15/05/2011	48.71	5
Posada Valle Guado	15/05/2011	0.71	3
Lorana Monte	16/05/2011	8.51	3
Posada Affluente	16/05/2011	8.37	3
Rio San Giuseppe Solago/Sarossa	17/05/2011	23.25	4
Lorana Valle	17/05/2011	4.50	3
Cedrino Irgoli Affluente	18/05/2011	21.44	4
Flumineddu Gorroppu	18/05/2011	-11.98	2
Corr'e Pruna Monte	19/05/2011	10.25	4
Corr'e Pruna Valle	19/05/2011	8.29	3
Corr'e Pruna Ponte	20/05/2011	14.25	4
Solana	20/05/2011	12.50	4
Picocca Ref	20/05/2011	11.48	4
Foddeddu Valle	21/05/2011	-9.79	3
Porceddu	21/05/2011	21.09	4
Museddu	22/05/2011	69	5+
Canale Monte Depuratore	22/05/2011	80.34	5+
E Gurue	23/05/2011	-38.82	1
Tirso	23/05/2011	-7.84	3

Results

		Pool		Riffle		Tot	
Cod	Sito	STAR_ICMi	Classe	STAR_ICMi	Classe	STAR_ICMi	Classe
S1	Barrastoni	1.015	1	1.014	1	1.015	1
S2	Liscia	1.121	1	0.980	1	1.051	1
S3	Cialdeniddu	0.851	2	0.712	3	0.782	2
S4	Safaa Aglientu REF	0.992	1	0.984	1	0.988	1
S5	Sperandeu REF	1.016	1	0.965	2	0.990	1
S6	Baldu Monte Culvert	1.092	1	1.091	1	1.091	1
S7	Baldu Down Culvert	0.929	2	0.913	2	0.921	2
S8	Sud Limbara Terra Mala Valle Ponte	0.954	2	0.764	2	0.859	2
S9	Sud Limbara Terra Mala Ref REF	1.024	1	0.798	2	0.911	2
S10	Saserra REF	1.153	1	1.152	1	1.152	1
S11	Posada Valle Guado REF	1.022	1	0.899	2	0.961	2
S12	Lorana Monte	1.114	1	1.039	1	1.077	1
S13	Posada Affluente REF	0.952	2	0.954	2	0.953	2
S14	Rio San Giuseppe	0.947	2	0.931	2	0.939	2
S15	Lorana Multiculvert	1.018	1	0.816	2	0.917	2
S16	Cedrino Irgoli Affluente	1.049	1	0.884	2	0.967	2
S17	Flumineddu REF	0.844	2	0.799	2	0.821	2
S18	Corr'e Pruna Monte	0.903	2	0.750	2	0.827	2
S19	Corr'e Pruna Valle	0.656	3	0.693	3	0.675	3
S20	Corr'e Pruna Ponte	0.867	2	0.627	3	0.747	2
S21	Solanas	0.812	2	0.880	2	0.846	2
S22	Picocca REF	1.237	1	1.001	1	1.119	1
S23	Foddeddu	0.802	2	0.714	3	0.758	2
S24	Porceddu	0.674	3	0.841	2	0.758	2
S25	Museddu	0.791	2	0.745	2	0.768	2
S26	Canale Monte Depuratore	0.628	3	0.560	3	0.594	3
S27	E Gurue	0.552	3	0.486	3	0.519	3
S28	Tirso REF	0.835	2	0.808	2	0.821	2

STAR_ICMi

MICARI project

Results

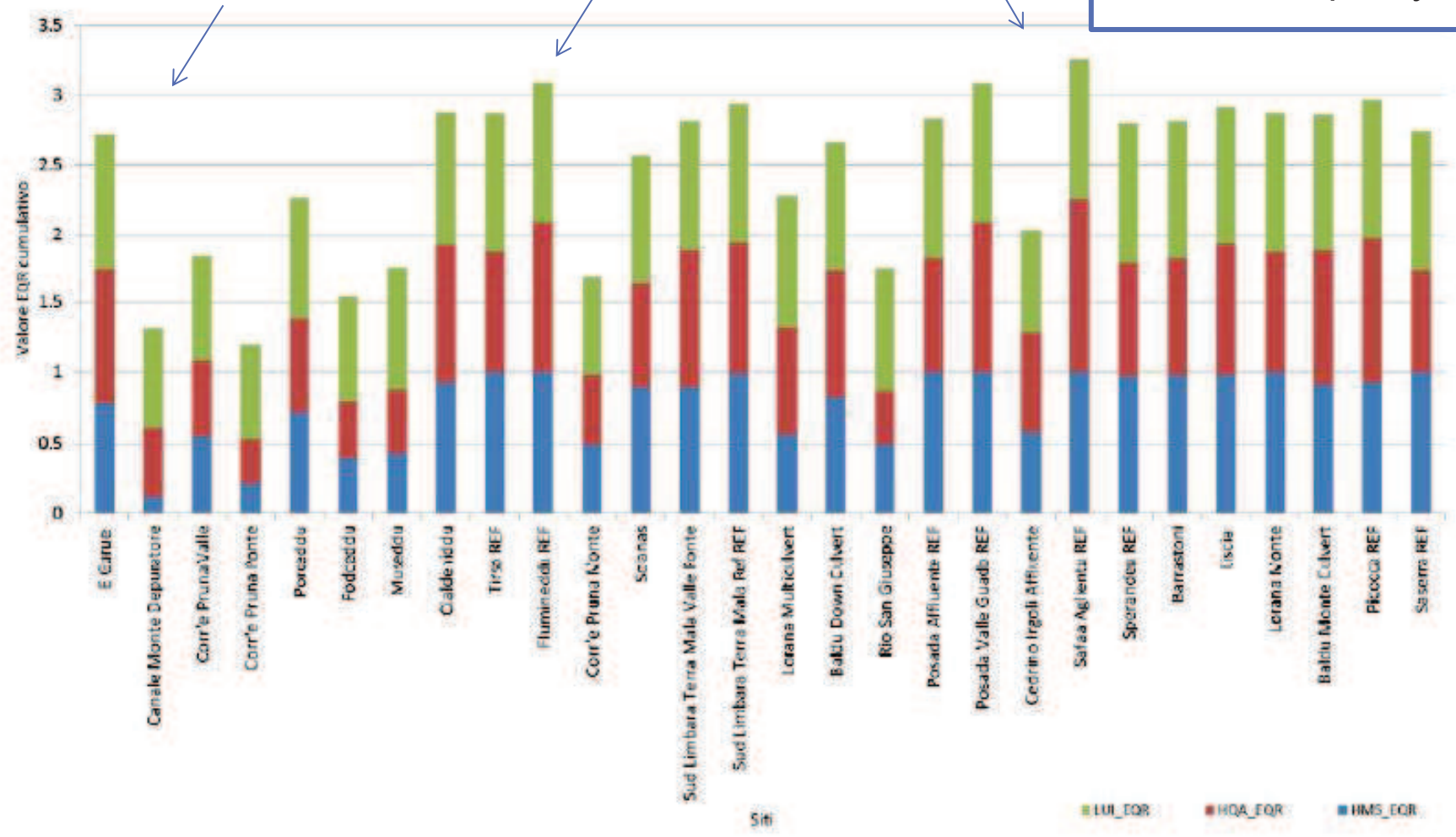
			Pool		Riffle		Tot	
Cod	Sito	mese/anno	STAR_ICMi	Classe	STAR_ICMi	Classe	STAR_ICMi	Classe
M1	Girasole Foce	02/04	0.550	3	0.633	3	0.592	3
M2	Girasole Foce	06/04	0.623	3	0.658	3	0.641	3
M3	Girasole Foce	08/04	0.793	2	0.605	3	0.699	3
M4	Mannu Valle	08/04	0.417	4	0.385	4	0.401	4
M5	Mannu Villamar	06/04	0.433	4	0.307	4	0.370	4
M6	Mirenu Condotta	02/04	0.630	3	0.561	3	0.595	3
M7	Mirenu Condotta Briglia	08/04	0.983	1	1.035	1	1.009	1
M8	Mirenu Monte Condotta	06/04	0.769	2	0.675	3	0.722	3
M9	Mulargia B - Autocampionatore	02/04	0.858	2	0.830	2	0.844	2
M10	Mulargia B - Autocampionatore	06/04	0.786	2	0.658	3	0.722	3
M11	Mulargia B - Autocampionatore	08/04	0.739	2	0.727	3	0.733	2
M12	Mulargia C - Guado Intermedio	08/04	0.790	2	0.845	2	0.818	2
M13	Mulargia C - Guado Monte	02/04	0.794	2	0.638	3	0.716	3
M14	Mulargia C - Guado Valle	06/04	0.560	3	0.552	3	0.556	3
M15	Mulargia D - Foce	02/04	0.640	3	0.607	3	0.623	3
M16	Mulargia D - Valle	08/04	0.742	2	0.783	2	0.762	2
M17	Mulargia D - Ponte Centralina	06/04	0.711	3	0.752	2	0.731	2
M18	Mulargia ref	02/04	1.204	1	0.954	2	1.079	1
M19	Mulargia ref	06/04	0.967	2	0.893	2	0.930	2
M20	Mulargia ref	08/04	0.638	3	0.913	2	0.775	2
M21	Oleandro ref	02/04	1.136	1	1.020	1	1.078	1
M22	Oleandro ref	06/04	1.000	1	1.001	1	1	1
M23	Oleandro ref	08/04	0.779	2	0.904	2	0.842	2
M24	Leni ref	06/04	0.924	2	0.899	2	0.912	2
M25	Pelau Ponte	08/04	0.881	2	0.803	2	0.842	2
M26	Su Corongiu Monte	06/04	0.875	2	0.696	3	0.786	2
M27	Su Corongiu Ponte	08/04	1.157	1	1.229	1	1.193	1
M28	Su Corongiu Valle	02/04	0.768	2	0.774	2	0.771	2
M29	Su Lernu Castagna	08/04	0.977	1	0.975	1	0.976	1
M30	Su Lernu Monte Padru	06/04	1.154	1	1.101	1	1.128	1
M31	Su Lernu ref	02/04	0.998	1	0.974	1	0.986	1
M32	Su Lernu ref	08/04	0.816	2	1.109	2	0.962	2
M33	Su Lernu ref	06/04	0.896	2	1.011	2	0.953	2
M34	Su Lernu Valle Padru	02/04	1.106	1	0.981	1	1.044	1
M35	S. Lucia Confluenza	02/04	1.045	1	1.172	1	1.109	1
M36	S. Lucia Ponte	08/04	1.171	1	1.208	1	1.190	1
M37	S. Lucia FFSS	06/04	0.971	1	0.974	1	0.973	1

STAR_ICMi

Results

Highest habitat quality

biological indices and habitat quality



gradient of increasing biological quality

Results

Axis	1	2	3	4
Eigenvalues	0,6743	0,1904	0,1349	0,086
Lenghts of gradient	4,4649	1,9641	2,2994	1,52224

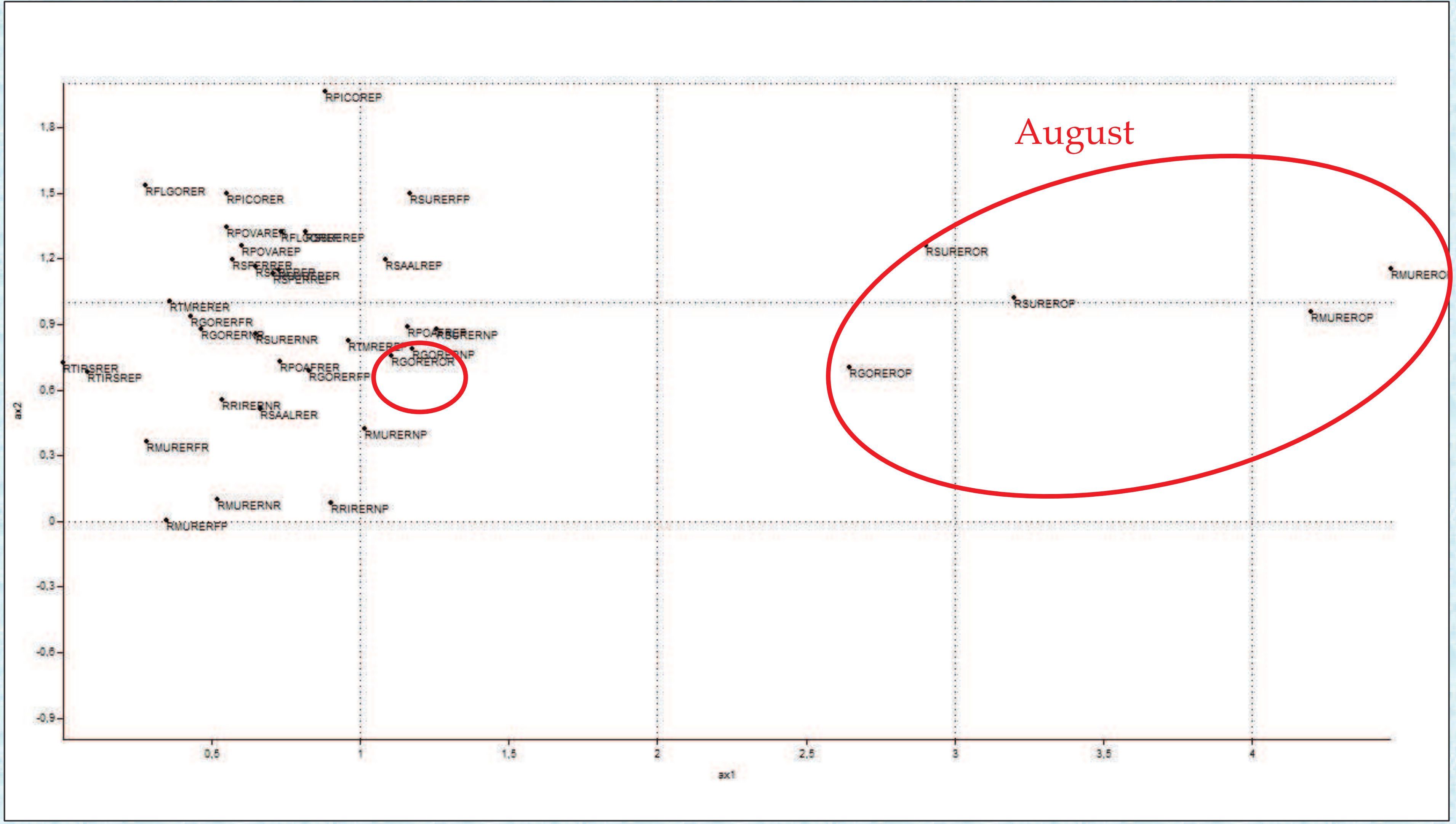
DCA results

Correlation between environmental parameters and DCA axes. [in red $p < 0.05$]

Environmental parameters	ρ Spearman	
	axis 1	*axis 2*
Conc_Ox	0,0555	-0,036
100-O%	-0,2	0,4739
Cloruri	0,2363	-0,124
N-NH4	0,1742	-0,418
N-NO3	0,0818	-0,421
P-PO4	0,1044	0,4944
TP	0,1443	-0,206
pH	-0,115	-0,015
Cond	0,0495	-0,228
Vmean_R	-0,427	0,3512
Vmean_P	-0,418	0,1144
Vmean_T	-0,431	0,3792
Dmean_R	0,0801	-0,033
Dmean_P	-0,004	0,5936
Dmean_T	-0,004	0,3709
HMS	-0,134	0,146
HQA	-0,159	0,1113
LRD Nat	0,4622	0,2449
LRD Art	-0,043	0,3708
LRD tot	0,4622	0,2449
OPDScore	-0,244	0,1642
LUlcara	-0,324	-0,139
IQH_TipoRAS	-0,165	-0,004
LIMeco	-0,222	0,3897
OPD_HMS_LUI	-0,238	0,1915
OPD_HMS	-0,24	0,1425
Site_Lat_DecDiGrado	0,096	0,3065
Site_Lon_DecDiGrado	0,1812	0,2046
Dist_in	-0,211	0,503
Dist_fin	-0,211	0,503
Sor_Cl_1	-0,091	0,4642
Sor_Dis	-0,211	0,503
Persist_num	-0,13	-0,156
alt	-0,107	-0,442
slope_th	0,0649	-0,591
morp_car	0,3005	-0,412
med_sub	0,1344	-0,223
w_chl	-0,217	0,6071
w_de_chl	0,0255	0,5656
wi_mean	-0,265	0,3547
ratio_wi	0,2559	0,1744
num_wet	-0,392	0,1612
LRD	0,4684	0,2874
wat_T_is	0,3632	0,1496

Results

Ordination (DCA) of sampling sites



Ordination of species

Objectives of the third year

- To improve the taxonomic knowledge of:
- - *Baetis ingridae* (molecular analysis)
- - *Baetis fuscatus*
- - *Baetis muticus*
- - *Electrogena zebrata*
- - *Caenis sp.*

- To investigate the distribution of species in different microhabitats


Grazie per l'attenzione!