

L'habitat come metrica per quantificare l'impatto delle alterazioni idro-morfologiche

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Trento, VaW-ETH Zurich, Rushing Rivers
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L'habitat come metrica per quantificare l'impatto delle alterazioni idro-morfologiche

La descrizione dell'idro-morfologia locale e delle sue relazioni con le comunità biotiche è necessaria al fine di quantificare l'habitat disponibile e fornire strumenti che valutino gli impatti delle alterazioni sia idrologiche che morfologiche.



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L'habitat come metrica per quantificare l'impatto delle alterazioni idro-morfologiche

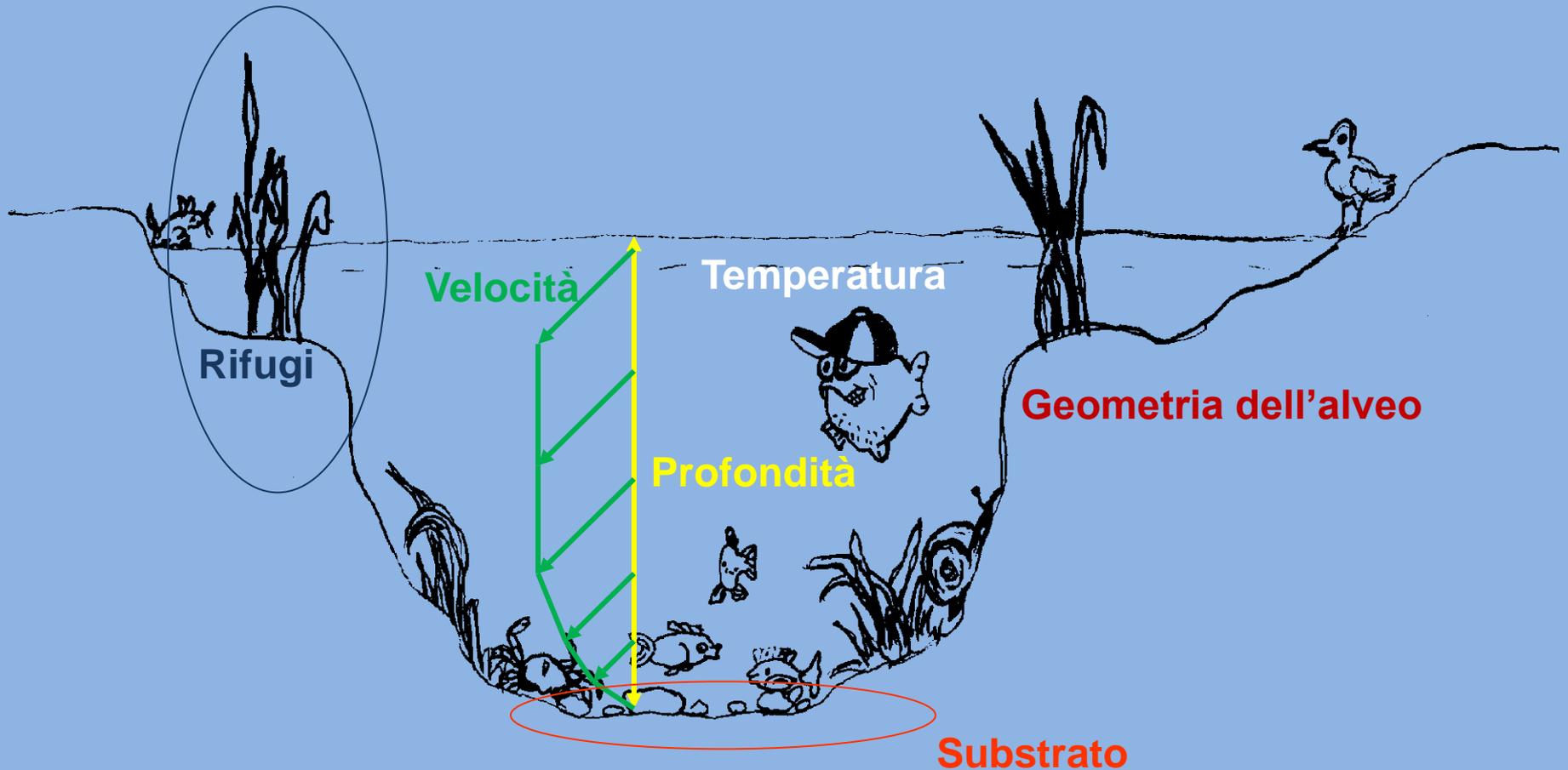
L'habitat è definito come “l'insieme di risorse e condizioni presenti in un'area che generano la presenza in termini di utilizzo, sopravvivenza e riproduzione di un determinato organismo” (Hall et al., 1997)

Quantificare l'habitat come metrica nella gestione ambientale dei corsi d'acqua permette di unire i mondi di:

- 1 - idraulica/idrologia (fluidodinamica, regime di deflusso);
- 2 - morfologia fluviale (geometria alveo, forme, substrati);
- 3 - biologia (comunità acquatiche e ripariali)

L'habitat, misurato tramite parametri fisici, può essere utilizzato come proxy per quantificare l'impatto sulle comunità biotiche, specialmente quando gli indicatori biologici presentano limitazioni o criticità (ad es., variazione naturale della popolazione, assenza della comunità target, ripopolamenti, introduzione di specie alloctone)

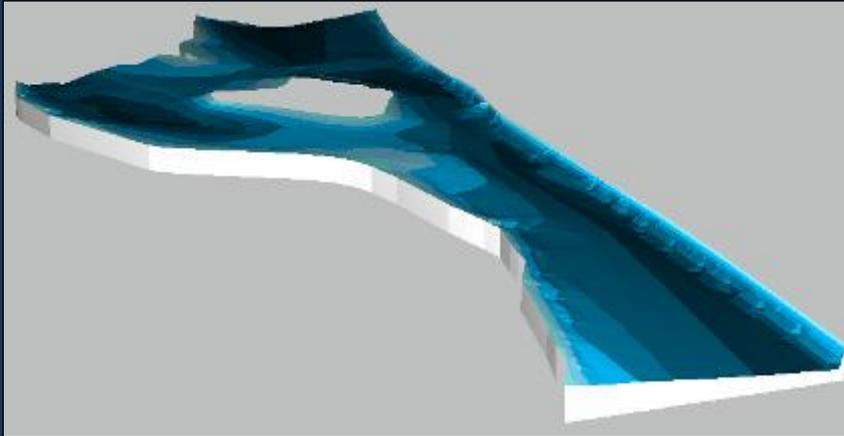
L'habitat come metrica per quantificare l'impatto delle alterazioni idro-morfologiche



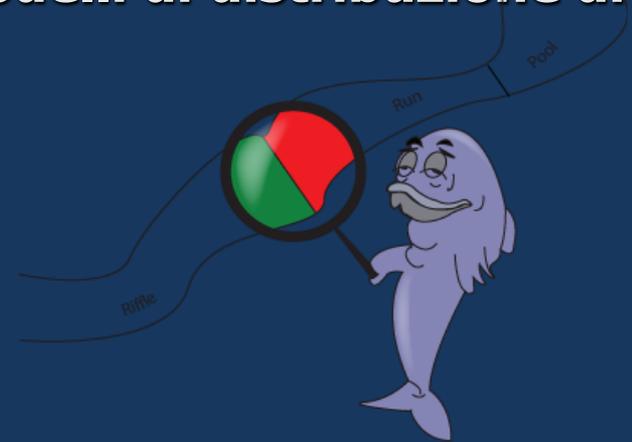
La variazione spazio-temporale di queste variabili fisiche rappresenta le risorse in termini di HABITAT, può essere quantificata e ne può essere misurata la deviazione rispetto a delle condizioni di riferimento.

Modelli di simulazione dell'habitat

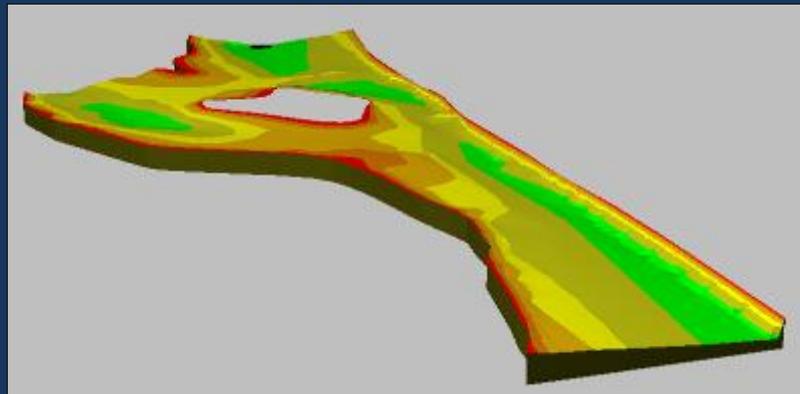
Idro-morfologia locale



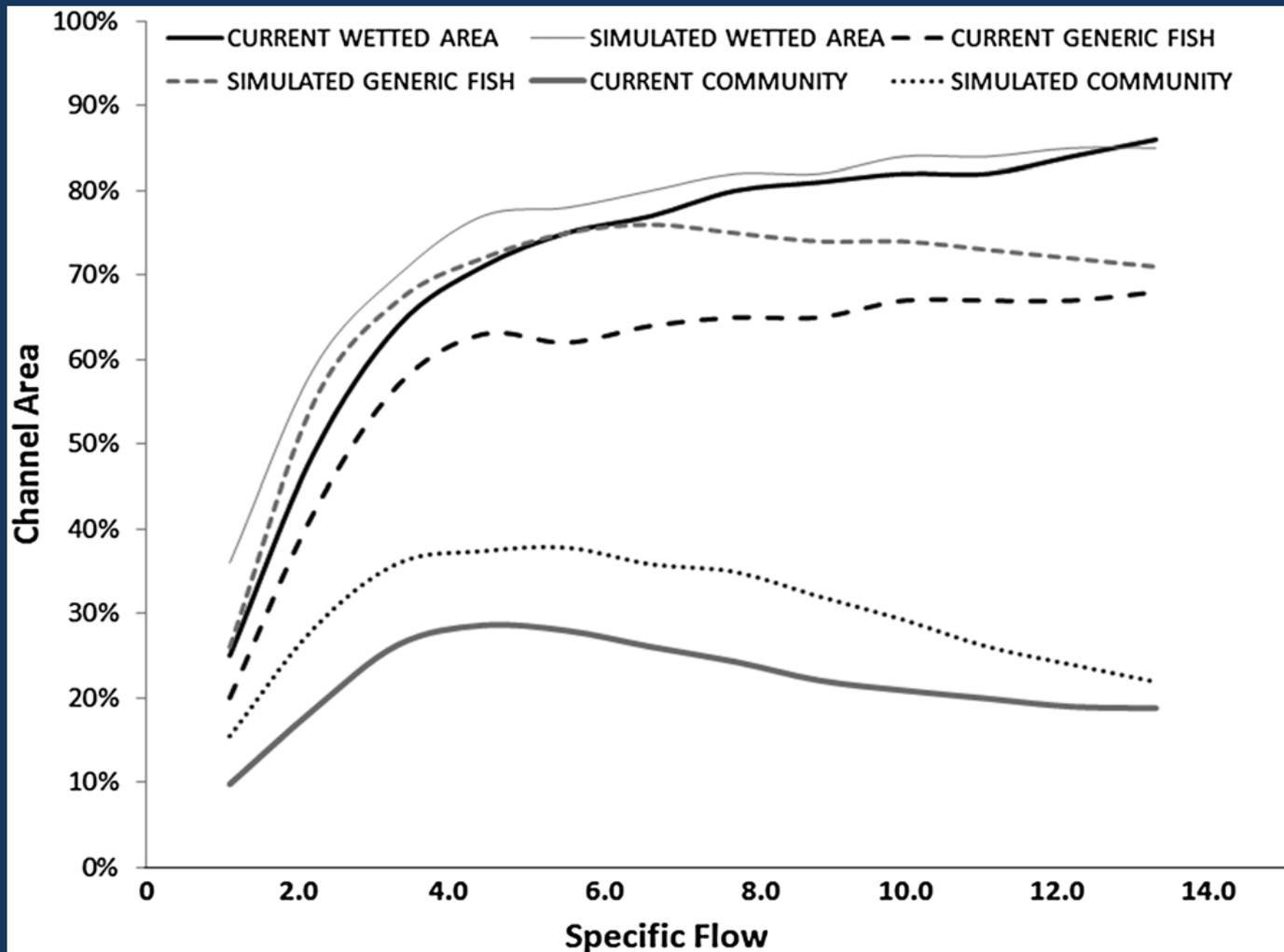
Modelli di distribuzione di specie



Quantificazione della variazione spazio-temporale dell'HABITAT



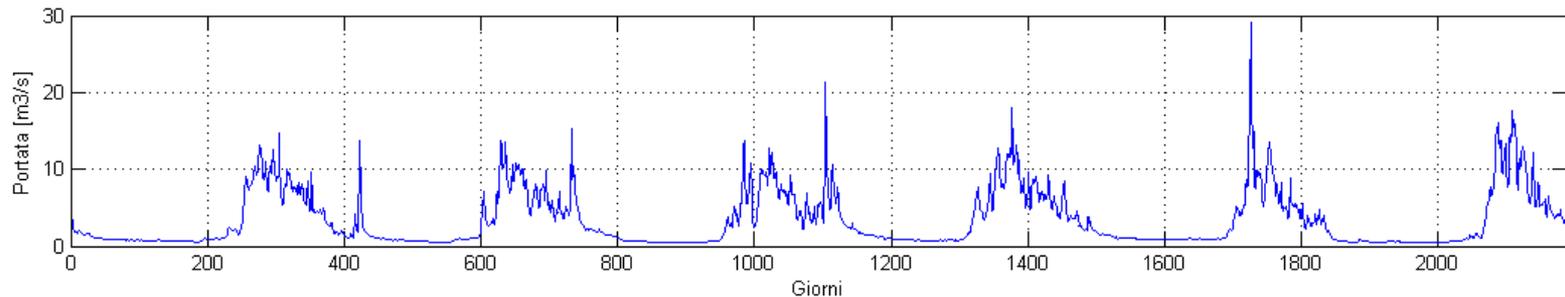
Relazione habitat - portata



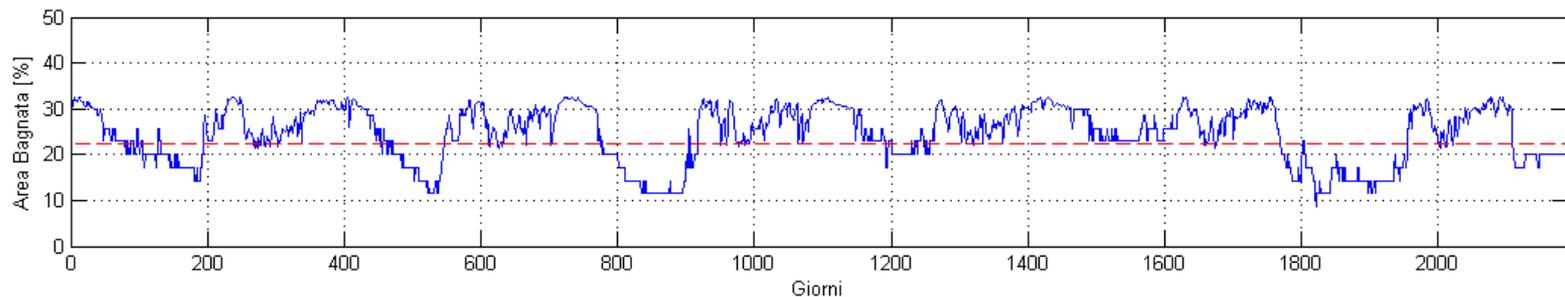
(Parasiewicz et al. 2012, Ecohydrology)

Analisi delle serie temporali

Serie storiche di portata



Serie storiche di habitat (ad es., *Salmo trutta* Ad.)



Indici di integrità spazio-temporale dell'habitat

Abbiamo proposto due indici di habitat:

I_{HQ} – Habitat Quantity Index

$$I_{HQ} = \min \left(1 - \frac{|A_{Qmode,r} - A_{Qmode}|}{A_{Qmode,r}} \right)_{species}$$

I_{HSD} – Habitat Stress Days Index

$$i_{SDA} = \frac{1}{d_{max,r}} \cdot \sum_{k=1}^{k=d_{max,r}} \left(\frac{|d_{c,AQ97} - d_{c,r,AQ97}|}{d_{c,r,AQ97}} \right)$$

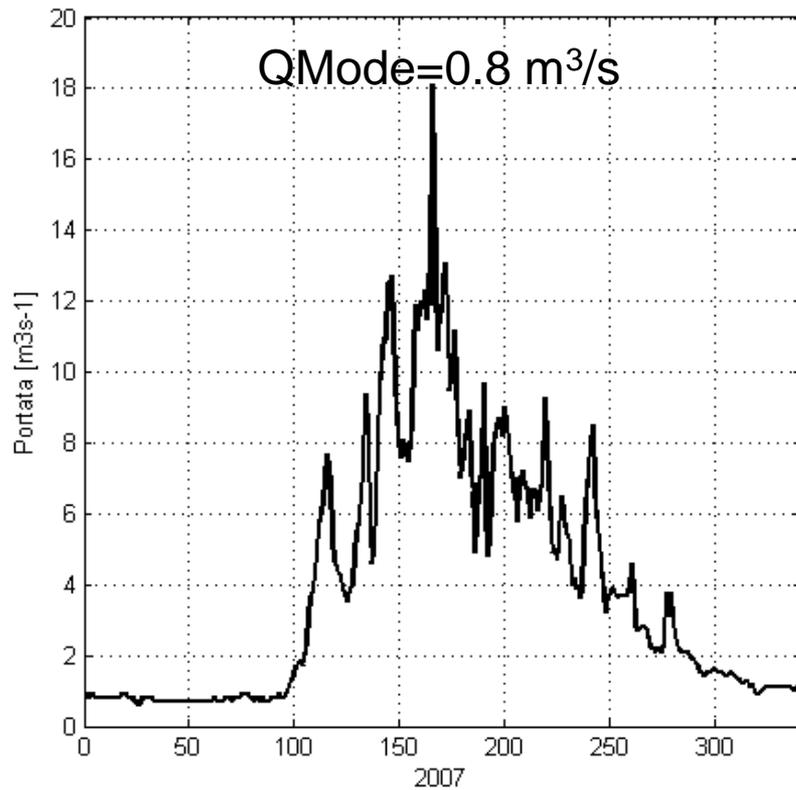
$$I_{HSD} = \min \left(e^{-0.38i_{SDA}} \right)_{species}$$

(Parasiewicz et al. 2012, Ecohydrology; Veza et al. 2014, IAEG)

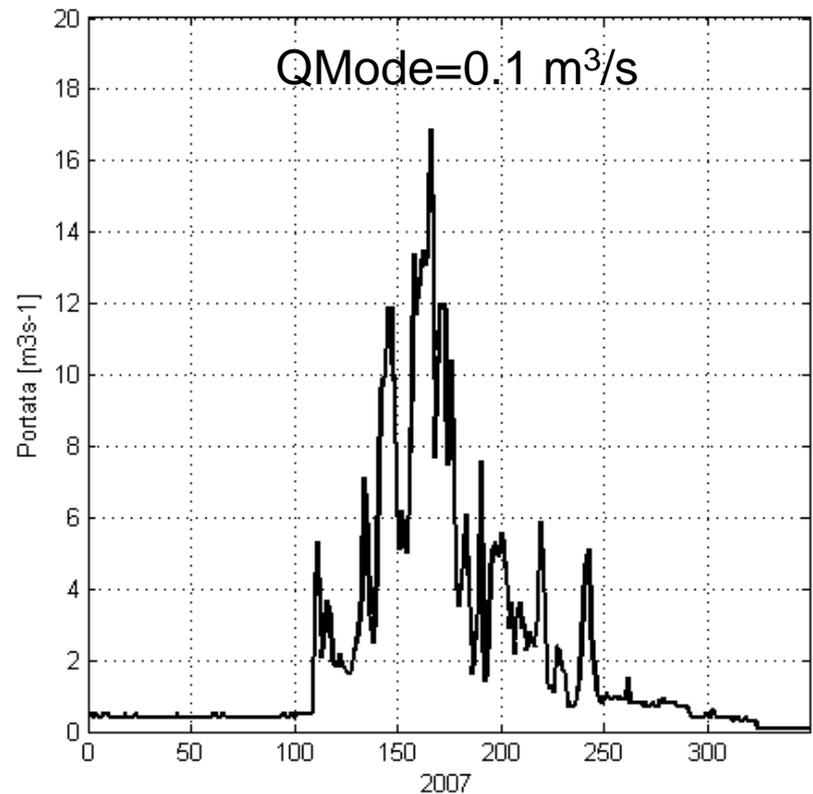
T. Savara - Molere (Aosta)

Serie di portata – Anno 2007

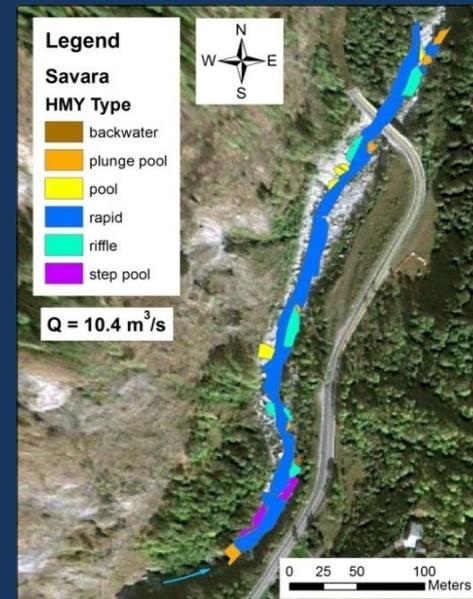
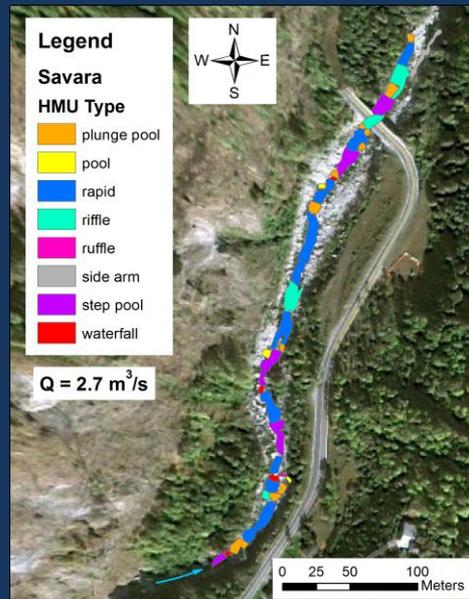
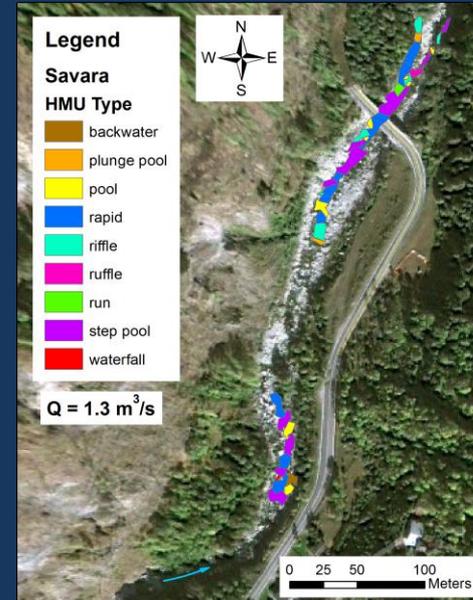
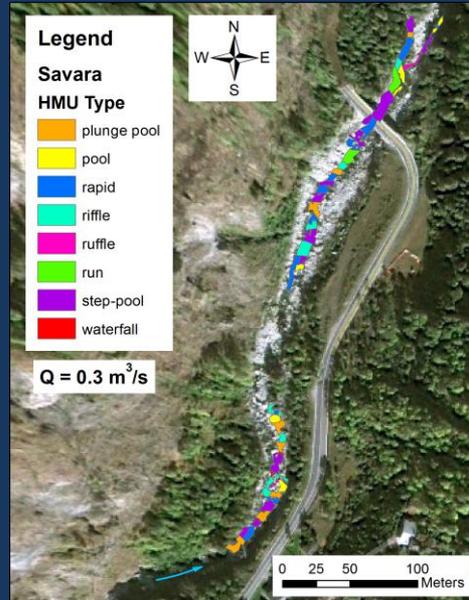
Monte (riferimento)



Valle (alterazione)



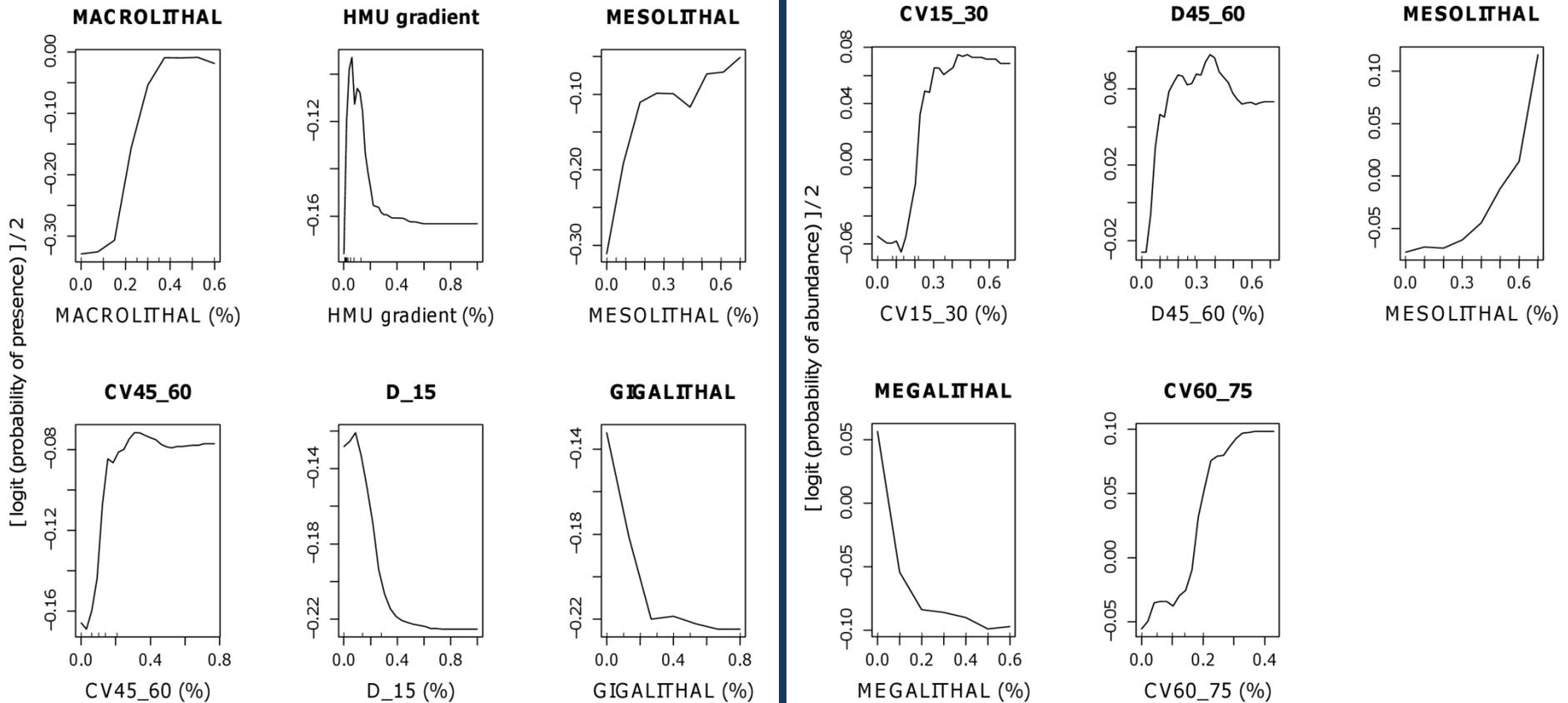
Mappatura del mosaico di mesohabitat



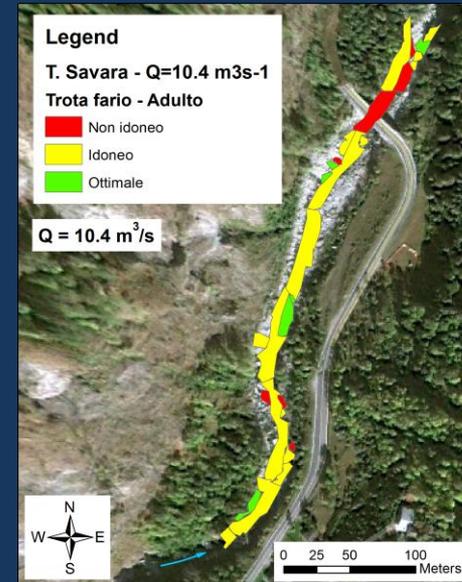
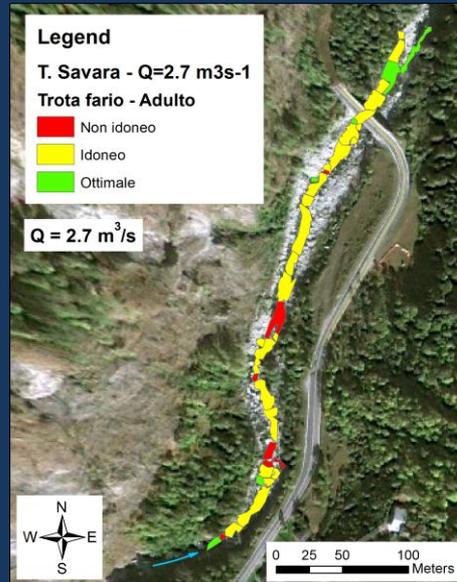
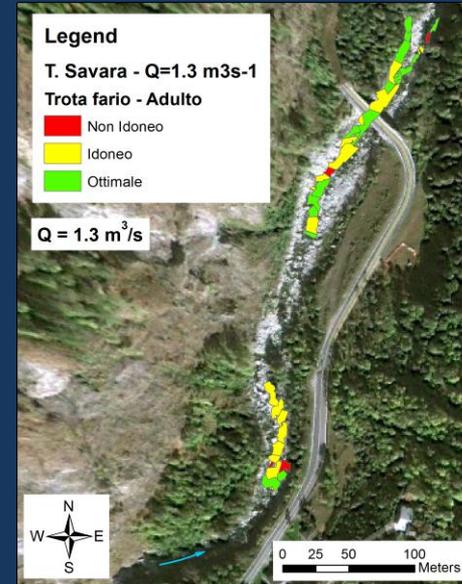
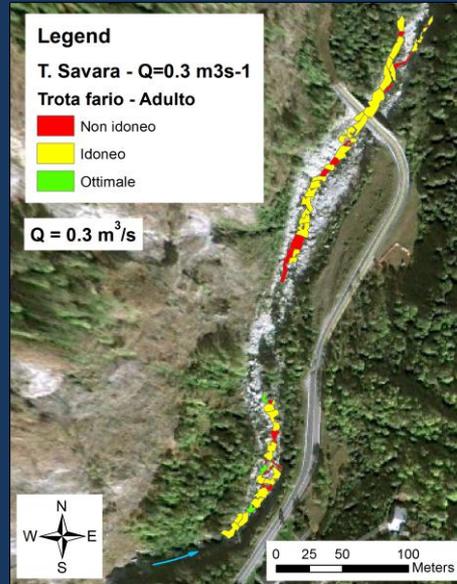
(Veza et al. 2014, Ecological Applications)

Modelli di distribuzione di specie

Salmo trutta Ad. – Random Forests

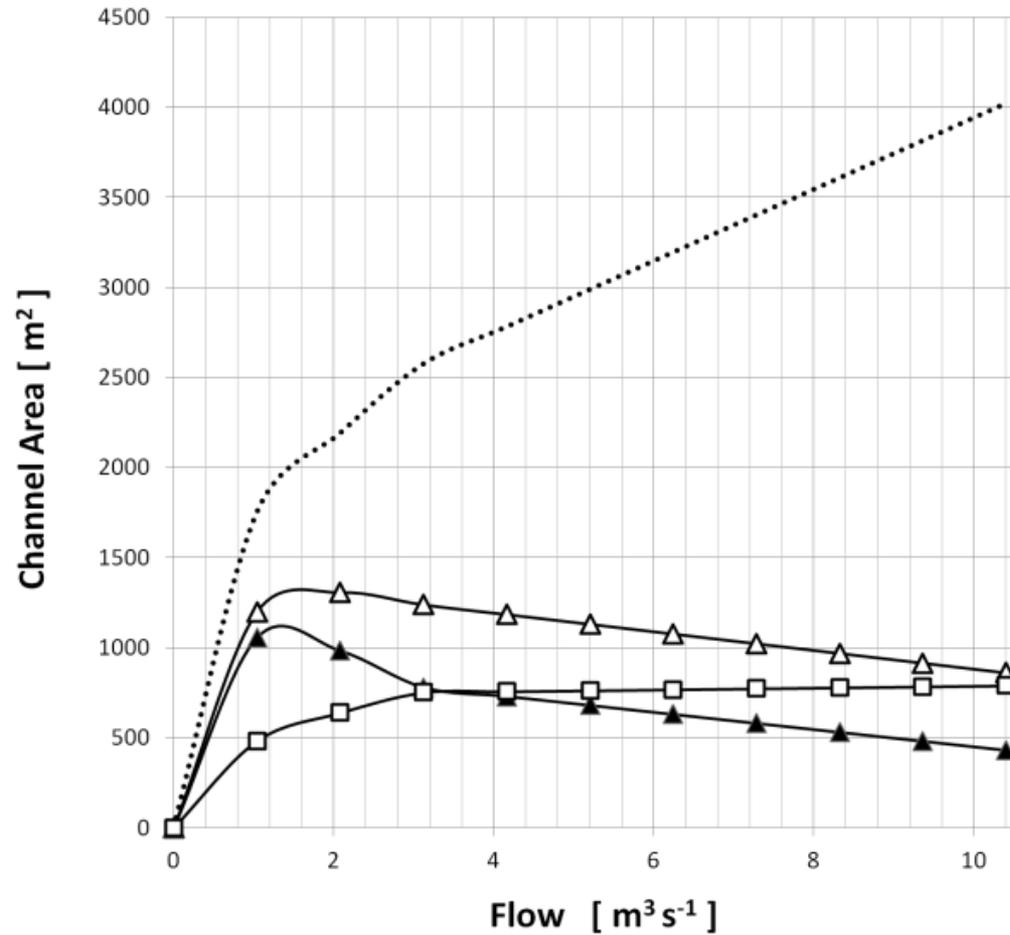


Mappe di idoneità dell'habitat



Relazione habitat - portata

Case #1: Habitat-Flow Rating Curve



..... Wetted Area

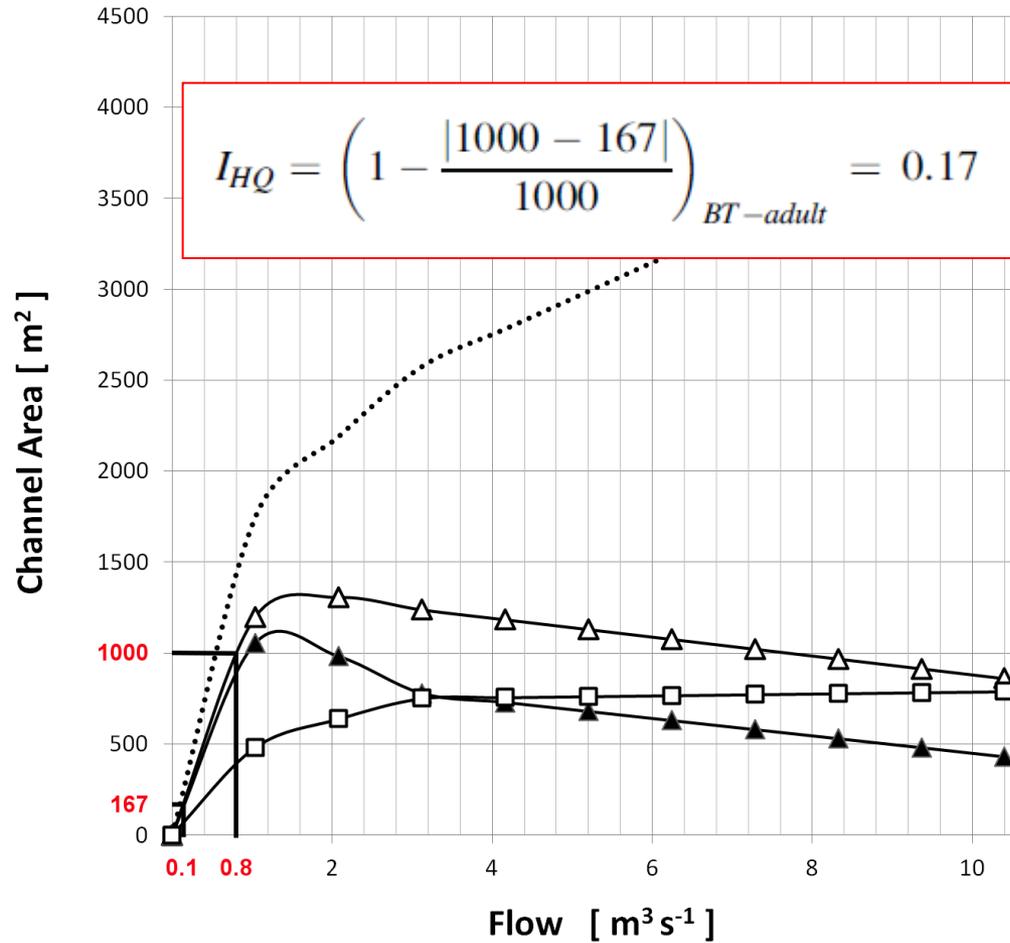
△ Brown trout - Adult

▲ Trout sp. - Juvenile

□ Marble trout - Adult

I_{HQ} – Habitat Quantity Index

Case #1: Habitat-Flow Rating Curve



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—△— Brown trout - Adult

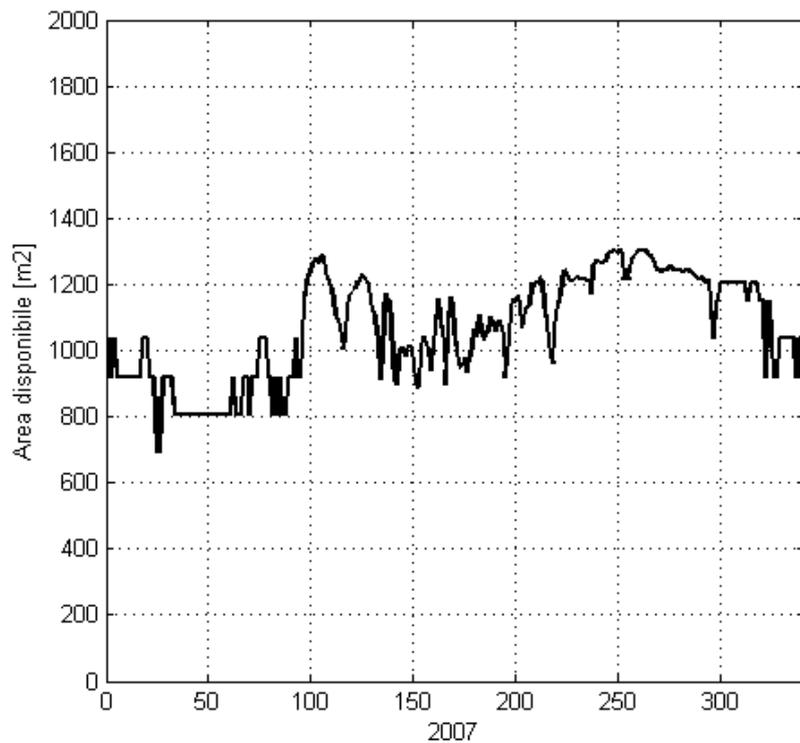
—▲— Trout sp. - Juvenile

—□— Marble trout - Adult

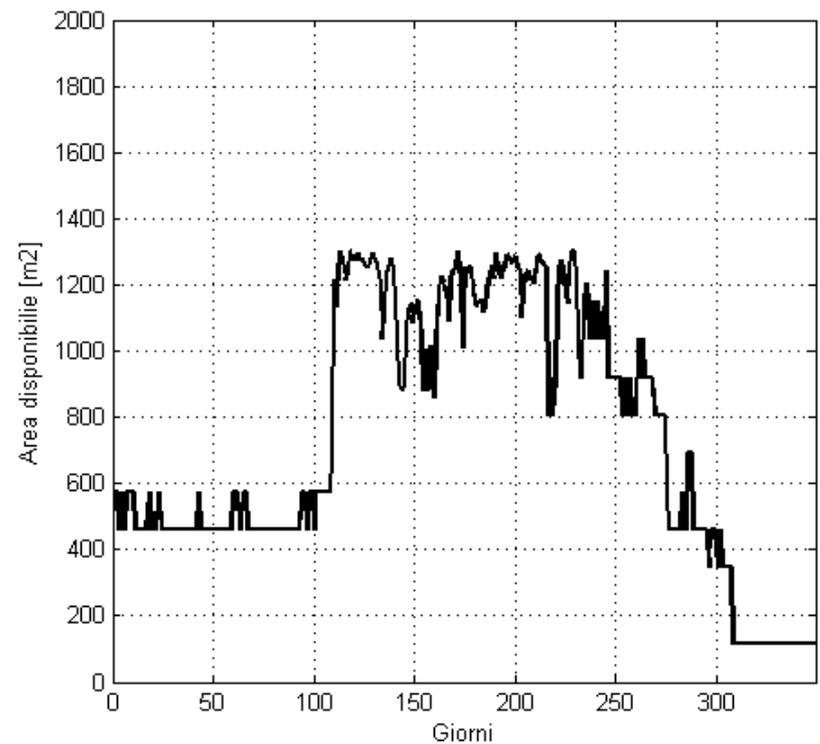
T. Savara - Molere (Aosta)

Serie storiche di habitat - Anno 2007

Monte (riferimento)



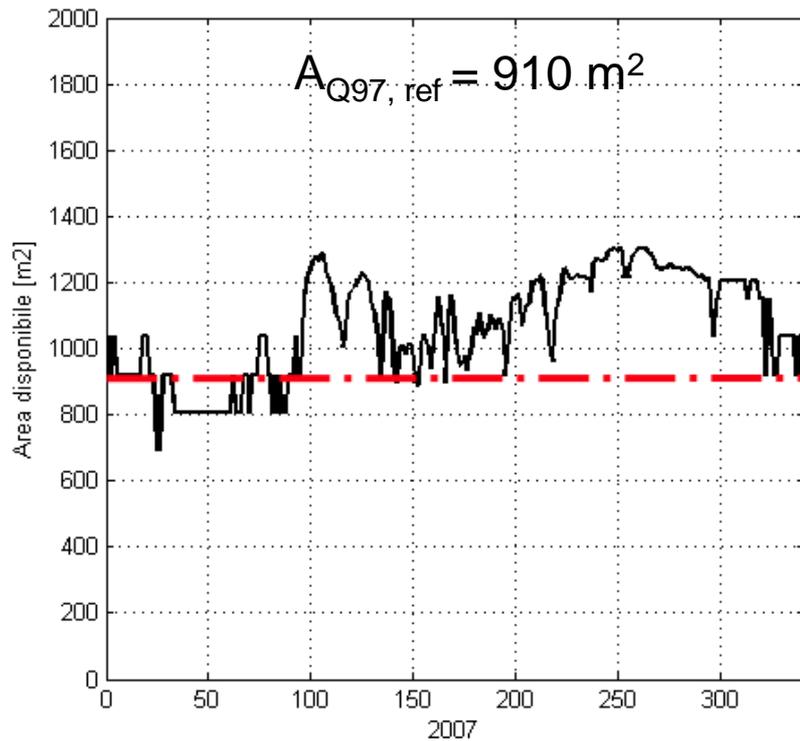
Valle (alterazione)



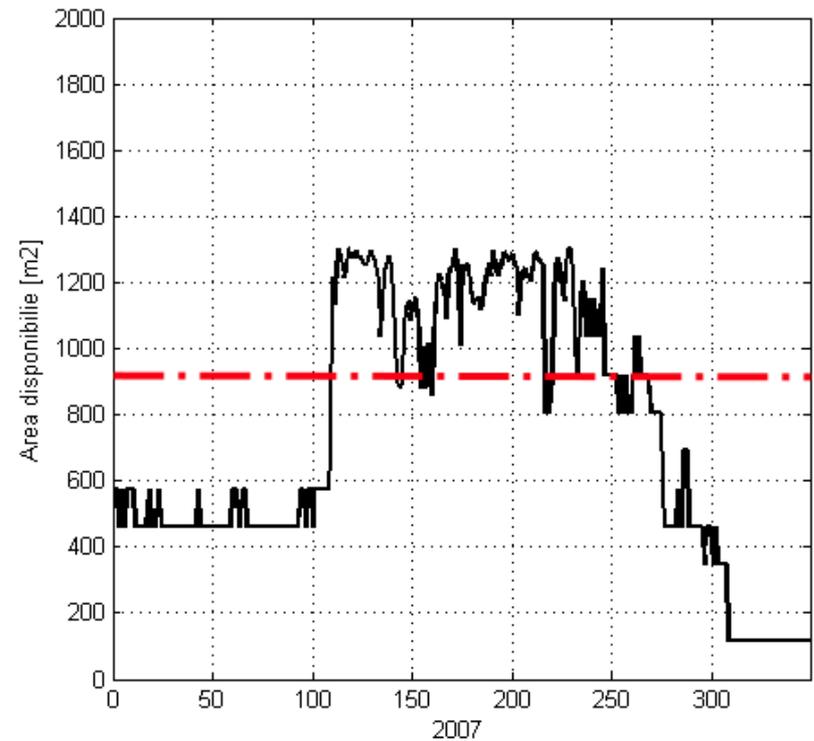
T. Savara - Molere (Aosta)

Serie storiche di habitat - Anno 2007

Monte (riferimento)



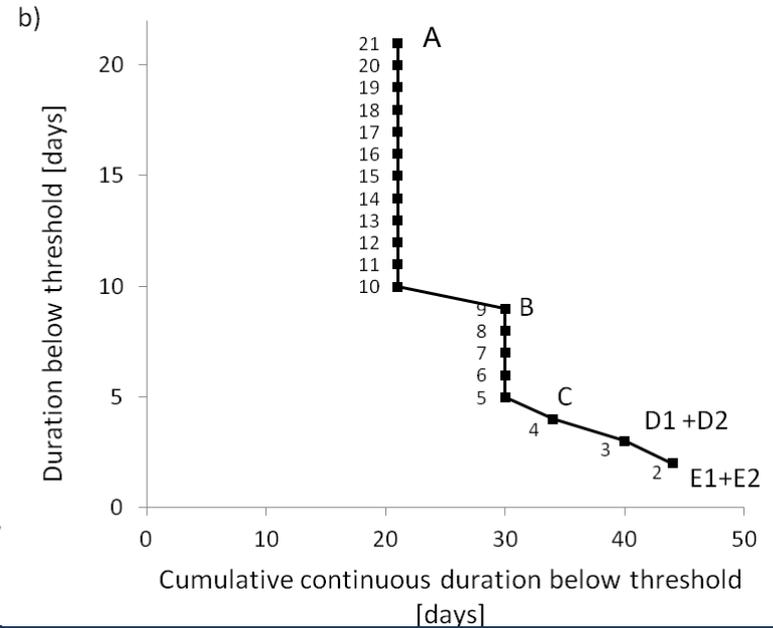
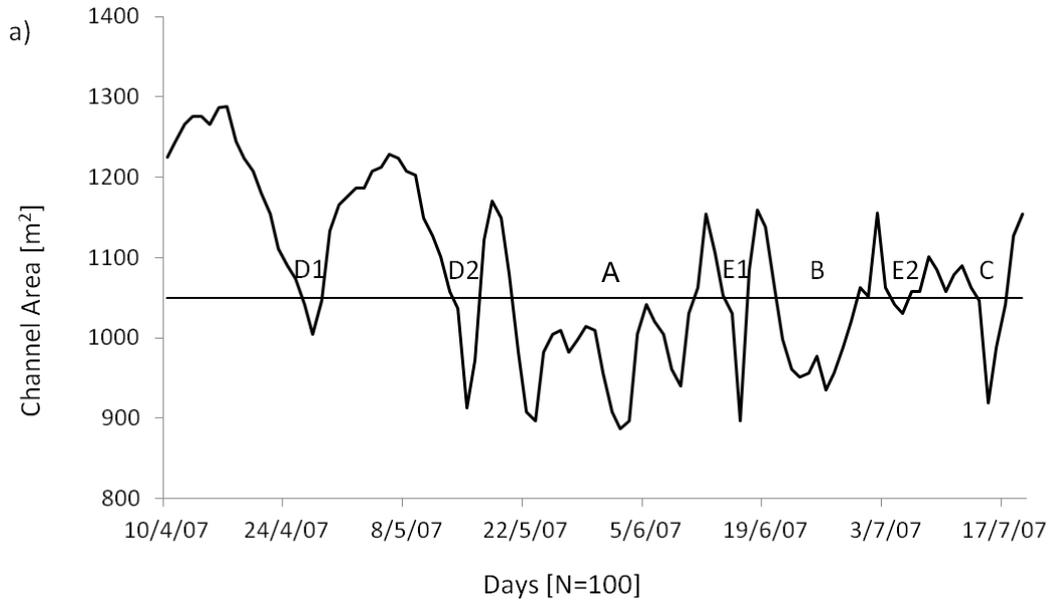
Valle (alterazione)



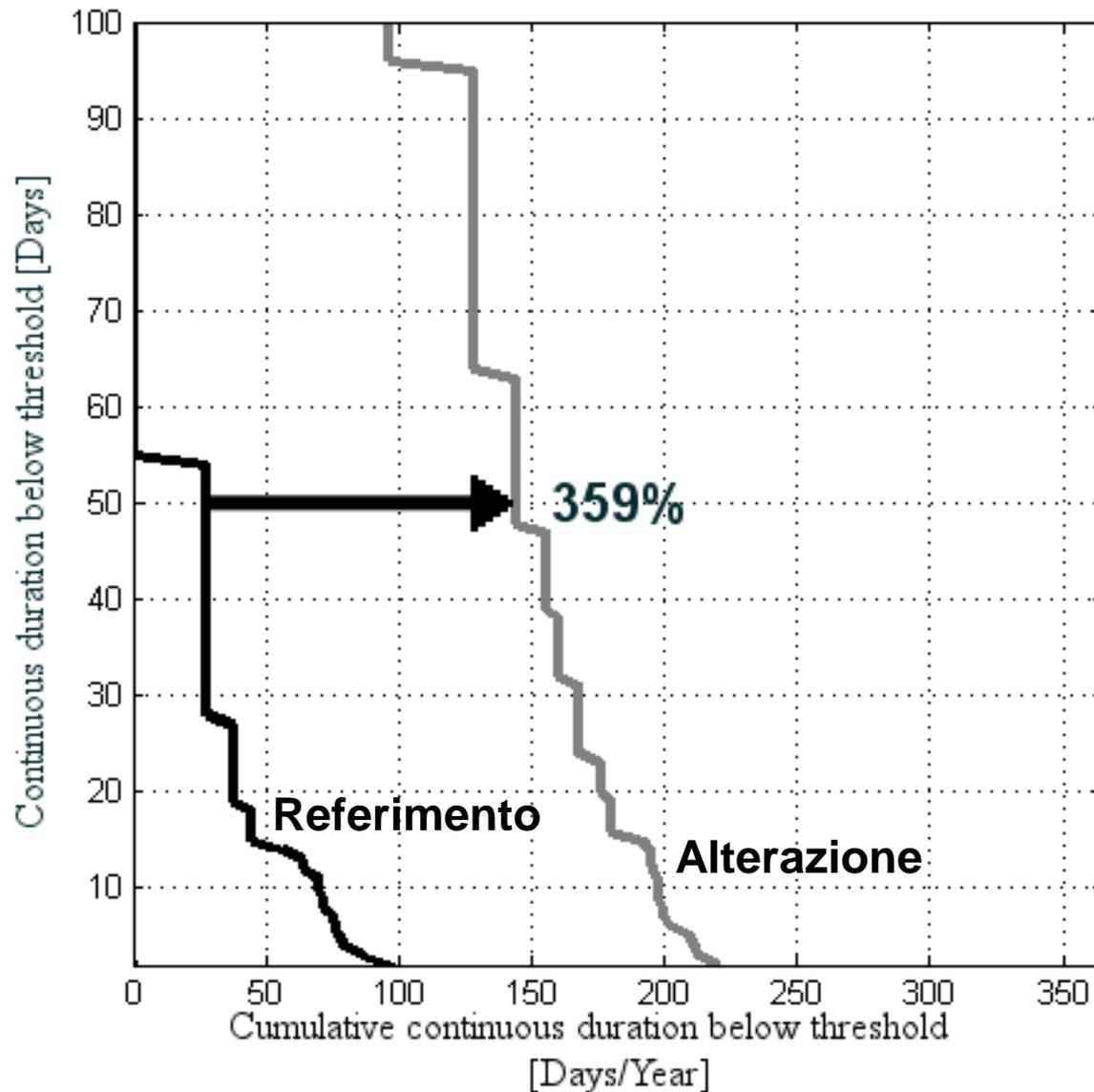
Serie storiche di habitat

Curve UCUT

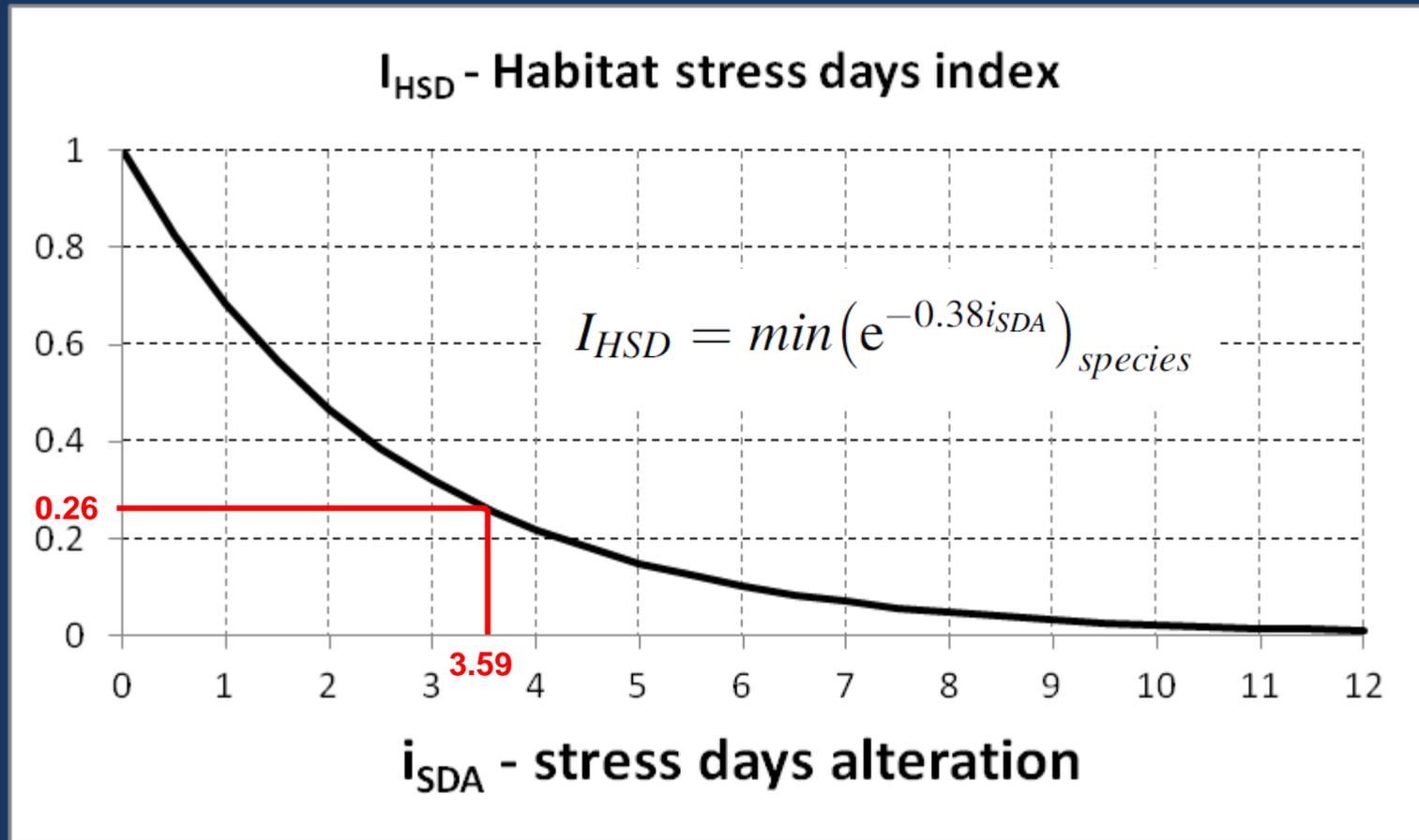
(Uniform Continuous Duration Under Threshold)



I_{HSD} – Habitat Stress Days Index



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i_{SDA} TR_Ad = 359%



I_{HSD} TR_Ad = 0.26

i_{SDA} TR_Juv = 75%



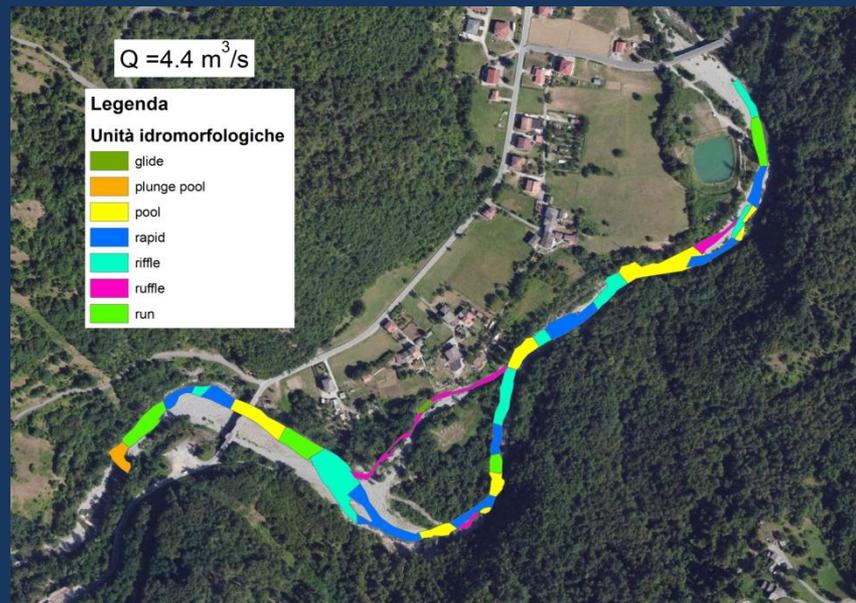
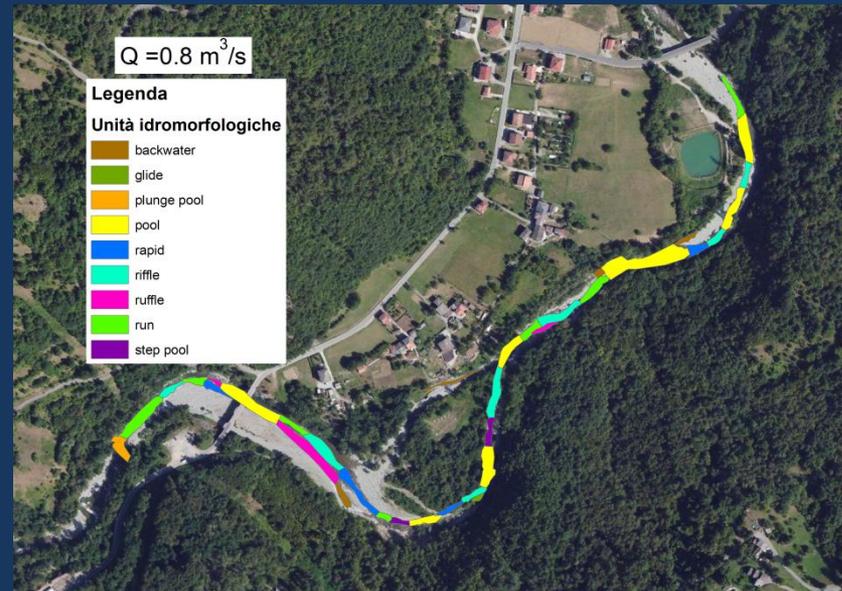
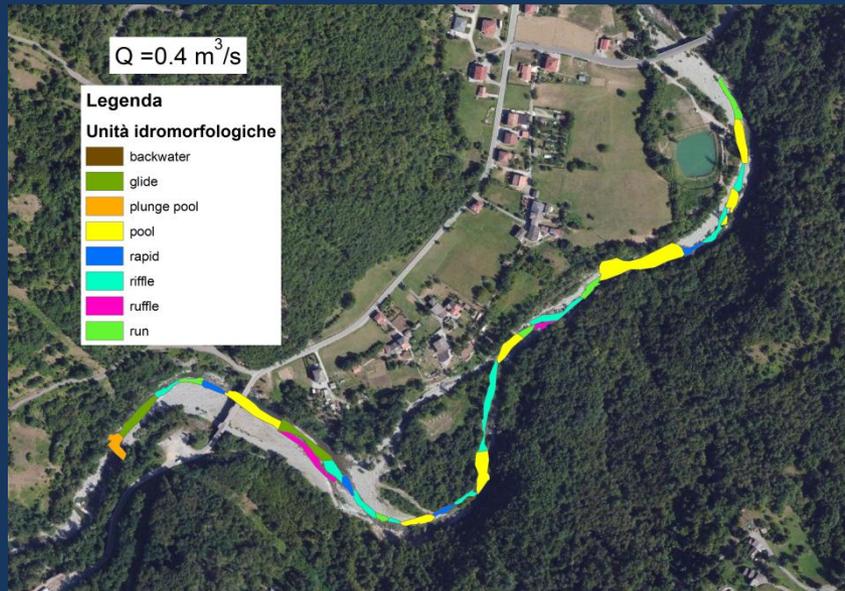
I_{HSD} TR_Juv = 0.78

i_{SDA} MT_Ad = 1050%



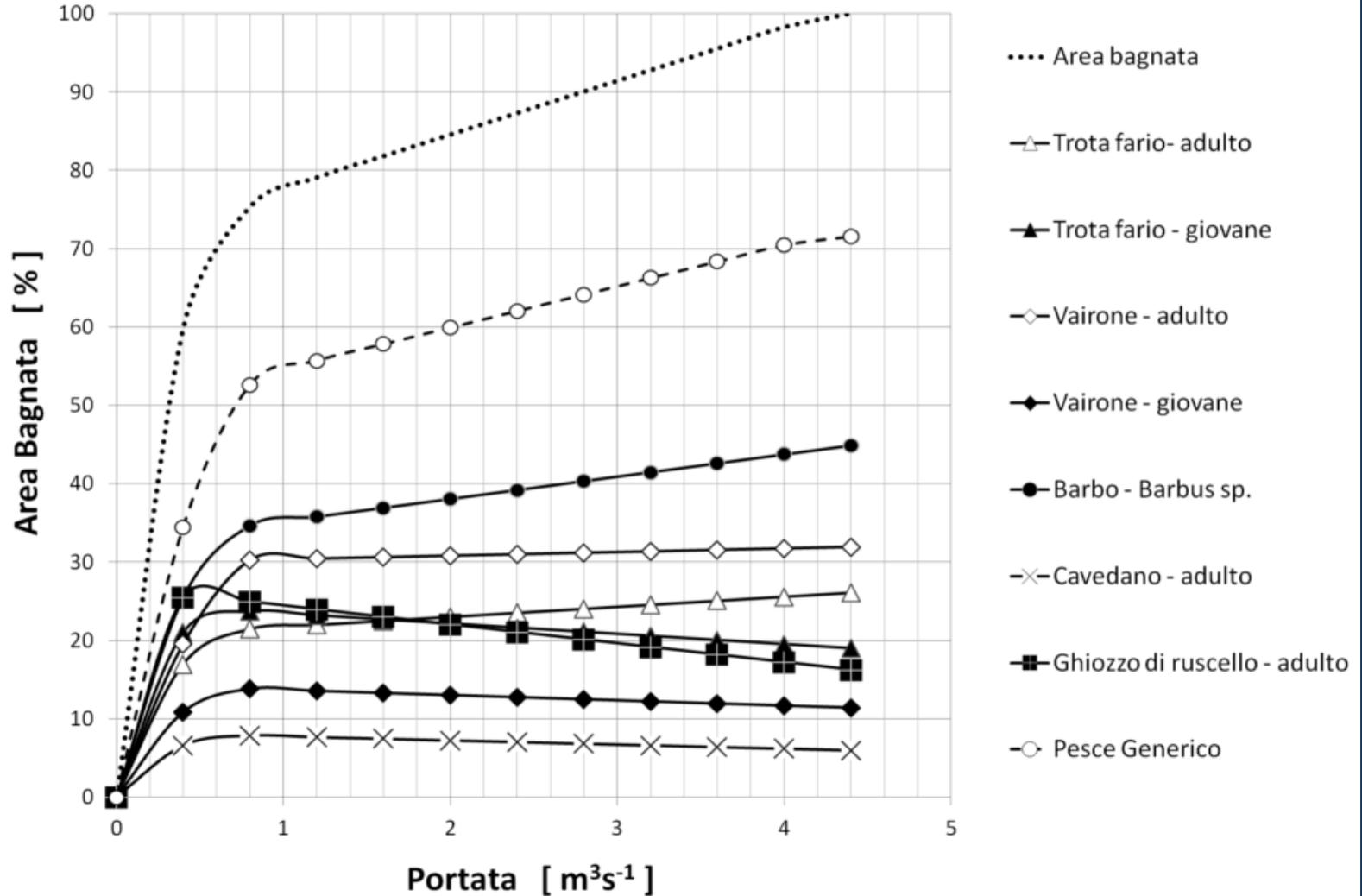
I_{HSD} MT_Ad = 0.19

Fiume Taro a Piane di Carniglia (PR)



Habitat-Flow rating curve

F. Taro - Piane di Carniglia
Relazione Habitat - Portata

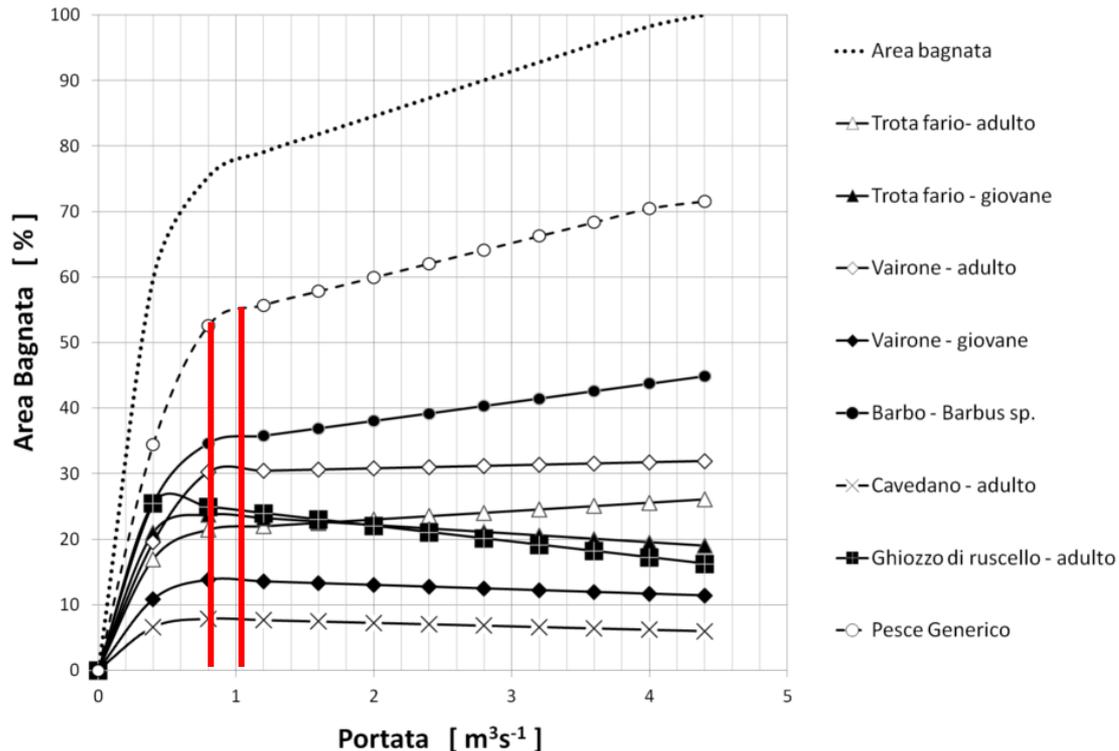


I_{HQ} – Habitat Quantity Index

$Q_{mode_Upstream} = 1.1 \text{ m}^3/\text{s}$

$Q_{mode_Downstream} = 0.8 \text{ m}^3/\text{s}$

F. Taro - Piane di Carniglia
Relazione Habitat - Portata



$$I_{HQ} TR_Ad = 1 - |22-21|/22 = 0.95$$

$$I_{HQ} TR_Juv = 1 - |23-23|/23 = 1.00$$

$$I_{HQ} VAIR_Ad = 1 - |30-30|/30 = 1.00$$

$$I_{HQ} VAIR_Juv = 1 - |14-14|/14 = 1.00$$

$$I_{HQ} BAR_sp = 1 - |35-34|/35 = 0.97$$

$$I_{HQ} CAV_Ad = 1 - |7-7|/7 = 1.00$$

$$I_{HQ} GOBY_Ad = 1 - |24-25|/24 = 0.96$$

I_{HSD} – Habitat Stress Days Index

$i_{\text{SDA}} \text{ TR_Ad} = 160\%$

$i_{\text{SDA}} \text{ TR_Juv} = 86\%$

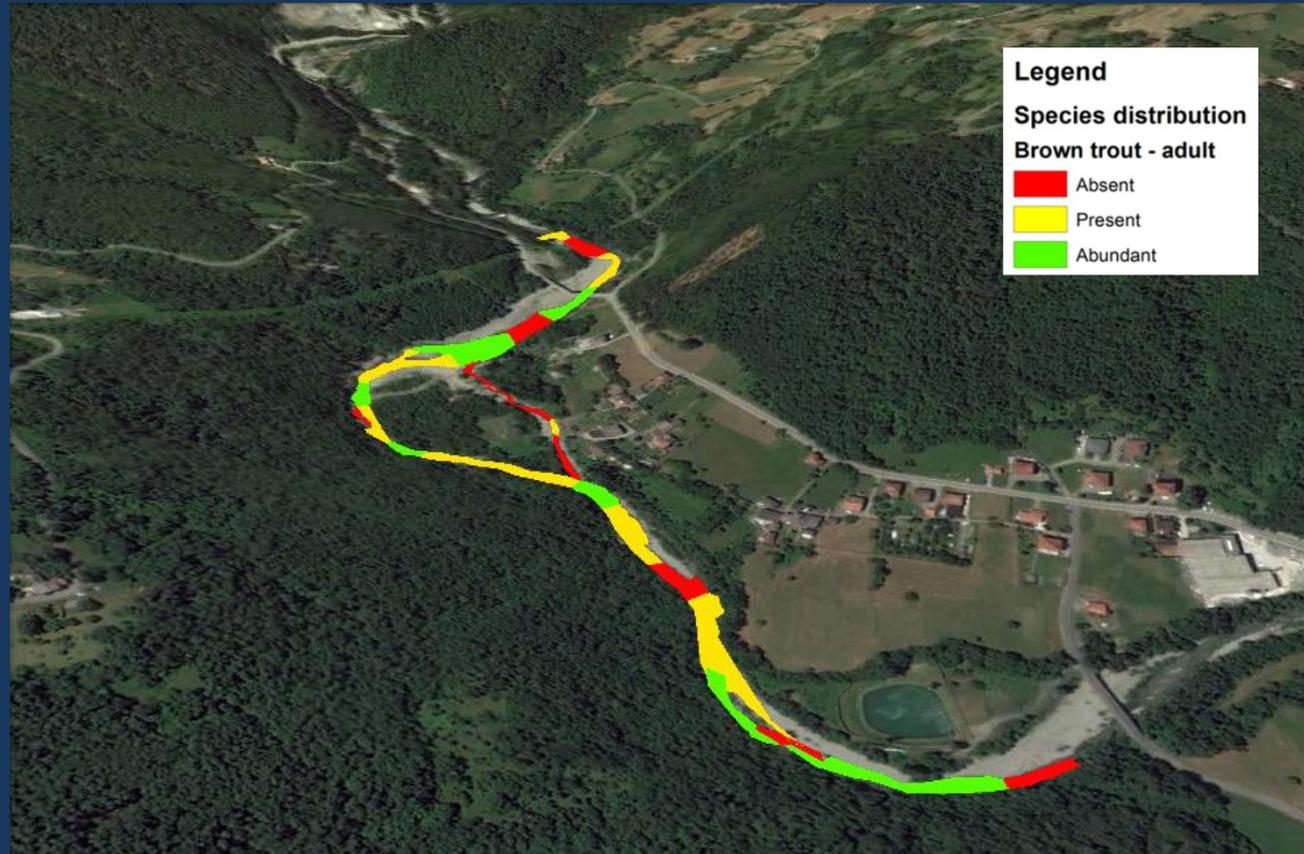
$i_{\text{SDA}} \text{ VAIR_Ad} = 13\%$

$i_{\text{SDA}} \text{ VAIR_Juv} = 93\%$

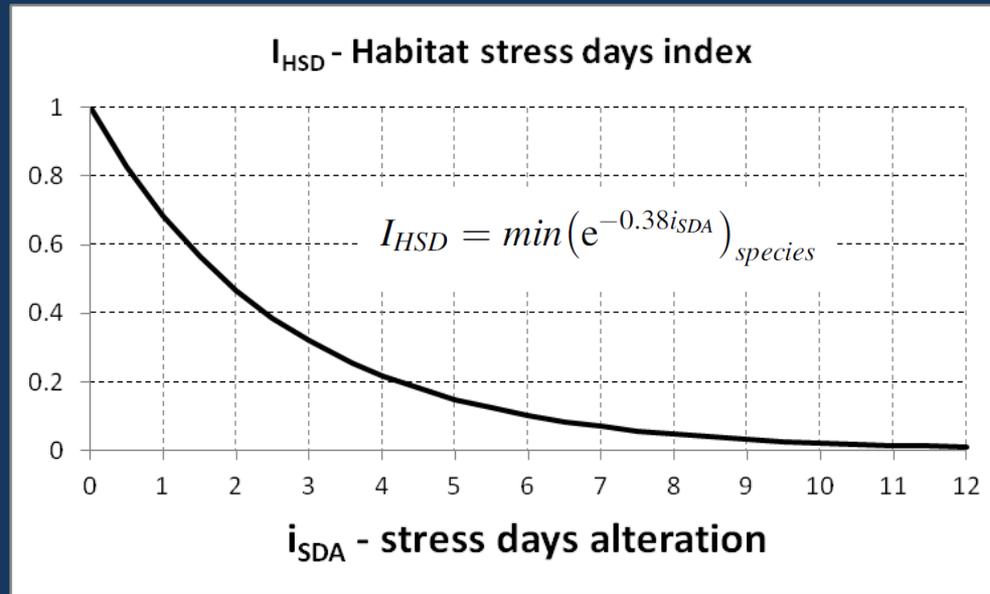
$i_{\text{SDA}} \text{ BAR_sp.} = 228\%$

$i_{\text{SDA}} \text{ CHUB_Ad} = 83\%$

$i_{\text{SDA}} \text{ GOBY_Ad} = 94\%$



I_{HSD} – Habitat Stress Days Index



i_{SDA} TR_Ad = 160%



$I_{HSD_TR_Ad} = 0.54$

i_{SDA} TR_Juv = 86%



$I_{HSD_TR_Juv} = 0.72$

i_{SDA} VAIR_Ad = 13%



$I_{HSD_VAIR_Ad} = 0.95$

i_{SDA} VAIR_Juv = 93%



$I_{HSD_VAIR_Juv} = 0.70$

i_{SDA} BAR_sp. = 228%



$I_{HSD_BAR_sp} = 0.42$

i_{SDA} CHUB_Ad = 83%



$I_{HSD_CHUB_Ad} = 0.72$

i_{SDA} GOBY_Ad = 94%



$I_{HSD_GOBY_Ad} = 0.69$

Sperimentazione DMV Valle d'Aosta – T. Savara

Table 1. List of indices used to monitor the Savara stream between 2008 and 2013

Index	Acronym	Reference	Ecological parameter
Level of Pollution from Macro-descriptors	LIM	D.L.152/99	Water physico-chemical quality
Extended Biotic Index	IBE	Ghetti (1997)	Benthic invertebrates
Fluvial Functional Index	IFF	Siligardi et al. (2007)	Hydro-morphological and biological characteristics
LIM to assess ecological status	LIMeco	D.M.260/2010	Water physico-chemical quality
Standardisation of river classifications, Intercalibration Common Metrix Index	STAR_ICMi	Buffagni and Erba (2007)	Benthic invertebrates
Intercalibration Common Metrix Index	ICMi	Mancini and Sollazzo (2009)	Diatoms
Macrophyte Biological Index for Rivers	IBMR	Haury et al. (2006)	Macrophytes
Ecological Status of Fish Communities Index	ISECI	Zerunian et al. (2009)	Fish
Morphological Quality Index	IQM	Rinaldi et al. (2013)	Geomorphology
Aggregate Index of Hydrological Alteration	IIHA	Goltara et al. (2011) Richter et al. (1997)	Hydrology
Index of Habitat Quantity	IHQ	Veza et al. (2014)	Habitat
Index of Habitat Stress Days	IHSD	Veza et al. (2014)	Habitat

Sperimentazione DMV Valle d'Aosta – T. Savara

Table 2. Monitoring data for the Savara stream during e-flows implementation (analysed period 2008 – 2013). Both ecological status and index values are reported.

Year	Min e-flow	LIM	IBE	IFF	LIMeco	STAR -ICMi	ICMi	IBMR	ISECI	IQM	IIHA	IHQ	IHSD
2008	0	I (520)	II (8.6)	II (226)	-	-	-	-	-	-	0.59	0.18	0.05
2009	130 l/s	I (560)	II (9.0)	II (226)	-	-	-	-	-	-	0.73	0.55	0.31
2010	130 l/s	I (520)	II (8.8)	II (226)	I (0.95)	I (1+)	I (0.95)	I (0.87)	V (0.2)	-	0.72	0.51	0.24
2011	130 l/s	I (520)	II (9.0)	II (226)	I (1.00)	I (1+)	I (0.91)	I (0.92)	V (0.2)	I (0.88)	0.70	0.49	0.23
2012	325 l/s	I (520)	II (9.0)	II (226)	I (0.98)	II (0.83)	I (0.89)	I (0.89)	V (0.2)	-	0.75	0.75	0.35
2013	325 l/s	I (520)	II (9.0)	II (226)	I (0.96)	II (0.83)	I (0.89)	-	V (0.2)	I (0.88)	0.71	0.67	0.33

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2008	0	I (520)	II (8.6)	II (226)	-	-	-	-	-	-	0.59	0.18	0.05
2009	130 l/s	I (560)	II (9.0)	II (226)	-	-	-	-	-	-	0.73	0.55	0.31
2010	130 l/s	I (520)	II (8.8)	II (226)	I (0.95)	I (1+)	I (0.95)	I (0.87)	V (0.2)	-	0.72	0.51	0.24
2011	130 l/s	I (520)	II (9.0)	II (226)	I (1.00)	I (1+)	I (0.91)	I (0.92)	V (0.2)	I (0.88)	0.70	0.49	0.23
2012	325 l/s	I (520)	II (9.0)	II (226)	I (0.98)	II (0.83)	I (0.89)	I (0.89)	V (0.2)	-	0.75	0.75	0.35
2013	325 l/s	I (520)	II (9.0)	II (226)	I (0.96)	II (0.83)	I (0.89)	-	V (0.2)	I (0.88)	0.71	0.67	0.33

Sperimentazione DMV Valle d'Aosta – T. Savara

Table 2. Monitoring data for the Savara stream during e-flows implementation (analysed period 2008 – 2013). Both ecological status and index values are reported.

Year	Min e-flow	LIM	IBE	IFF	LIMeco	STAR -ICMi	ICMi	IBMR	ISECI	IQM	IIHA	IHQ	IHSD
2008	0	I (520)	II (8.6)	II (226)	-	-	-	-	-	-	0.59	0.18	0.05
2009	130 l/s	I (560)	II (9.0)	II (226)	-	-	-	-	-	-	0.73	0.55	0.31
2010	130 l/s	I (520)	II (8.8)	II (226)	I (0.95)	I (1+)	I (0.95)	I (0.87)	V (0.2)	-	0.72	0.51	0.24
2011	130 l/s	I (520)	II (9.0)	II (226)	I (1.00)	I (1+)	I (0.91)	I (0.92)	V (0.2)	I (0.88)	0.70	0.49	0.23
2012	325 l/s	I (520)	II (9.0)	II (226)	I (0.98)	II (0.83)	I (0.89)	I (0.89)	V (0.2)	-	0.75	0.75	0.35
2013	325 l/s	I (520)	II (9.0)	II (226)	I (0.96)	II (0.83)	I (0.89)	-	V (0.2)	I (0.88)	0.71	0.67	0.33

Sperimentazione DMV Valle d'Aosta – T. Savara

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2009	130 l/s	I (560)	II (9.0)	II (226)	-	-	-	-	-	-	0.73	0.55	0.31
2010	130 l/s	I (520)	II (8.8)	II (226)	I (0.95)	I (1+)	I (0.95)	I (0.87)	V (0.2)	-	0.72	0.51	0.24
2011	130 l/s	I (520)	II (9.0)	II (226)	I (1.00)	I (1+)	I (0.91)	I (0.92)	V (0.2)	I (0.88)	0.70	0.49	0.23
2012	325 l/s	I (520)	II (9.0)	II (226)	I (0.98)	II (0.83)	I (0.89)	I (0.89)	V (0.2)	-	0.75	0.75	0.35
2013	325 l/s	I (520)	II (9.0)	II (226)	I (0.96)	II (0.83)	I (0.89)	-	V (0.2)	I (0.88)	0.71	0.67	0.33

Sperimentazione DMV Valle d'Aosta – T. Savara

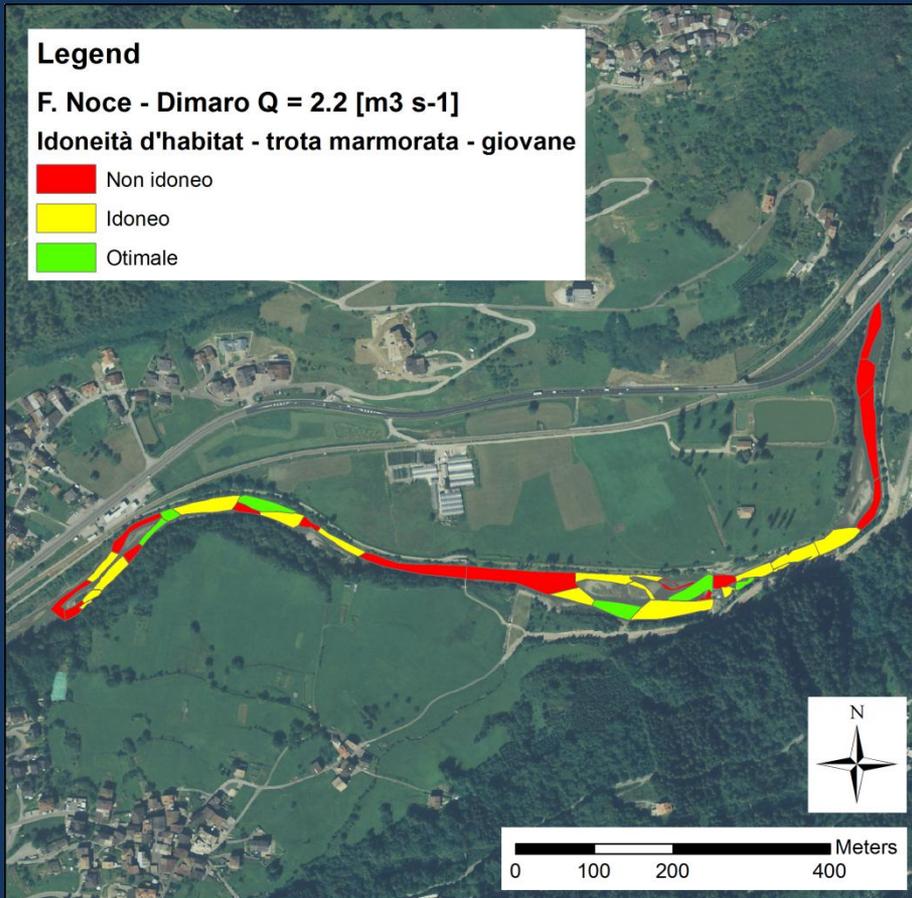
Table 2. Monitoring data for the Savara stream during e-flows implementation (analysed period 2008 – 2013). Both ecological status and index values are reported.

Year	Min e-flow	LIM	IBE	IFF	LIMeco	STAR -ICMi	ICMi	IBMR	ISECI	IQM	IIHA	IHQ	IHSD
2008	0	I (520)	II (8.6)	II (226)	-	-	-	-	-	-	0.59	0.18	0.05
2009	130 l/s	I (560)	II (9.0)	II (226)	-	-	-	-	-	-	0.73	0.55	0.31
2010	130 l/s	I (520)	II (8.8)	II (226)	I (0.95)	I (1+)	I (0.95)	I (0.87)	V (0.2)	-	0.72	0.51	0.24
2011	130 l/s	I (520)	II (9.0)	II (226)	I (1.00)	I (1+)	I (0.91)	I (0.92)	V (0.2)	I (0.88)	0.70	0.49	0.23
2012	325 l/s	I (520)	II (9.0)	II (226)	I (0.98)	II (0.83)	I (0.89)	I (0.89)	V (0.2)	-	0.75	0.75	0.35
2013	325 l/s	I (520)	II (9.0)	II (226)	I (0.96)	II (0.83)	I (0.89)	-	V (0.2)	I (0.88)	0.71	0.67	0.33

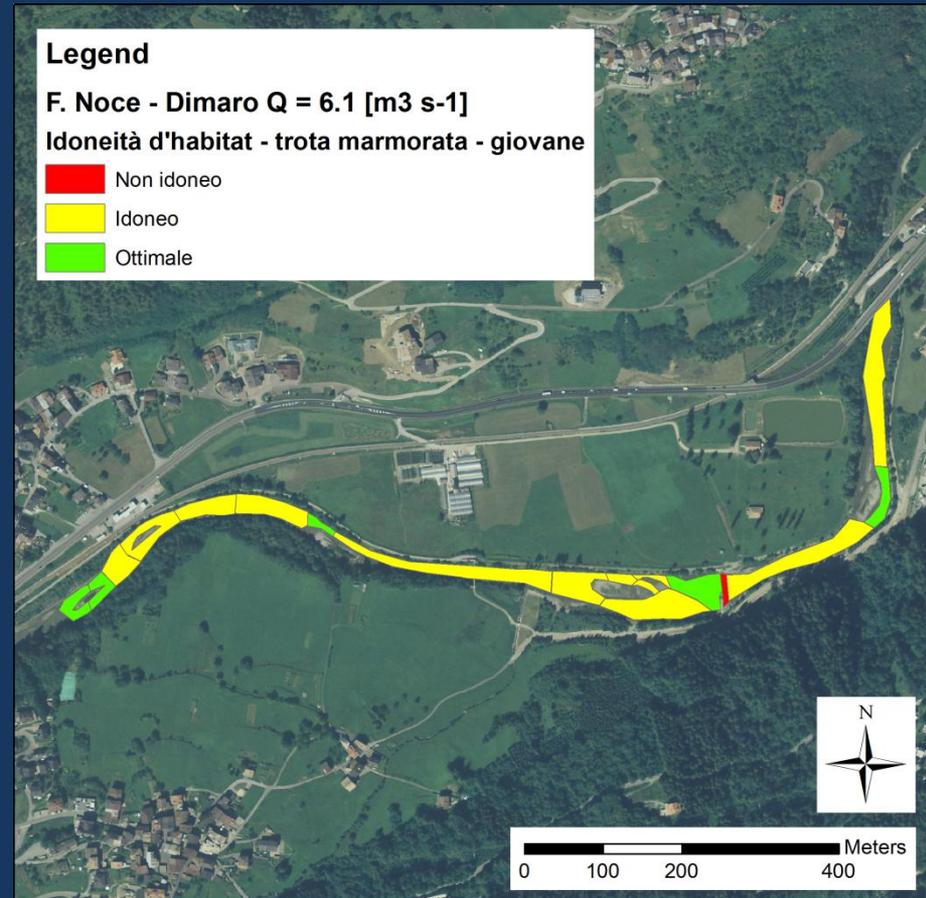
F. Noce – Marileva (TN)

Variazione spaziale habitat

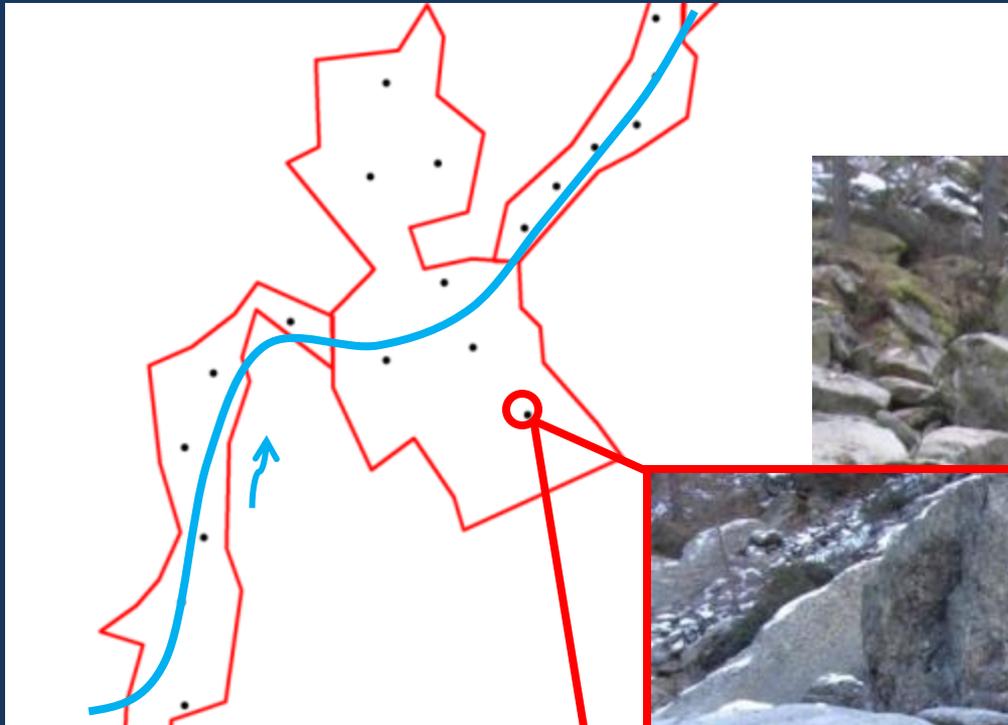
$Q = 2.2 \text{ m}^3/\text{s}$



$Q = 6.1 \text{ m}^3/\text{s}$

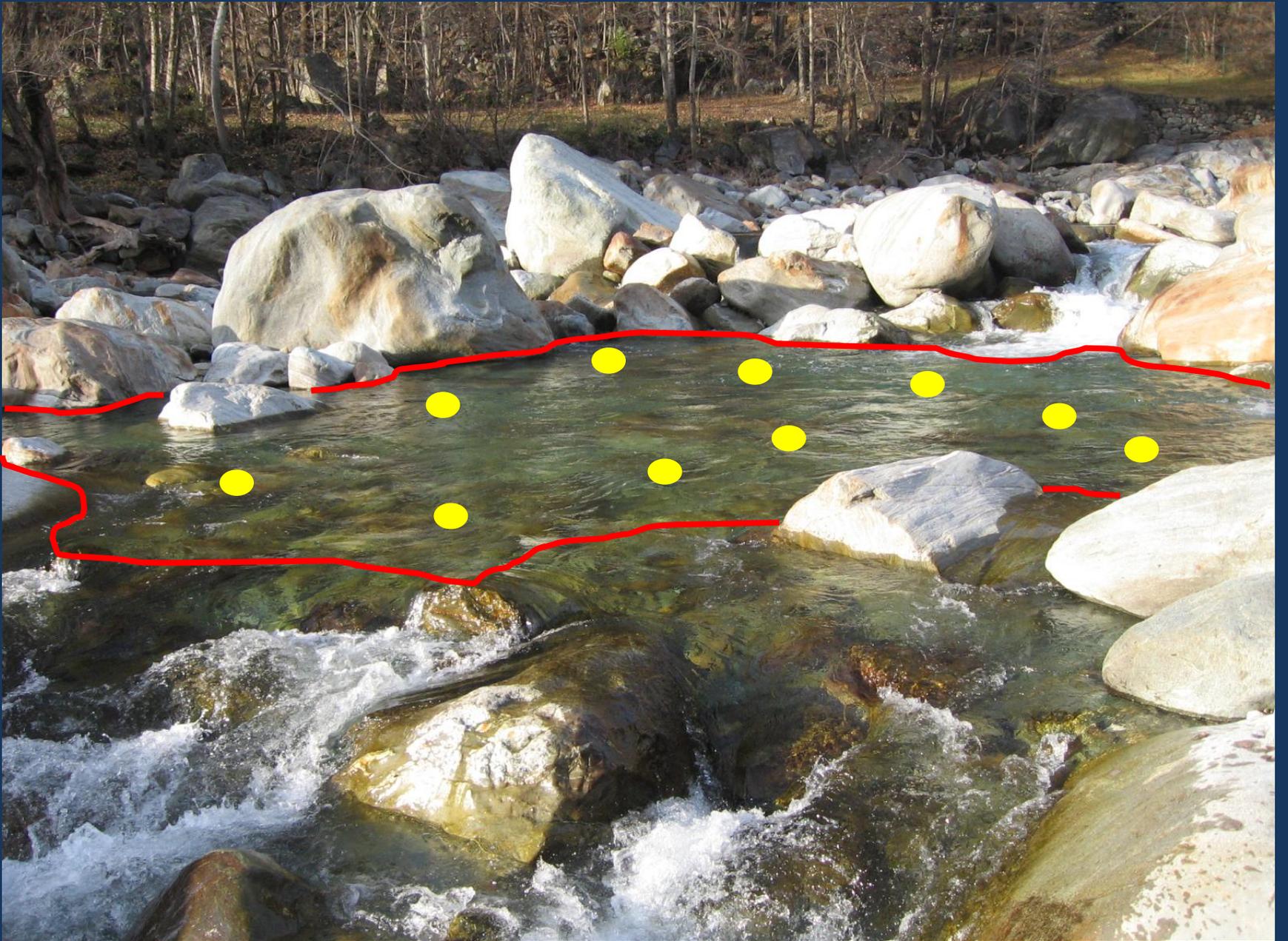


La descrizione degli habitat

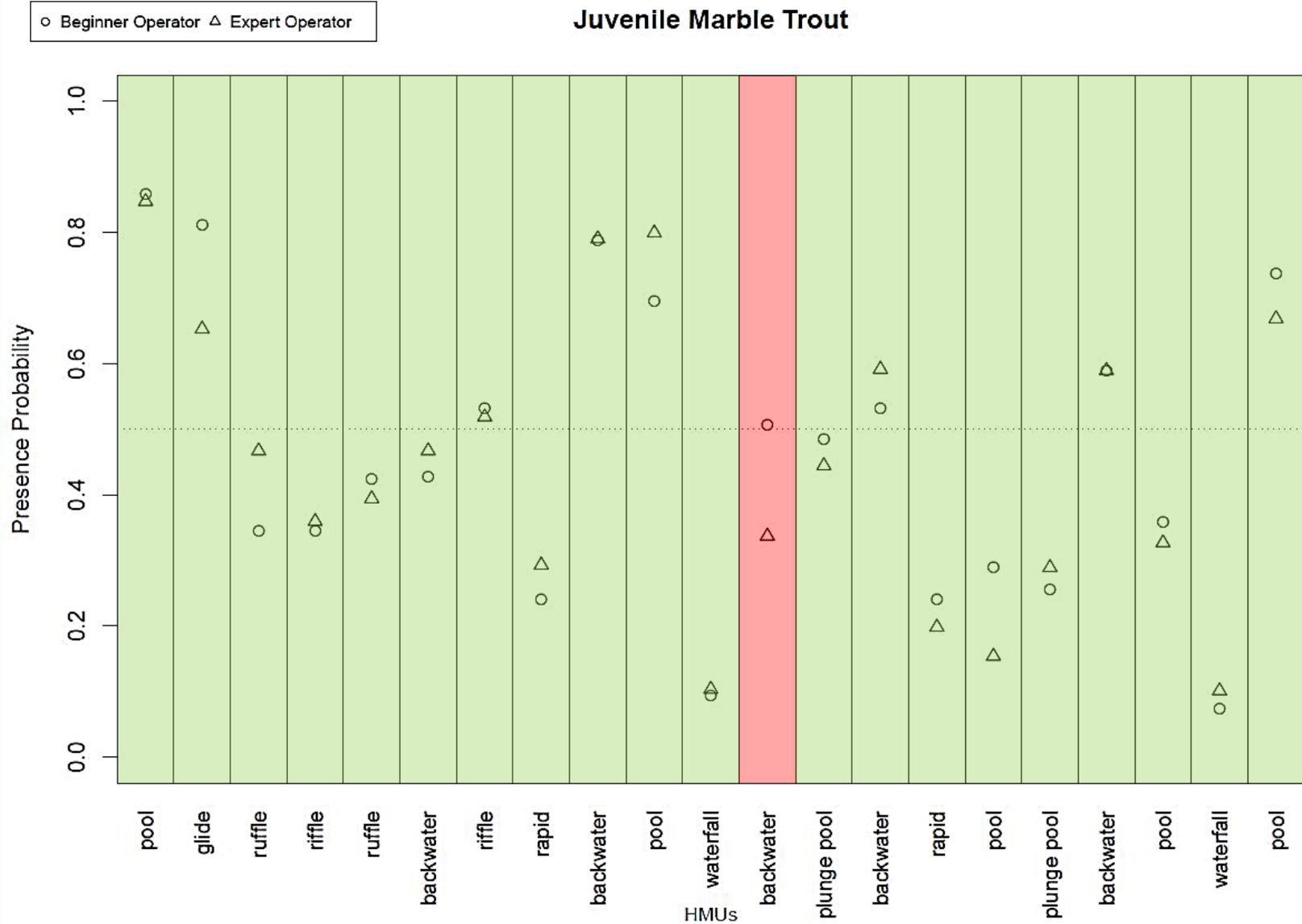


La descrizione degli habitat





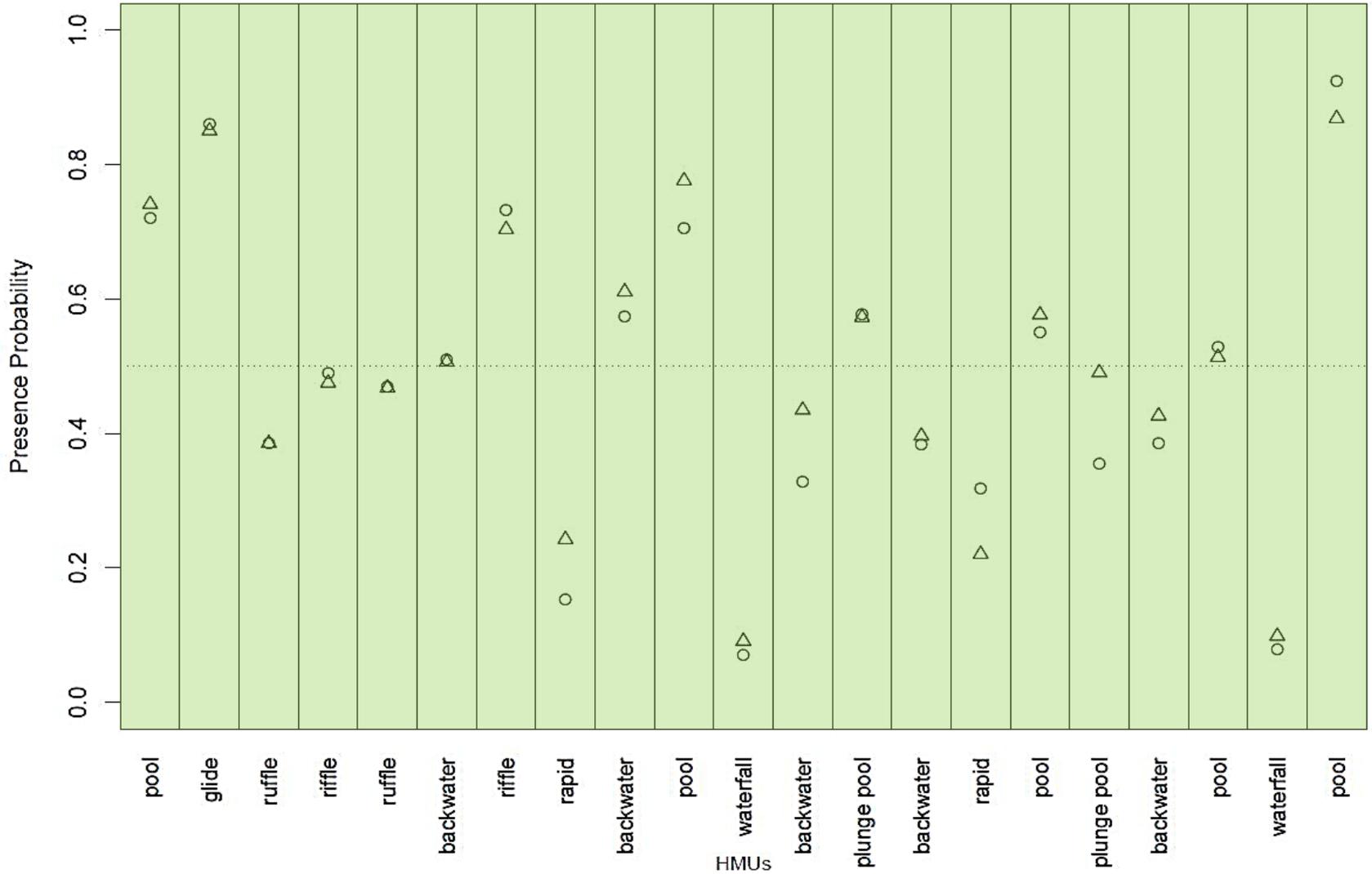
Test di sensitività - operatore



Test di sensitività - operatore

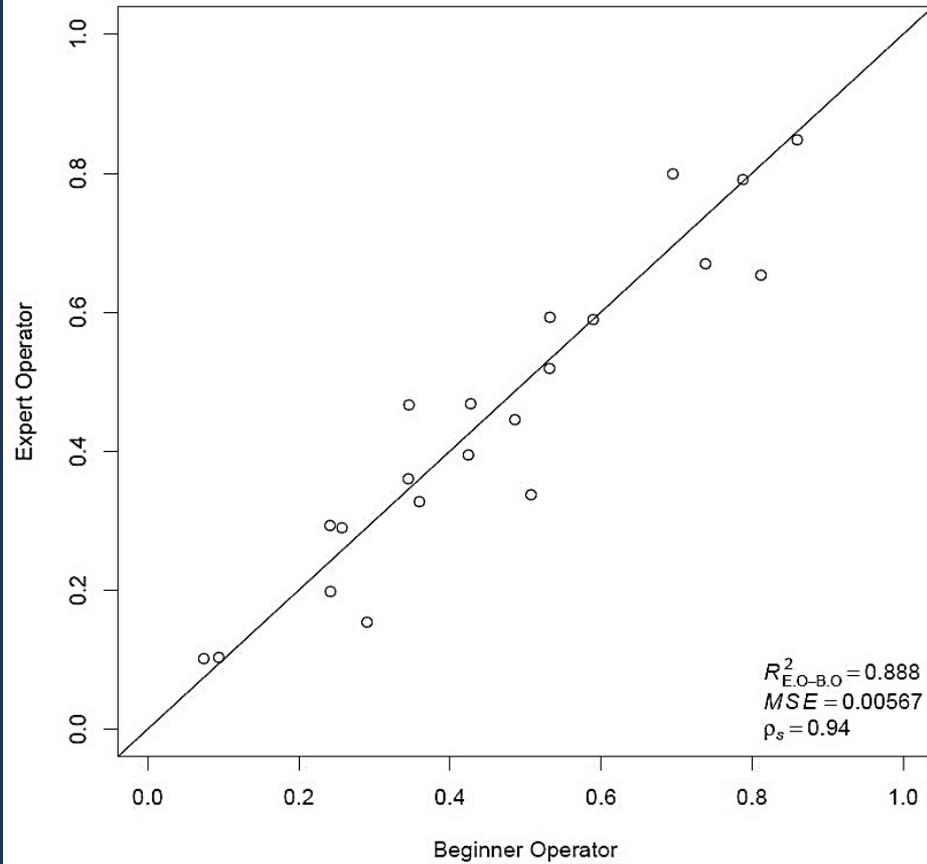
○ Beginner Operator △ Expert Operator

Adult Marble Trout

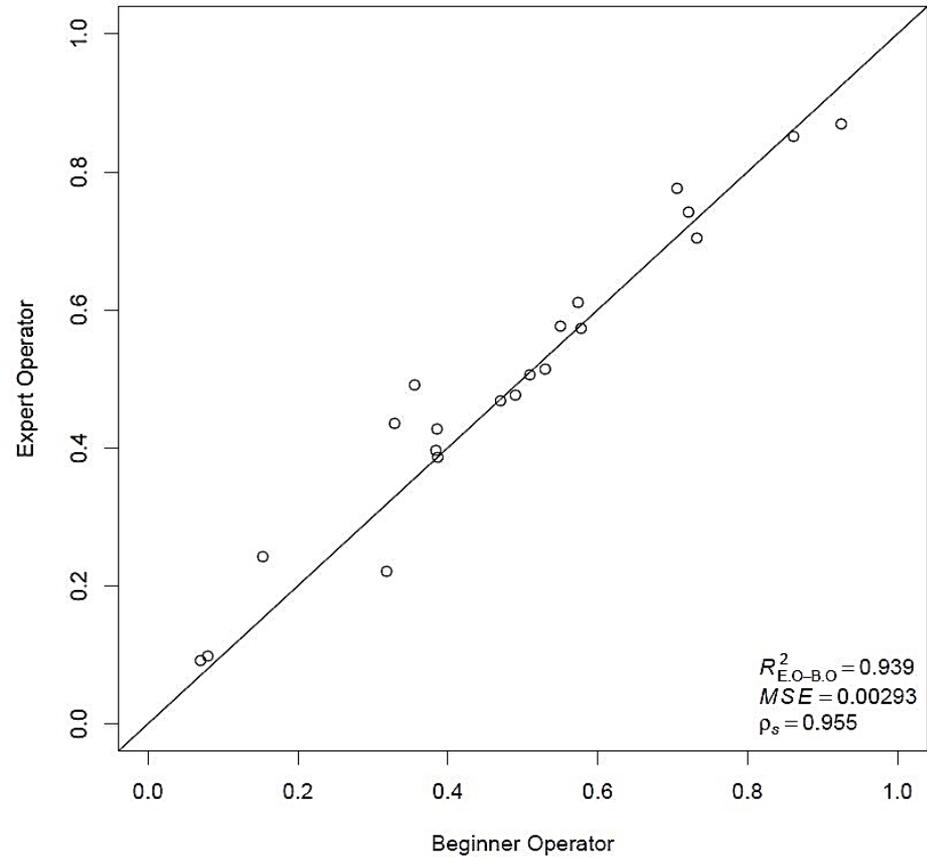


Test di sensitività - operatore

Juvenile Marble Trout



Adult Marble Trout



Conclusioni

Gli indici biologici disponibili non permettono per corsi d'acqua montani la quantificazione dell'impatto delle alterazioni idro-morfologiche (o in alcuni casi non la rilevano).

Per alcune comunità biotiche (ad es., i pesci) le alterazioni idro-morfologiche non sono l'unico driver della struttura e composizione delle popolazioni, le quali possono essere artificialmente modificate da ripopolamenti, pesca, introduzione di specie alloctone.

Gli indici proposti utilizzano l'HABITAT come metrica per valutare l'impatto sulle comunità biotiche, i parametri fisici descrittivi di un corso d'acqua sono quantificabili e misurabili, ed è possibile determinarne la deviazione spazio-temporale rispetto a delle condizioni di riferimento.

Gli indici proposti possono quantificare alterazioni sia idrologiche sia morfologiche e possono essere calcolati per diversi tipi di pressioni (derivazioni, disalvei, svassi, sistemazioni, hydropeaking).

Grazie per l'attenzione

