



## INHABIT

**Local hydro-morphology, habitat and RBMPs: new measures to improve ecological quality in South European rivers and lakes**

# **Habitat control on Ecological Status: the example of the lentic-lotic character in Sardinian streams**

CNR-IRSA, RAS, ARPA Piemonte, UniTuscia-DEB

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LIFE08 ENV/IT/00413 INHABIT



REGIONE AUTONOMA DELLA SARDEGNA





Tabella verifica criteri per la selezione di siti di riferimento fluviali per la Direttiva 2000/60/EC

**Validazione dei siti di riferimento – compilazione tabella verifica criteri per la selezione di siti di riferimento fluviali per la Direttiva 2000/60/EC' (CNR-IRSA, 2008) [totale di 57 criteri]**

Nome sito	Gorroppu
Fiume	Riu Flumineddu
Regione	Sardegna
Latitudine	4451954.52
Longitudine	1544156.78
CodiceTipo	21SS3Tsa
Codice Cor	0102-CF005500

ordine	codice	Scala di applicazione	Criterio	codice	Valore	Tipo di informazione	Lunghezza del tratto	Metodo	Commenti / Fonte di alterazione
1	A1	INQUINAMENTO PUNTIFORME	bacino	1	% di uso artificiale (soglia <0.4; se fino = 0.8%: verifica qualità acqua)	A1	0.02		GIS, CORINE
2	A2			2	È presente qualche fonte particolare di inquinamento industriale (e.g. NaCl, inquinamento termico)?	A2	No		GIS, CORINE
3	A3			3	Le variabili chimico-fisiche di base mostrano concentrazioni pari a quelle tipo-specifiche attese in condizioni naturali?	A3	si		Campionamento
4	A4			4	Sono presenti inquinanti sintetici specifici (e.g. pesticidi)?	A4	no		Campionamento
5	A5			5	Sono presenti inquinanti specifici non sintetici (e.g. metalli)?	A5	no		Campionamento
6	A6			6	La temperatura dell'acqua si discosta dalle condizioni attese?	A6	no		
7	B1	INQUINAMENTO DIFFUSO	bacino	7	C'è rischio significativo di erosione del suolo nel bacino?	B1	no		GIS, CORINE
8	B2			8	Il fondovalle è principalmente occupato da aree naturali, semi-naturali e/o agricole a bassa intensità (e.g. pascoli)?	B2	Si		GIS, CORINE
9	B3			9	% di agricoltura intensiva (soglia < 20%; in aree di pianura fino < 50%: verifica qualità acqua)	B3	0.10		GIS, CORINE
10	B4			10	% Vigneti, frutteti (soglia < 1% e non situati nella zona riparia)	B4	0.00		GIS, CORINE
11	B5			11	% Campi irrigati (soglia < 10%; in aree di pianura fino < 25%: verifica qualità acqua)	B5	0.00		GIS, CORINE
12	B6			12	% Silvicultura (e.g. conifere, eucalipti; soglia < 30%)	B6	13.77		GIS, CORINE
13	B7			13	Allevamento: solo allevamento non intensivo - indicare criteri e tipo di allevamento	B7	Significativo		GIS, CORINE
14	B8			14	Eventuali incendi su meno del 7% del bacino negli ultimi 6 anni e non lungo le sponde fluviali (tratto)	B8	Pochi		GIS, CORINE
15	B9			15	Sono evidenti segni di eutrofizzazione (e.g. proliferazione di vegetazione acquatica)?	B9	no		Sopralluoghi
16	B10			16	Il pH è > 6? Se pH < 6, è necessario determinare se il sito è acido per ragioni naturali	B10	8.6		campionamento
17	C1	AREA RIPARIA	tratto	17	% Uso naturale (sponda, berm, piana di esondazione, aree periferuali; 15-100 m; soglia > 80% del tratto)	C1	95.86		CARAVAGGIO
18	C2			18	% Uso agricolo non intensivo	C2	4.14		CARAVAGGIO
19	C3			19	% Agricoltura intensiva oltre la sommità di sponda (sommatà alle aree artificiali: soglia < 10%)	C3	0		CARAVAGGIO
20	C4			20	% Agricoltura intensiva sulla sponda (sommatà alle aree artificiali: soglia < 1%)	C4	0		CARAVAGGIO
21	C5			21	% Aree artificiali oltre la sommità di sponda (sommatà alle aree ad agricoltura intensiva: soglia < 10%)	C5	0		CARAVAGGIO
22	C6			22	% Aree artificiali sulla sponda (sommatà alle aree ad agricoltura intensiva: soglia < 1%)	C6	0		CARAVAGGIO
23	C7			23	Il sito è (quasi) interamente delimitato dalla vegetazione naturale (o seminaturale) tipo-specifica?	C7	si		CARAVAGGIO
24	C8			24	La vegetazione riparia è Continua, Semi-continua, A gruppi irregolari, Piante isolate	C8	si		CARAVAGGIO
25	C9			25	Le rive sono alterate (mosse) dal calpestio dovuto alla presenza di bestiame?	C9	no		CARAVAGGIO
26	D1	bacino		26	Sono presenti dighe a monte? Se no: 0; se si, indicare quante	D1	0		GIS, info dal territorio
27	D2			27	A quale distanza è la diga più vicina a monte? (in % della distanza del sito dalla sorgente)	D2	100		GIS, info dal territorio

Local hydro-morphology, habitat and RBMPs: new measures to improve ecological quality in South European rivers and lakes



			# domande	Safaa Aglientu	Sperandeu	Terra Mala Ref	Saserra Ref	Posada Valle Guado	Riu s'Astore Posada Affluente	Flumineddu Gorroppu	Picocca Ref	Tirso Ref	E Gurue
Categorie di criteri	Inquinamento puntiforme – Score A		6	0.81	0.90	1	0.90	0.90	0.90	1	0.90	0.90	0.81
	Inquinamento diffuso – Score B		10	0.97	0.88	0.97	0.84	0.88	0.88	0.84	0.84	0.84	0.88
	Vegetazione riparia – Score C		9	1	0.91	0.76	1	1	0.96	0.98	0.91	0.93	0.91
	Alterazioni morfologiche – Score D		18	1	0.95	0.96	0.99	0.91	0.97	0.97	0.93	0.96	0.72
	Alterazioni idrologiche – Score E e F		7	1	1	1	0.90	1	1	1	0.90	1	0.95
	Pressioni biologiche – Score G		5	1	1	1	1	1	1	1	1	1	1
	Altre pressioni – Score H		2	1	1	1	1	1	1	1	1	1	1
	Punteggio finale		57	0.97	0.92	0.95	0.95	0.92	0.96	0.97	0.92	0.95	0.85
# domande con soglie superate	Irrinunciabile	riferimento		-	1	1	1	1	1	-	1	1	1
		rifiuto		1	1	-	-	1	-	-	-	-	3
	Importante	riferimento		-	1	1	1	2	2	2	4	3	3
		rifiuto		-	1	1	1	1	-	-	1	-	1
	Accessorio	riferimento		1	1	1	3	2	2	2	3	2	3
		rifiuto		-	2	1	-	-	1	1	1	1	-
Indici HABITAT - EQR	EQR HMS			1	0.97	0.99	1	1	1	1	0.93	1	0.79
	EQR LUI			1	1	0.996	1	1	1	1	0.996	0.996	0.974
	EQR HQA			1.255	0.809	0.957	0.745	1.085	0.83	1.087	1.043	0.891	0.978
	IQH			1.085	0.926	0.981	0.915	1.028	0.943	1.029	0.99	0.962	0.914
Indici HABITAT - CLASSI	CLASS HMS			1	1	1	1	1	1	1	2	1	3
	CLASS LUI			1	1	1	1	1	1	1	1	1	1
	CLASS HQA			1	1	1	1	1	1	1	1	1	1
	CLASS IQH			1	1	1	1	1	1	1	1	1	1
	Risultato finale			Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Non Ok

9 Reference sites → validated



- **Reference sites validation process (I1d1-I1d4)**

Ongoing process at national level - CNR-IRSA activity closely related to INHABIT (dedicated research contract)

Tipo fluviali (HER, origine e taglia/morfologia alveo)	1	2	3	4	5	6	7	8	9	10	11	12	Tot
	AB	BZ	CA	ER	LI	PI	TN	UM*	VA	VE	SA	FV	
1 01GH									5				5
2 01SS1						1			2				3
3 01SS2						4			3				7
4 02SR6										2		3	5
5 02SS1							1			2			3
6 02SS1 (siliceo collinare)												4	4
7 02SS1 (siliceo media altitudine)												4	4
8 02SS2										1		5	6
9 02SS3												2	2
10 03GH		3					1			1			5
11 03SR6		2								3			5
12 03SS1		3					1						4
13 03SS2							3						3
14 03SS3		1											1
15 04SS1						2							2
16 04SS2						1							1
17 06AS6										3			3
18 06IN7										1			1
19 06SR6										1			1
20 06SS1										1			1
21 06SS2						2							2
22 06SS4				1									1

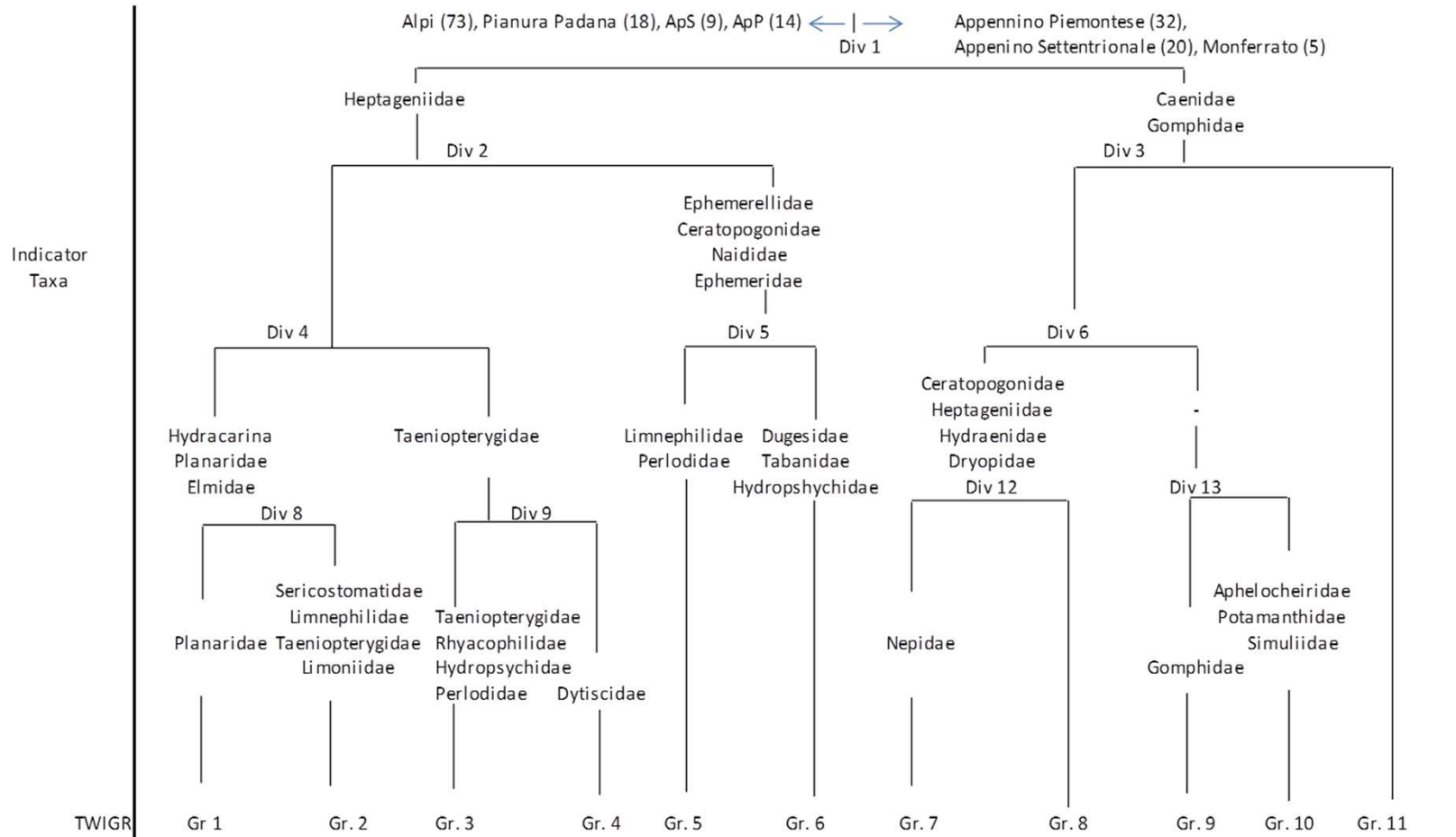
# of confirmed reference sites after validation process



River types biological validation (I1d4)

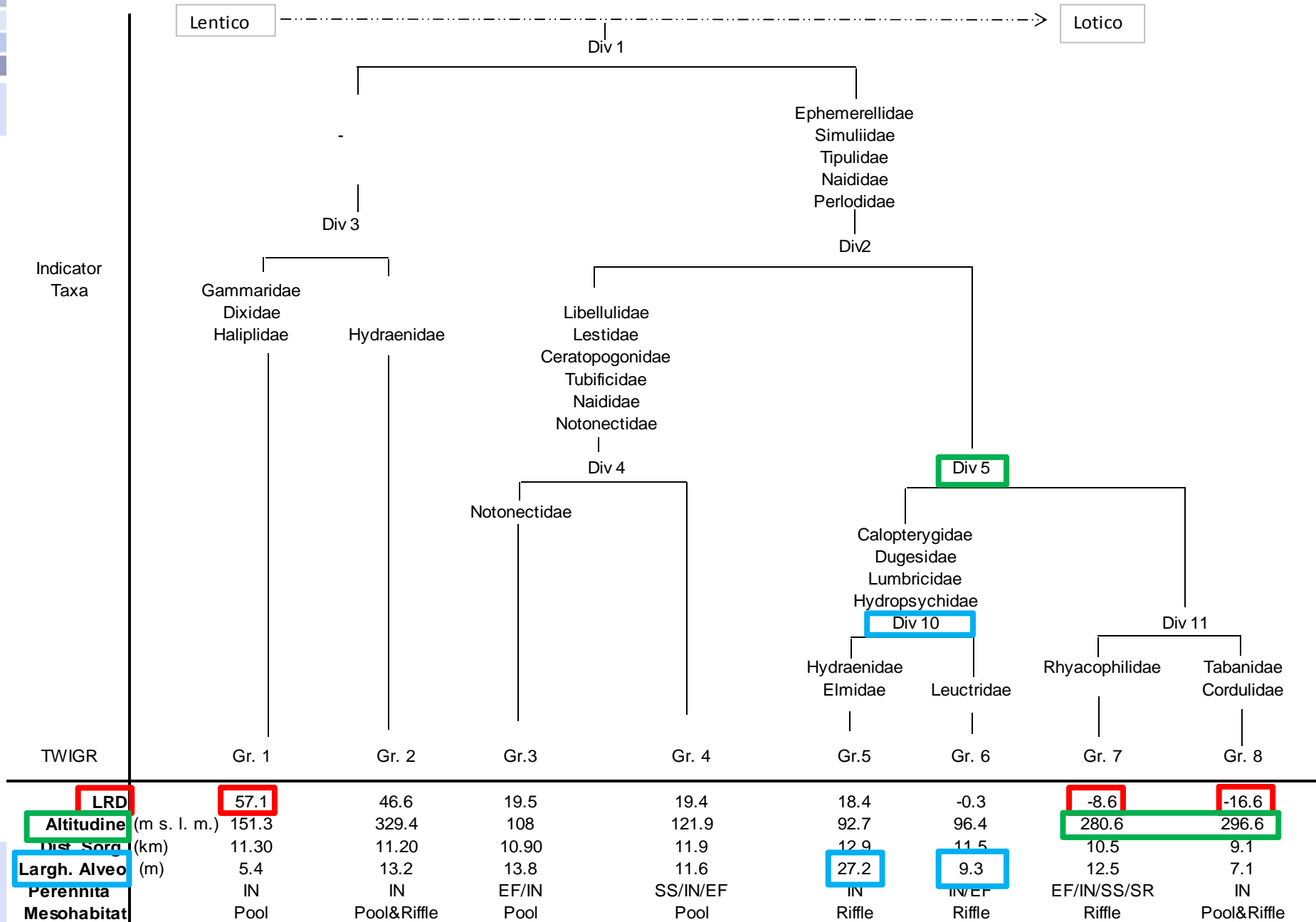
TWINSpan analysis

Piedmont



Ncampioni	37	21	17	6	19	14	2	32	8	16	Miseria (gen11)
HER	AIO	AIM	ApP e ApS	ApP	AIO e PP	PP (e AP)	MO	ApS e ApP	ApS e ApP	ApP	ApS
Origine e Dist. Sorg.	SS2; SS1	SS2, SS3	SS1, SS3	SS2, SS1	SS2	SS2	SS2	SS2, SS1, SS3	SS3	SS3	-
Temperatura °C	9.5	9.3	4.9	6.2	9.8	10.7	19.5	14.1	18.4	14.4	-
Ca++ mg/l	13.5	32.4	48.2	68.5	10.7	36.1	125.0	66.5	52.6	49.9	-

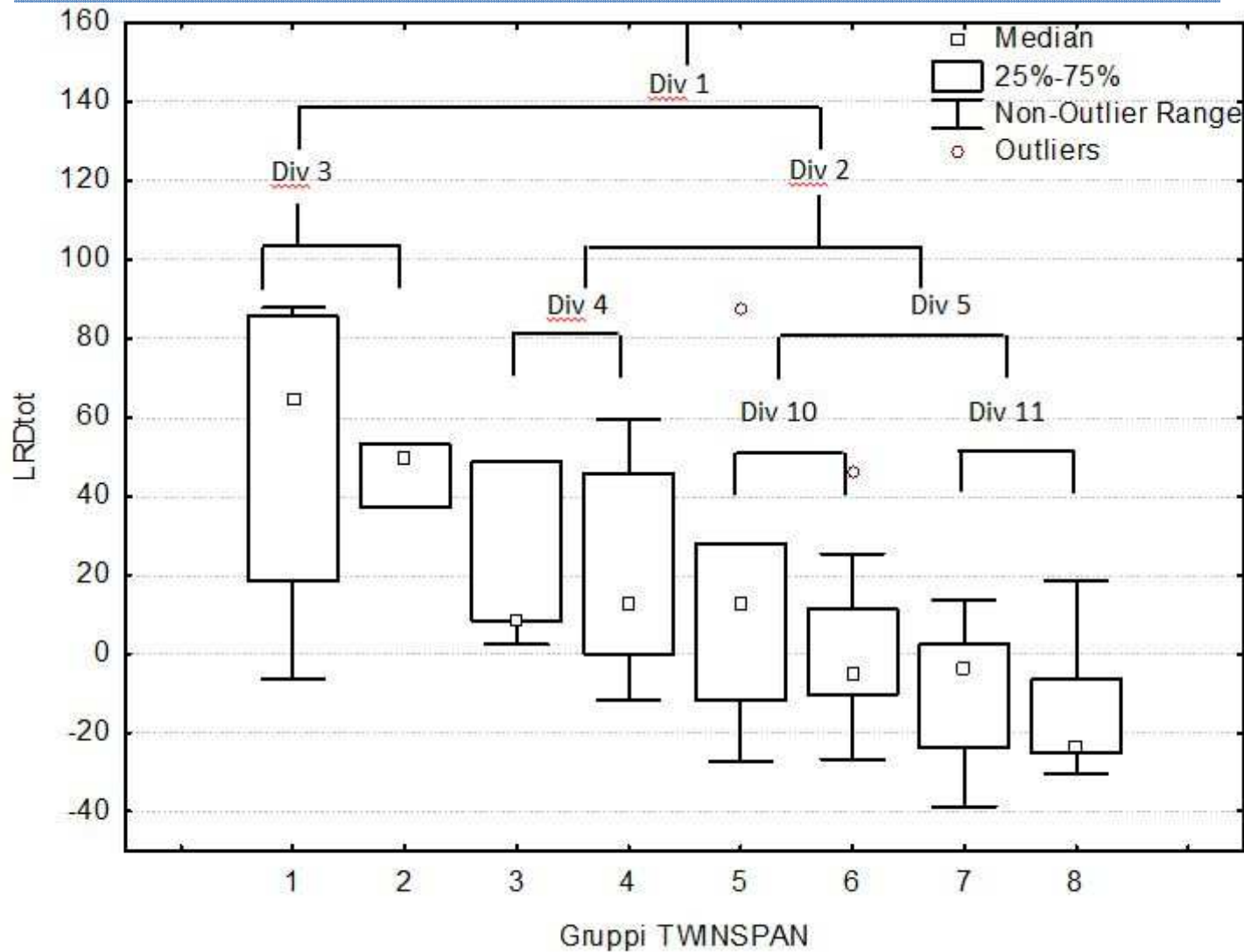
# Natural variability: benthic bio-types in Sardinia



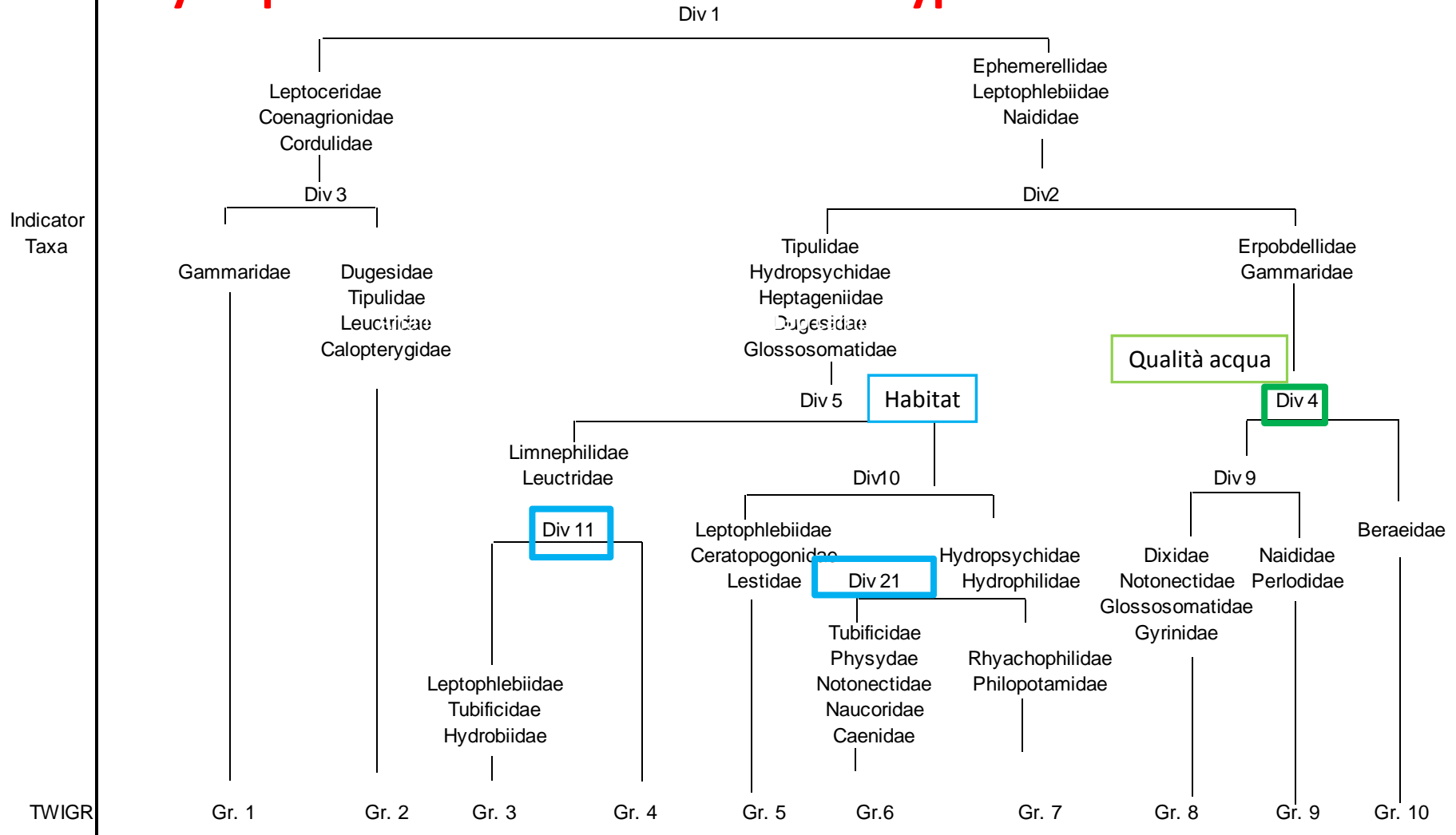


# Natural variability: benthic bio-types in Sardinia

## LRD vs TWINSPAN groups



# Variability at perturbed sites: benthic bio-types in Sardinia

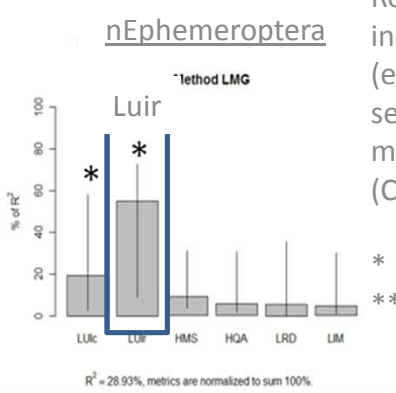
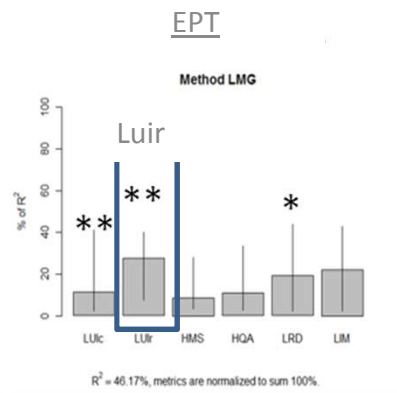
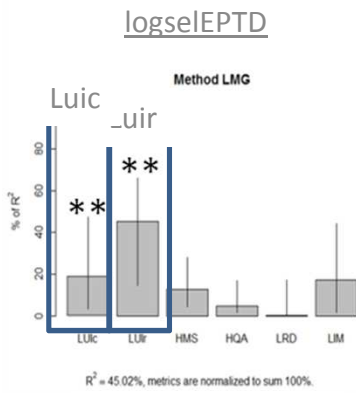
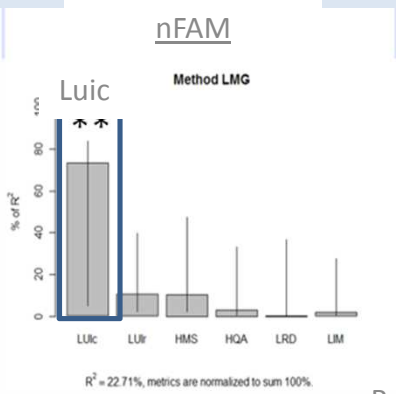
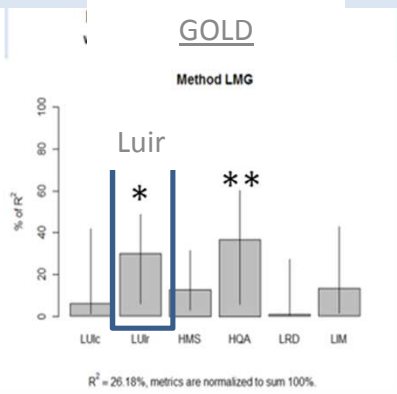
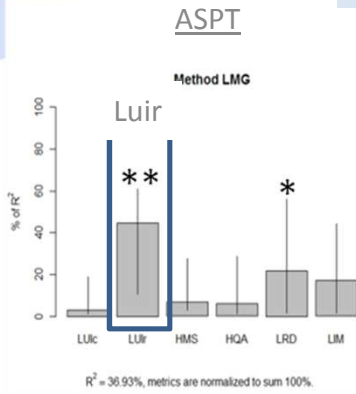


	Gr. 1	Gr. 2	Gr. 3	Gr. 4	Gr. 5	Gr. 6	Gr. 7	Gr. 8	Gr. 9	Gr. 10
<b>LRD</b>	53.8	17.9	25.3	-2.3	14.6	15.7	4.9	1.58	-0.7	-22.6
<b>Altitude</b> (m s. l. m.)	301.6	67.1	71.6	73.4	149.1	65.6	120.2	336.1	387.1	292
<b>Dist. Sorg.</b> (km)	16.56	16.20	9.63	18.06	9.99	12.2	12.02	14.06	14.89	6.22
<b>Largh. Alveo</b> (m)	7.5	18.9	8.7	27.5	10.7	16.7	21.5	8.4	7.5	6.5
<b>Mesohabitat</b>	Pool&Riffle	Pool&Riffle	Pool&Riffle	Riffle	Pool	Pool&Riffle	Riffle	Pool&Riffle	Pool&Riffle	Pool&Riffle
<b>HMS</b>	15	22.8	6.3	31.25	6.7	40.9	15.3	8.6	25.3	0.25
<b>HQA</b>	44.2	53.6	60	51.6	51.3	42.6	50.2	47.4	47.9	67.7
<b>LUI</b>	3.99	2.02	1.15	2.4	0.51	5.83	2.14	1.2	3.74	0.04
<b>LIM</b>	0.71	0.77	0.83	0.82	0.9	0.73	0.95	0.58	0.42	0.86



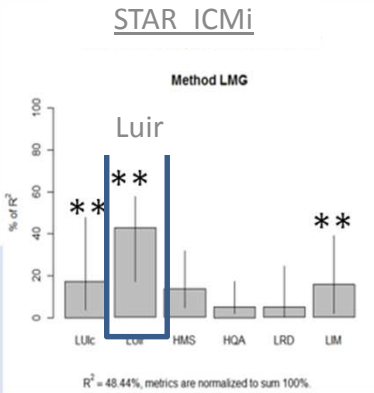
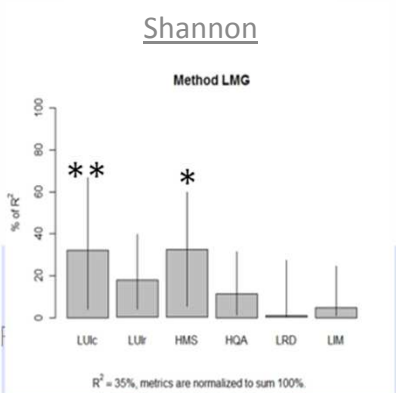
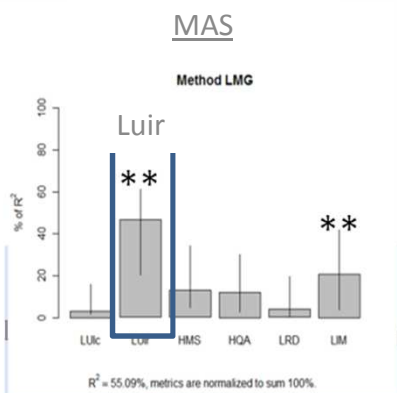
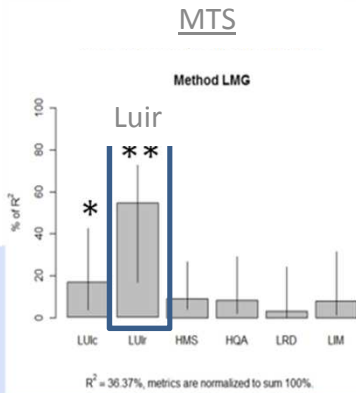


# Habitat and invertebrates (Land use index)



Relative Importance of the individual regressors (environmental indices) in a set of multiple regression: mediterranean rivers (Cyprus); Campioni Pool

\*  $p < 0.05$   
\*\*  $p < 0.01$

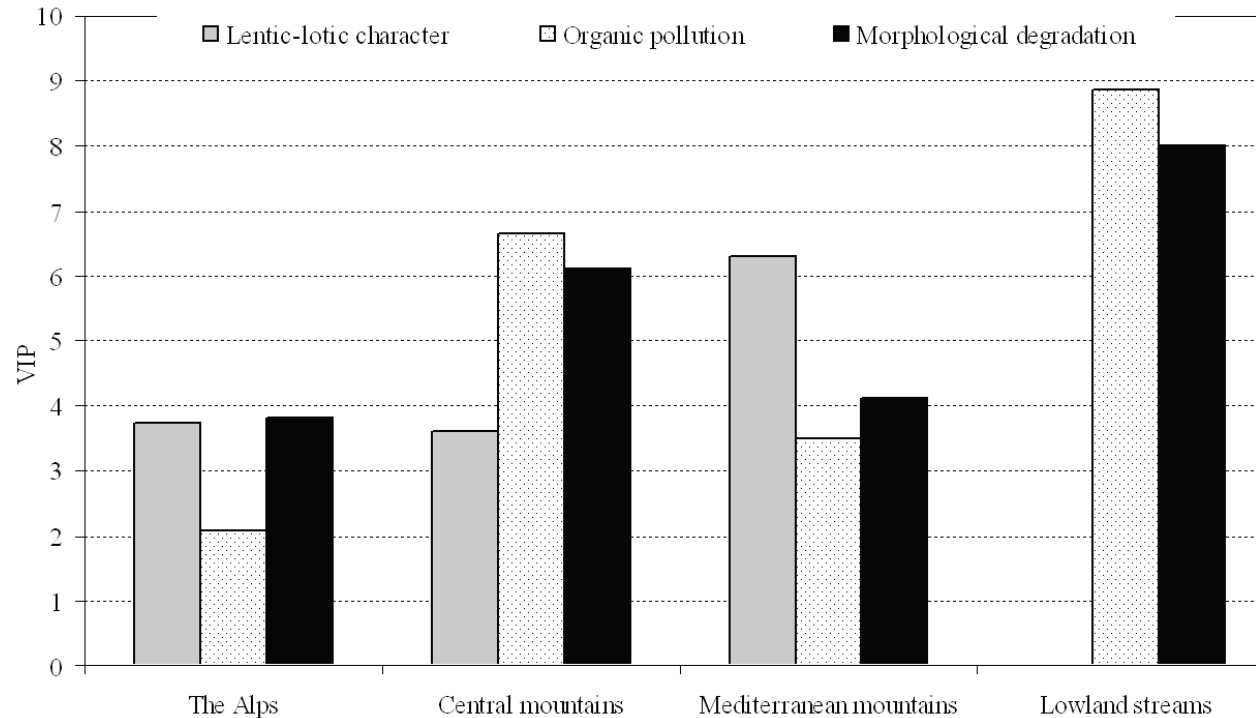


# Habitat information for Ecological status: is that useful??

## INHABIT: the main theme

- Relative importance of different pressures (stressors) in European rivers
- HMS: Morphological degradation; OPD: Physiochemical pollution
- The contribution of the Lentic-lotic River Descriptor (LRD)

Cumulative significance VIP values in the four geographic contexts



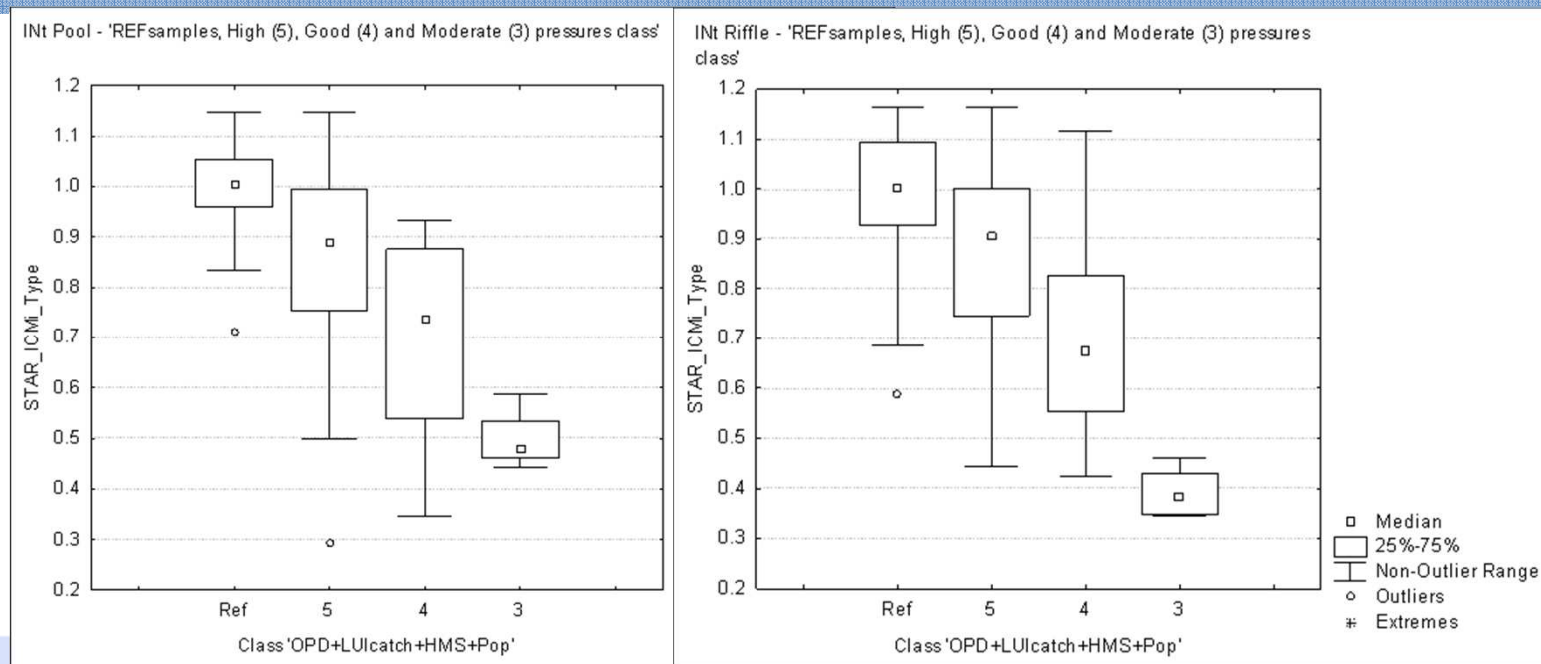
Buffagni A., Erba S. & Armanini D.G. 2010. The lentic-lotic character of Mediterranean rivers and its importance to aquatic invertebrate communities *Aquatic sciences*.



# The contribution of Habitat-oriented methods (1)

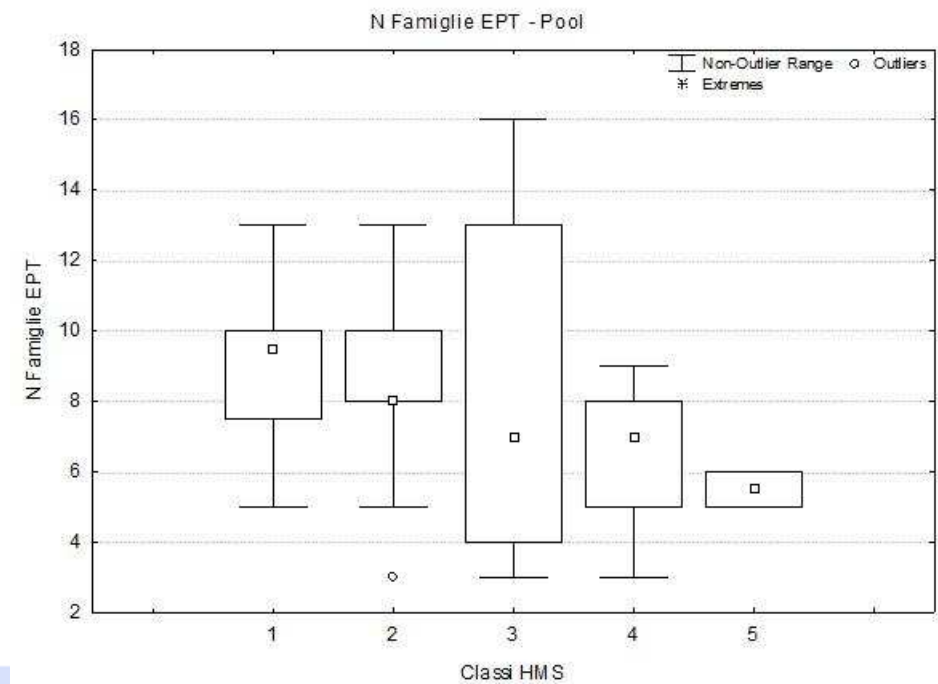
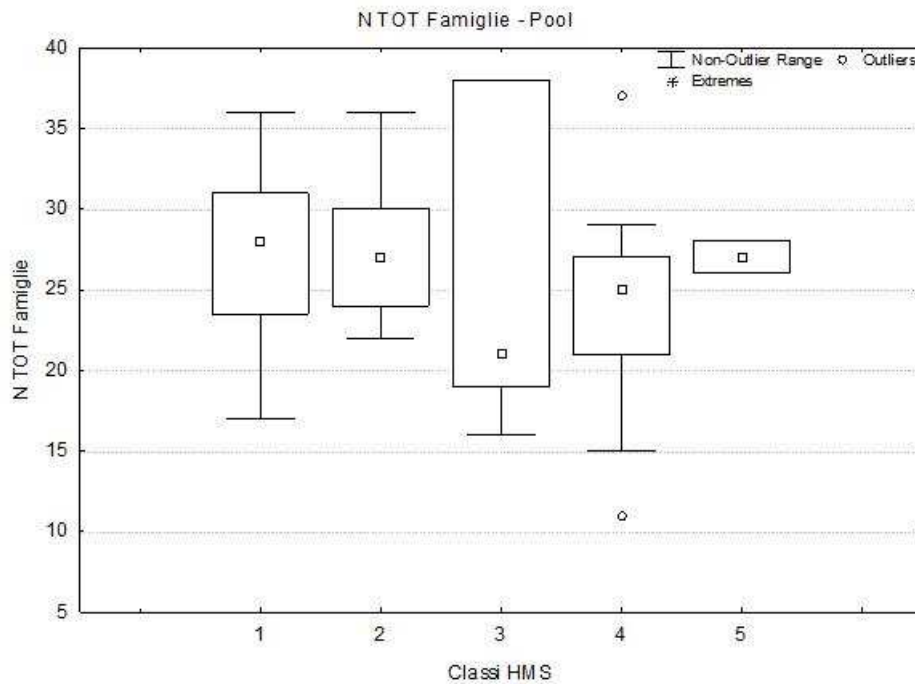
## Quantifying pressures

- Can we implement an ecological assessment system able to detect anthropogenic impact in a hydrological driven environment?
- CARAVAGGIO indices, catchment & water chemistry → Clear separation between pressure classes for STAR\_ICMi in Intermittent river type (INT, CY example, WDD), for both Pools and Riffles





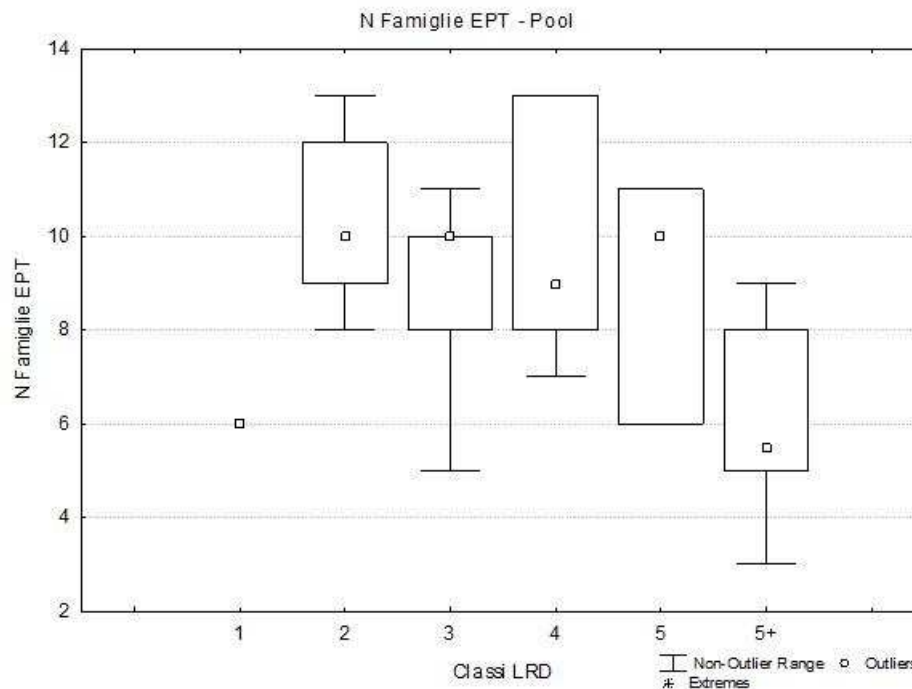
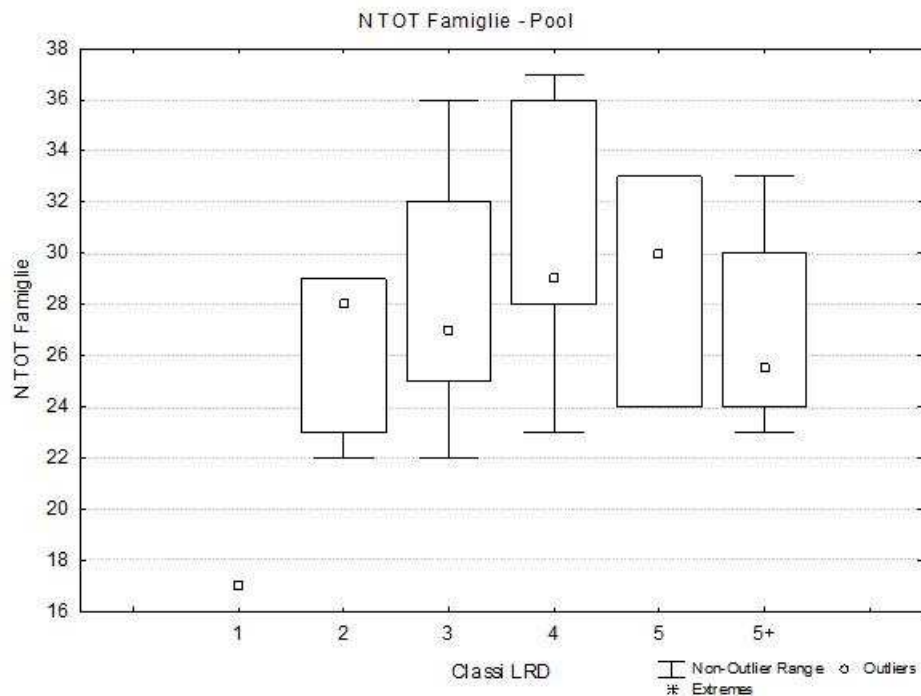
## Assessment of variability in perturbed sites - single pressures vs benthic metrics Sardinia Med rivers

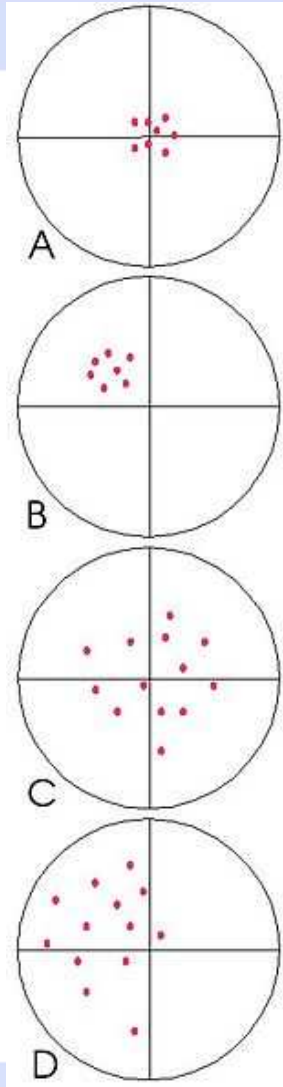




# The contribution of Habitat-oriented methods (2) Quantifying natural variability

## Assessment of natural variability (only REF/slightly perturbed sites), benthic metrics Sardinia Med rivers





**WFD: uncertainty in estimating Ecological Status: what is really relevant?**

**What about 'uncertainty' in defining reference conditions??**

A conceptual example of accuracy and precision of a series of data (red dots).

- A- Precise and accurate
- B- Precise but not accurate
- C- Accurate but imprecise
- D- Not accurate nor precise

[http://it.wikipedia.org/wiki/File:Accuracy\\_and\\_precision\\_example.jpg](http://it.wikipedia.org/wiki/File:Accuracy_and_precision_example.jpg)

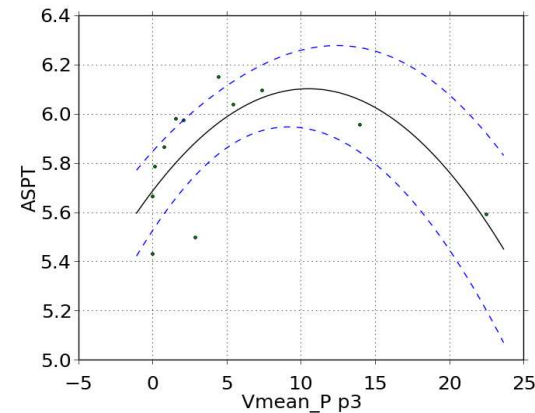
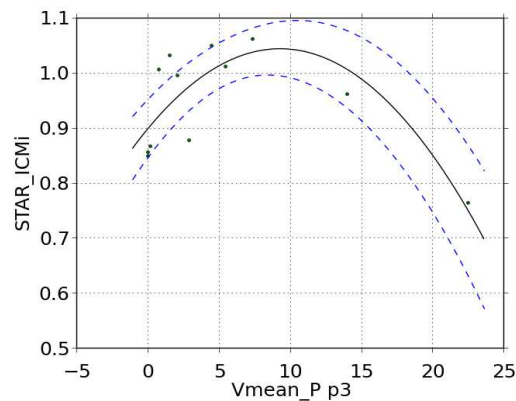


# Influence of habitat on invertebrate metrics:

## Water Velocity (local)

STAR_ICMi	ASPT	n_FAM <sup>2</sup>	n_EPT <sup>2</sup>	1-GOLD <sup>3</sup>	Shannon	log(SelEPTD+1)
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		STAR_ICMi	n samples/group=6						
'Pool' mesohabitat / Sardinia REF&slightly perturbed sites (REF RAS)			0.126	0.259	0.675	0.342	0.790	0.151	0.757
			NS	NS	NS	NS	NS	NS	NS
			4.478	2.2	0.4	1.6	0.3	3.8	0.3
		all samples (n=36)	0.58	0.32	-0.28	0.19	-0.42	0.53	-0.38
			-2.9	-0.7	-0.1	0.4	-1.2	-1.7	0.7
			1.6	3.2	3.9	4.3	0.2	2.2	0.5
V_mean ('Pool' mesohabitat sar)	p	0.022	0.009	0.058	0.232	0.081	0.336	0.113	0.193
	sl	*	**	(*)	NS		NS	NS	NS
	F	4.3	8.3	4.0	1.7	3.4	1.2	2.8	2.0



25	0.15
.5	1.2
.0	1.7

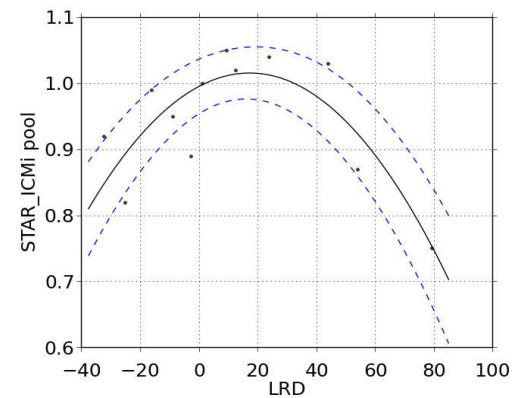
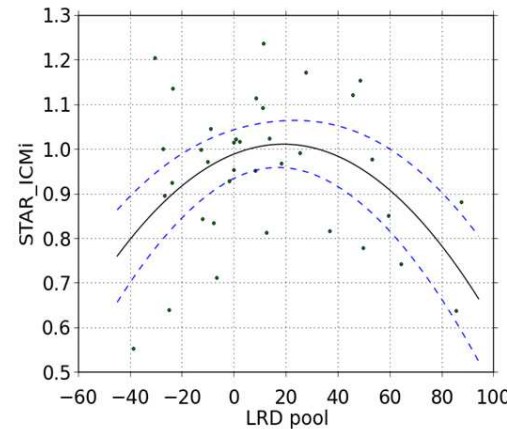


# Influence of habitat on invertebrate metrics:

## LRD (river stretch)

STAR_ICMi	ASPT	n_FAM <sup>2</sup>	n_EPT <sup>2</sup>	1-GOLD <sup>3</sup>	Shannon	log(SelEPTD+1)
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		STAR_ICMi	n samples/group=6						
'Pool' mesohabitat / Sardinia REF&slightly perturbed sites (REF RAS)		STAR_ICMi	0.048	<b>0.017</b>	0.045	<b>0.003</b>	<b>0.020</b>	0.342	<b>0.060</b>
			*	*	*	***	*	NS	(*)
			9.9	<b>20.9</b>	10.3	<b>71.6</b>	<b>19.1</b>	1.6	<b>8.3</b>
		all samples (n=36)	0.78	0.89	0.79	0.97	0.88	0.18	0.74
			-3.2	-2.4	-1.1	-2.9	-3.6	-1.1	-1.5
			3.1	8.7	9.2	24.5	5.3	1.5	5.6
LRD <sup>1</sup> (Reach scale, 500 m)	p	0.025	<b>0.006</b>	0.066	<b>0.002</b>	0.006	0.223	0.319	0.222
	sl	*	**	(*)	***	**	---	---	NS
	F	4.1	<b>9.8</b>	3.	0.3	-0.	45.		



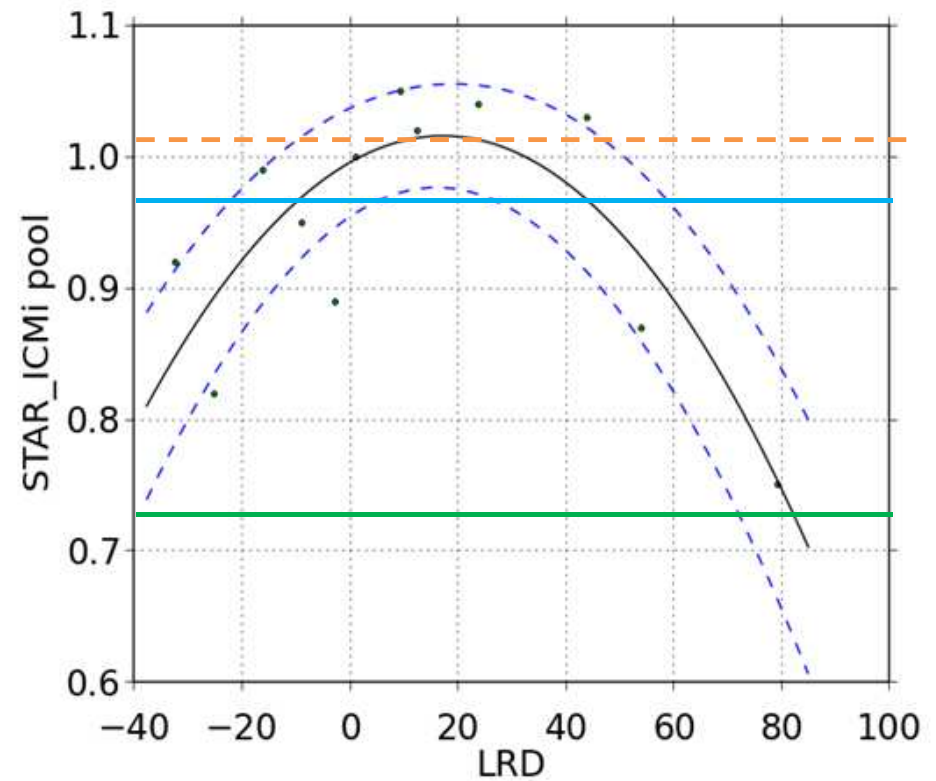




## What about accuracy in Ecological Status classification ??

REF value  
STAR\_ICMi: 1.019

Class boundaries (Italy – R-M5)  
HG: 0.97  
GM: 0.73

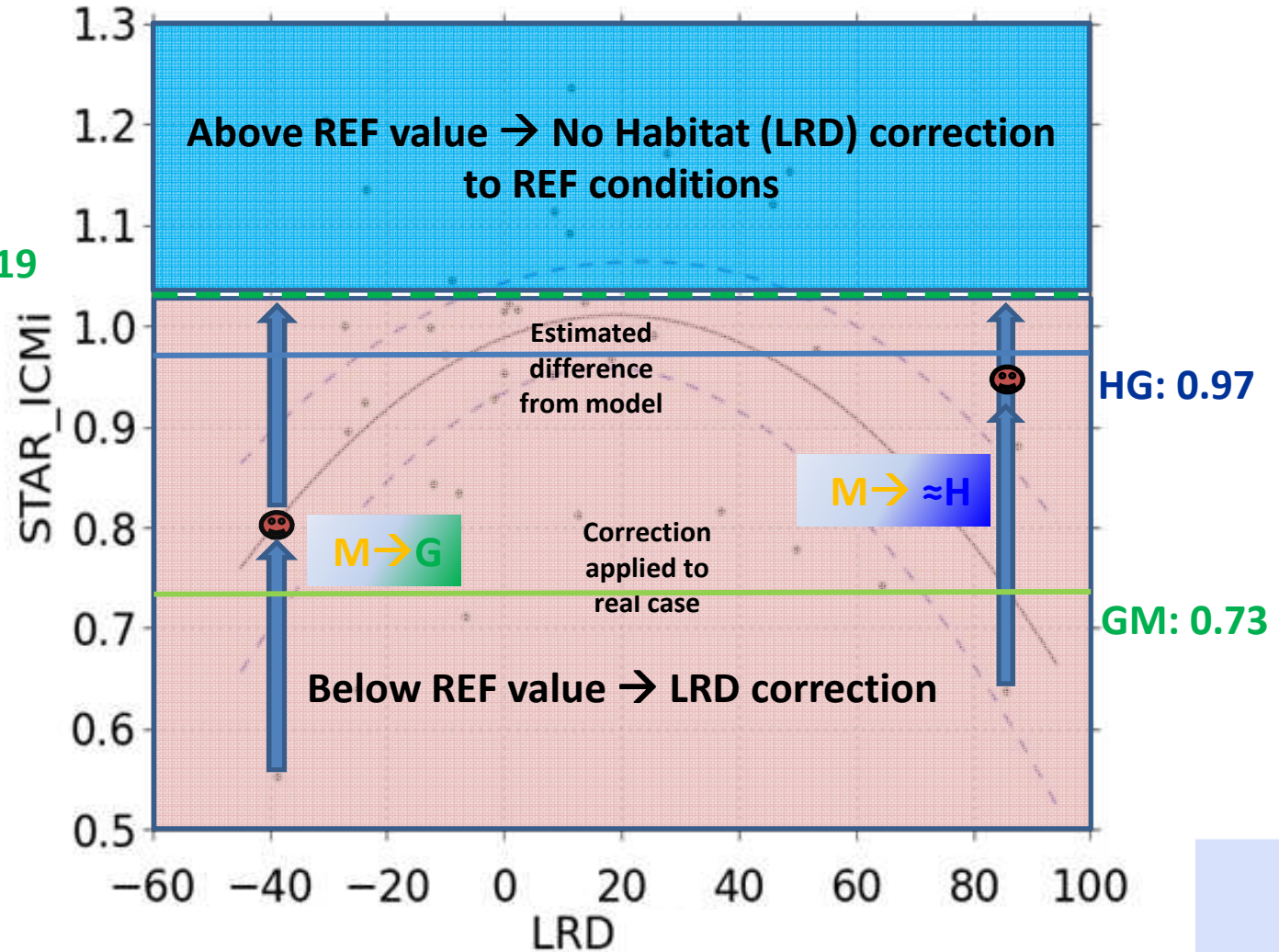




## Direct use of Habitat information Case 1a – Modeling reference conditions

No (significant) water abstraction upstream/flow increase

REF value  
STAR\_ICMi: 1.019



e.g. different sites in the same area, type, season, year

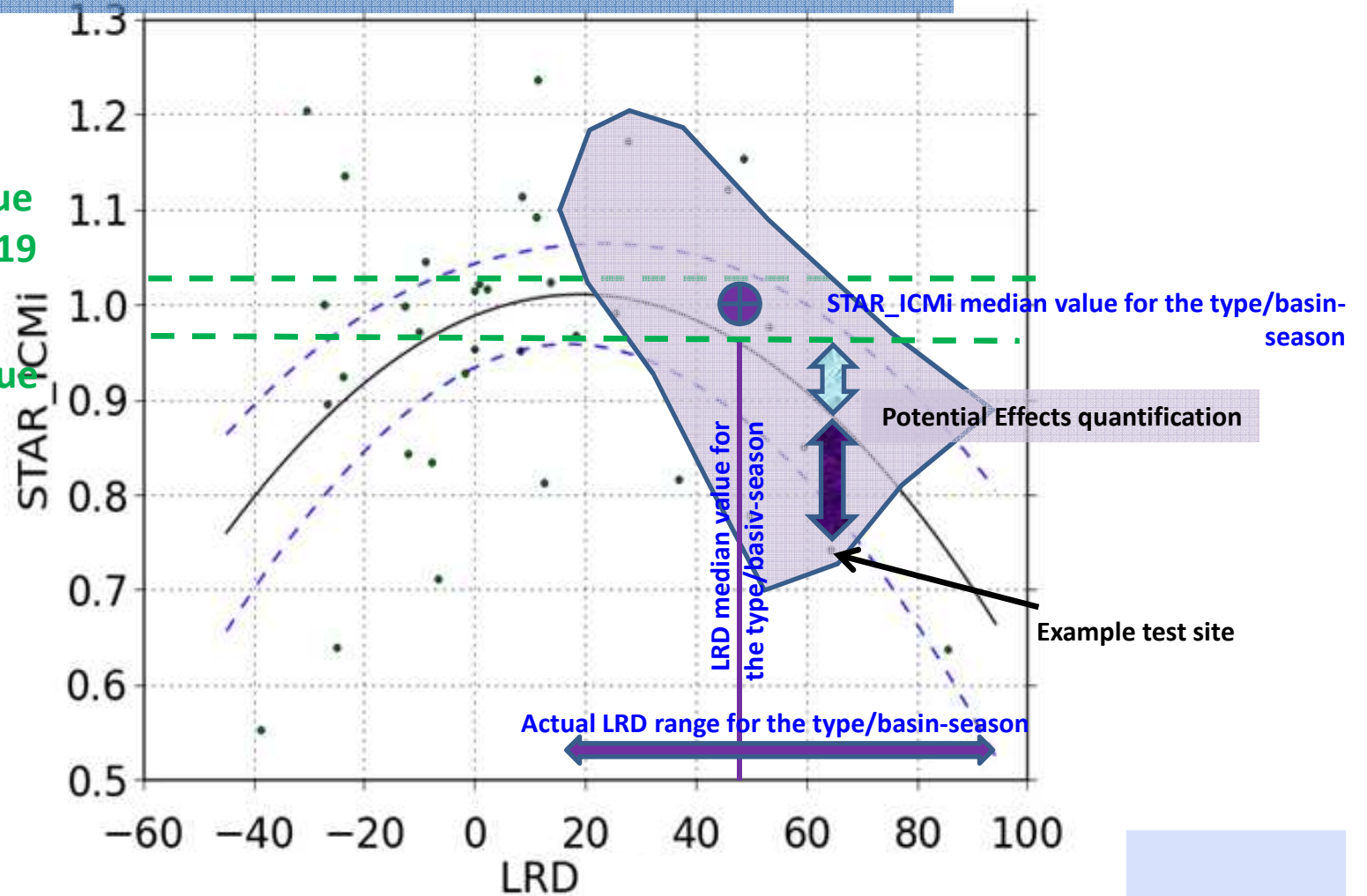


# Direct use of Habitat information

## Case 1b – Refining Reference conditions (type/season/site adjusted) & Assessing Impacts

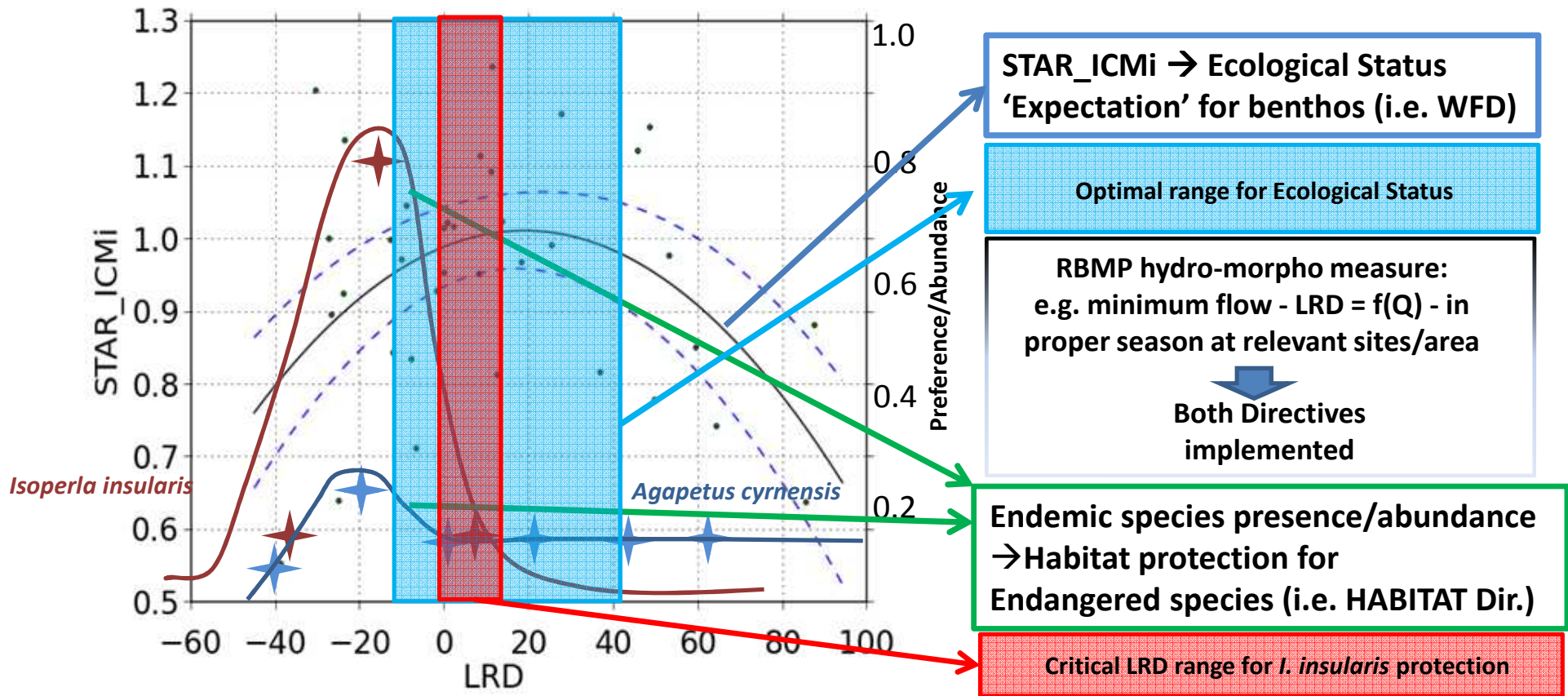
Overall REF value  
STAR\_ICMi: 1.019

Refined REF value  
STAR\_ICMi:  
e.g. 0.970





**Direct use of Habitat information**  
**Case 4 – Habitat is a bridge between the WFD and the Habitat Directive..**





# Some INHABIT conclusions – Habitat biota issue

- River typologies in Med rivers very weak.
- Influence of Habitat features on communities very strong.
- Lentic-lotic character accounting for general trends in benthic metrics and classification indices.
- Accuracy of present methods for Ecological Status classification potentially very poor.
- Corrections to classification systems possible (and needed!), based on habitat information.
- Simple functions defined e.g. Metrics  $f(\text{LRD})$ .
- REF conditions refined (for whole areas, types, seasons, etc.).
- Potential effects of water abstraction estimated.
- Habitat as a 'bridge' between the WFD and the HABITAT Directive.  
→ Links to hydrology to be more explicitly defined

Thanks for your attention!!

