



Istituto di Ricerca sulle Acque
CONSIGLIO NAZIONALE DELLE RICERCHE



Regione
Lombardia



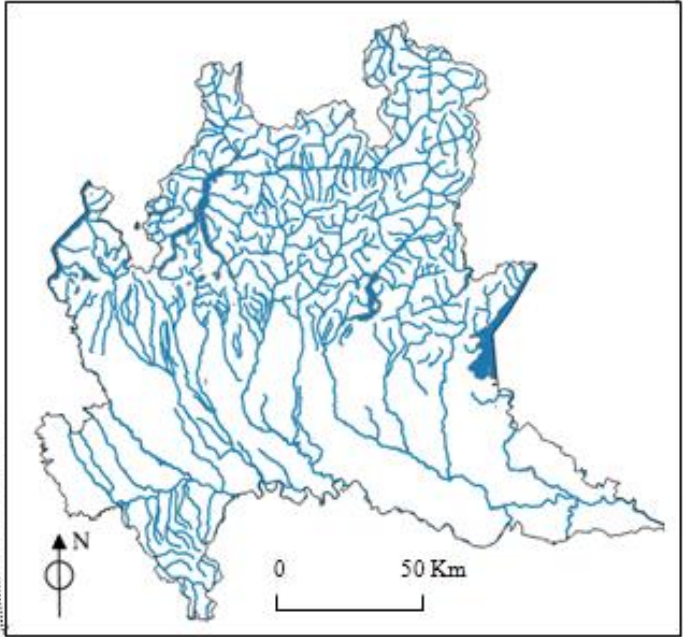
Biotic impact of different sediment flushing practices in Italian alpine rivers



Genova – 15 Giugno 2017



Daniele Demartini, Andrea Buffagni, David G Armanini, Almudena Idígoras, Laura Terranova,
Pietro Genoni, Erika Lorenzi, Cristina Borlandelli & Clara Bravi

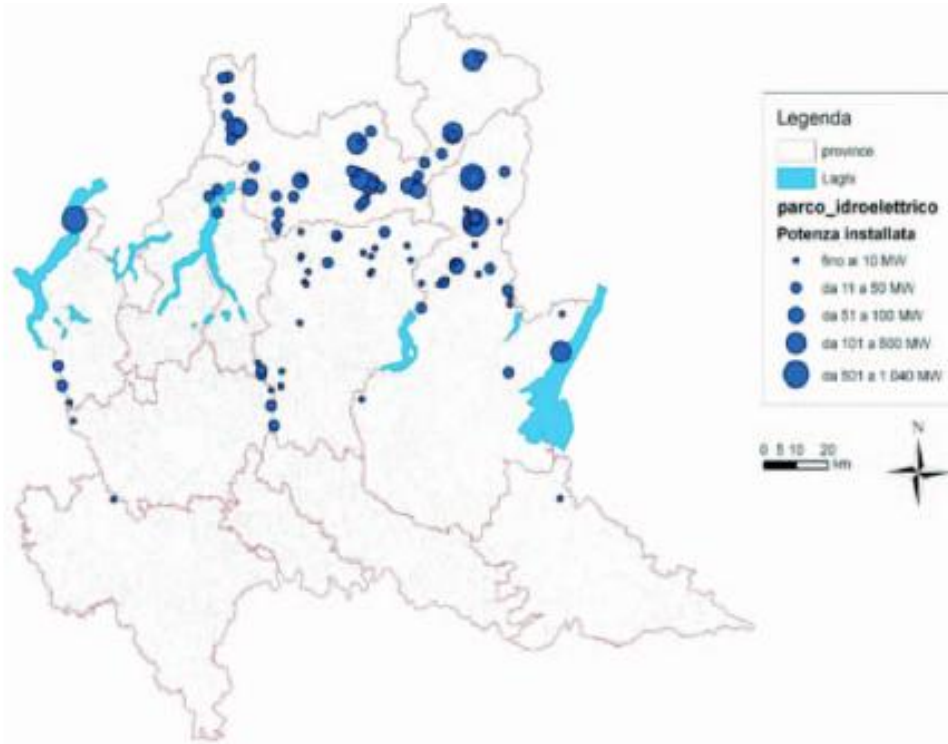


Study area





Lombardia

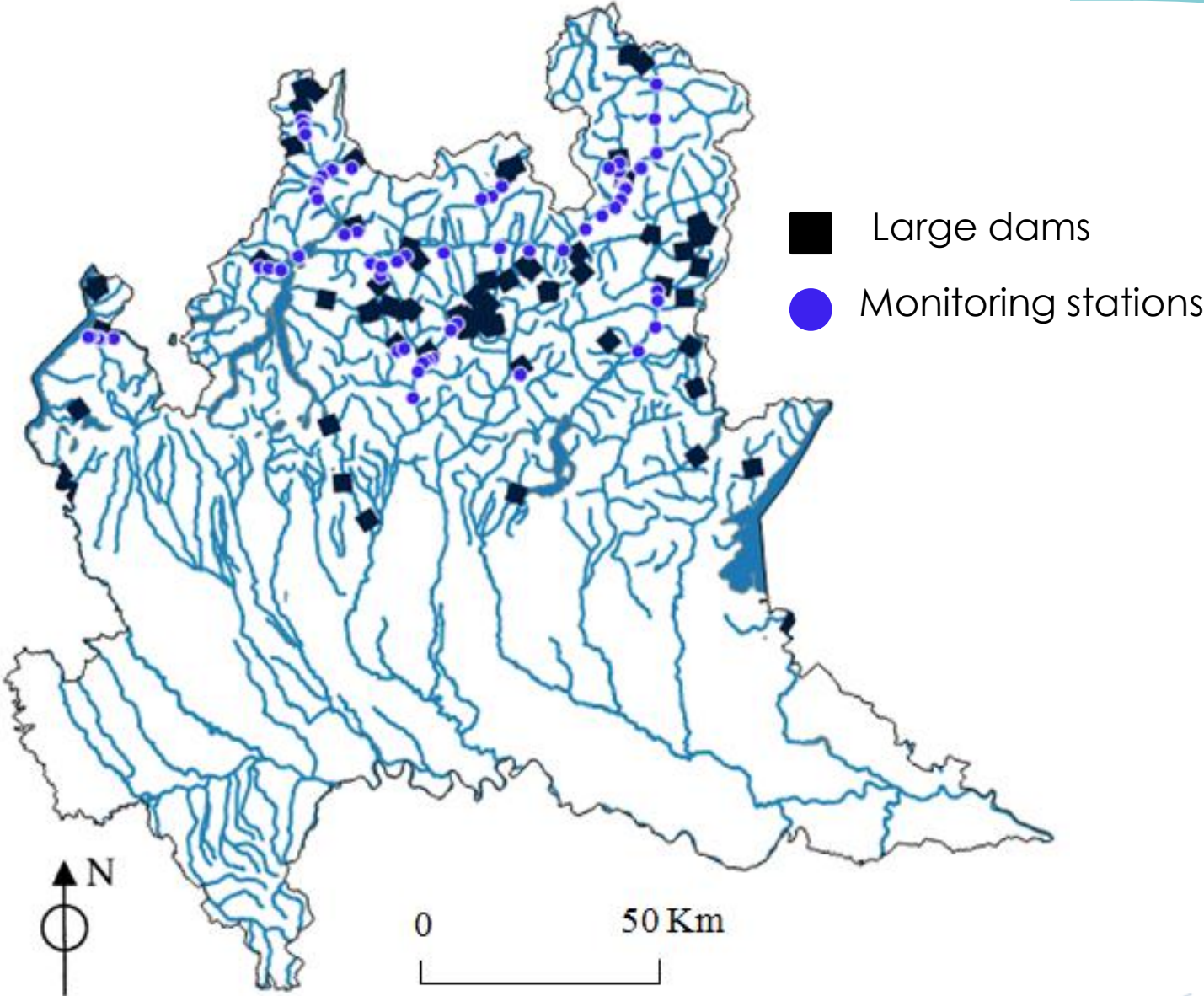


Fonte: Regione Lombardia, 2008

- More than 10 millions people living in Lombardia
- 41 % of the region is mountainous territory
- More than 400 hydropower stations
- ≈ 70 are licences for water diversion for hydropower production (Power > 3000 kW)
- Many of these are represented by large dams that need flushing operations to remove sediments



Lombardia



Study area



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Data collected from ≈ 30 flushing operations during last 10 years (2006-2015). Different types of operations in terms of duration and concentration of suspended solids.

- Fish data: ≈ 150 samples
- Macroinvertebrates data: ≈ 430 samples
- Suspended Solids Concentrations were measured during flushing operations: Data collected at least hourly



Data available





To evaluate impact of flushing operations → Calculation of SEV model (Severity of ill effects) on sites interested by flushing events.

SEV (Newcombe & Jensen 1996) → predictor of potential impact of sediments

$$\text{SEV} = a + b(\log_e x) + c(\log_e y)$$

a, b, c: regressions coefficients

x: duration of exposure (h)

y: suspended solids concentration (mg/l)



Impact of sediments on fish



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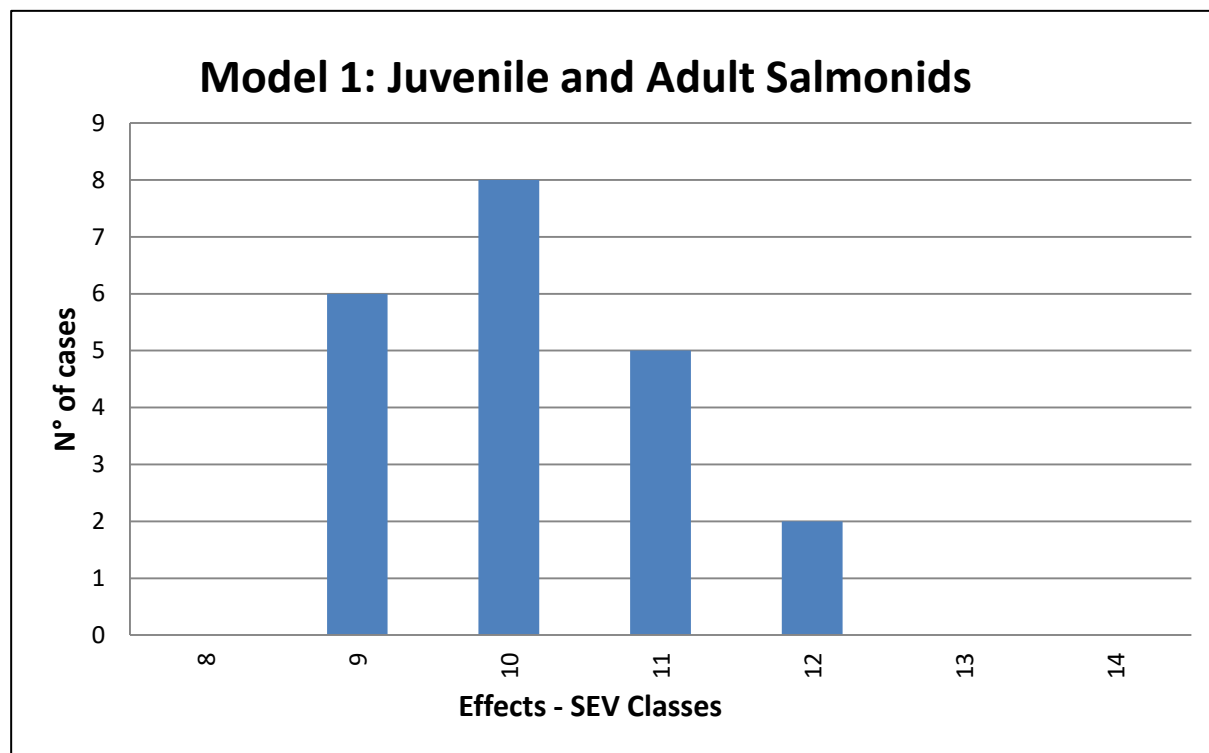
Model [*]	Taxonomic Group	Status
[1]	Juvenile and Adult Salmonids	Peer Reviewed [**]
[2]	Adult Salmonids	Peer Reviewed [**]
[3]	Juvenile Salmonids	Peer Reviewed [**]
[4]	Eggs and Larvae of Salmonids and Nonsalmonids	Peer Reviewed [**]
[5]	Adult Estuarine Nonsalmonids	Peer Reviewed [**]
[6]	Adult Freshwater Nonsalmonids	Peer Reviewed [**]
[7]	Freshwater Invertebrates, and Freshwater Flora	Draft-level Model
[8]	Freshwater Invertebrates	Draft-level Model
[9]	Freshwater Flora	Partial data

SEV	Description of effect [*]
	Nil effect
0	No behavioral effects
	Behavioral effects
1	Alarm reaction
2	Abandonment of cover
3	Avoidance response
	Sublethal effects
4	Short-term reduction in feeding rates; short-term reduction in feeding success
5	Minor physiological stress; increase in rate of coughing; increased respiration rate
6	Moderate physiological stress
7	Moderate habitat degradation; impaired homing
8	Indications of major physiological stress; long-term reduction in feeding rate; long-term reduction in feeding success; poor condition
	Lethal and para-lethal effects
9	Reduced growth rate; delayed hatching; reduced fish density
10	0-20% mortality; increased predation; moderate to severe habitat degradation
11	>20-40% mortality
12	>40-60% mortality
13	>60-80% mortality
14	>80-100% mortality





Application of SEV to 21 stations interested by flushing operations

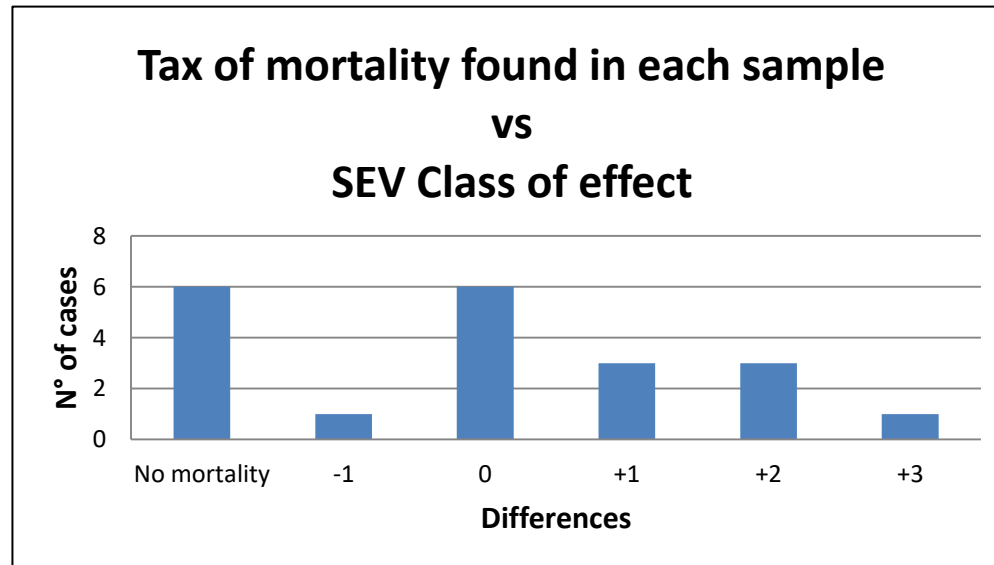


- Lethal and para-lethal effects**
- 9 Reduced growth rate; delayed hatching; reduced fish density
 - 10 0-20% mortality; increased predation; moderate to severe habitat degradation
 - 11 >20-40% mortality
 - 12 >40-60% mortality
 - 13 >60-80% mortality
 - 14 >80-100% mortality





- On these 21 stations → Pre-post fish data. Samples collected before the events and about 1 month after the end of the flushing events.
- Calculation of mortality for each stations



- 1: SEV overestimates the mortality found in the samples. 1 Class of differences (20 %)
- 0: Correspondence between SEV classes and mortality found in the samples
- +1: SEV underestimates the mortality found in the samples. 1 Class of differences (20 %)
- +2: SEV underestimates the mortality found in the samples. 2 Class of differences (40 %)
- +3: SEV underestimates the mortality found in the samples. 3 Class of differences (60% or more)

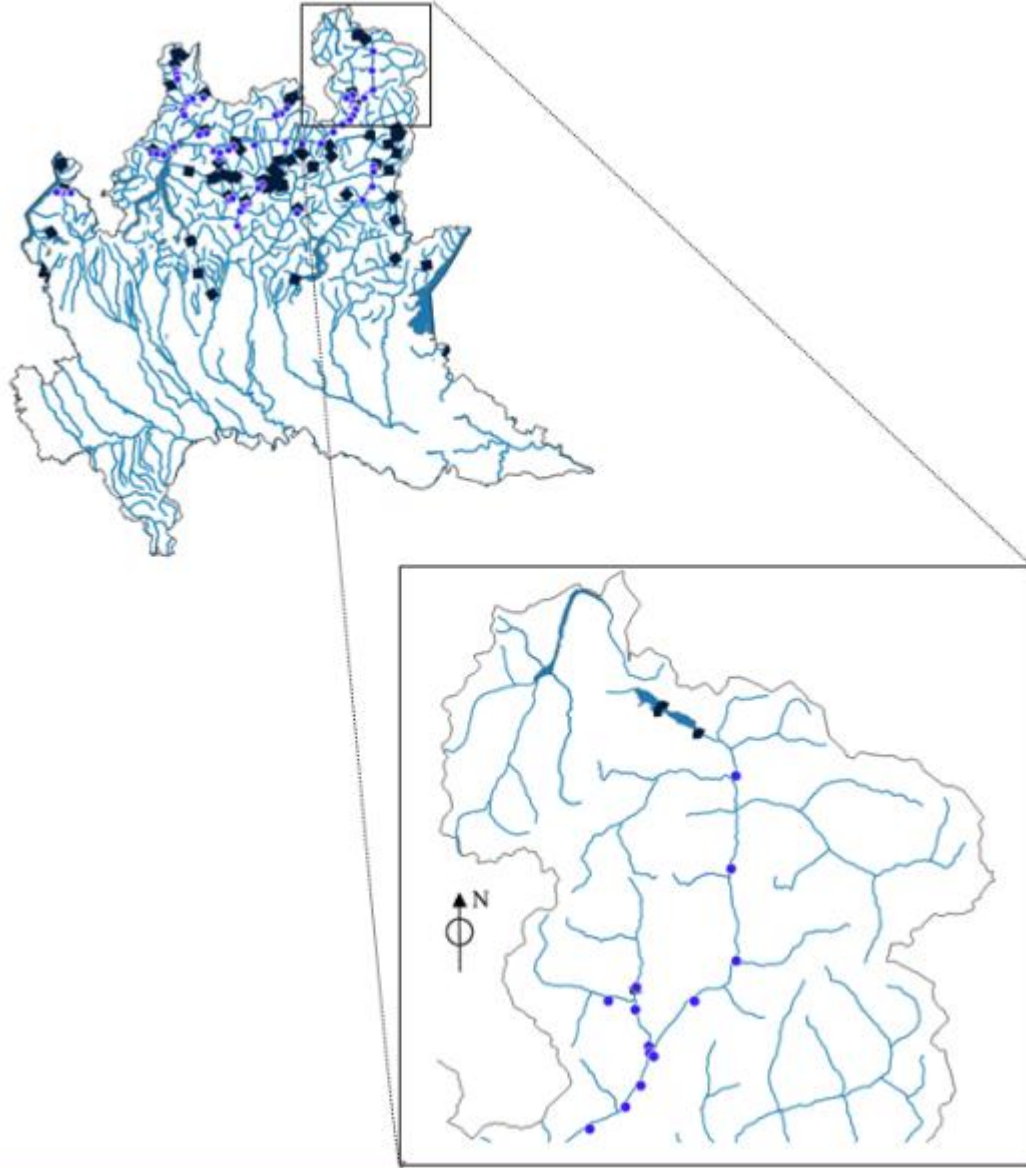




- SEV model seems to underestimate the real effects. Nevertheless the model could provide information about flushing events effect → Could be useful in the planning phase of the event
- A specific SEV model adapted to this area could be developed to better predict the effects
- In some cases there was no mortality but the community increased: probably fauna input provided by local fishermen (Even though the regional directives provide for measures to avoid repopulation)



Macroinvertebrates



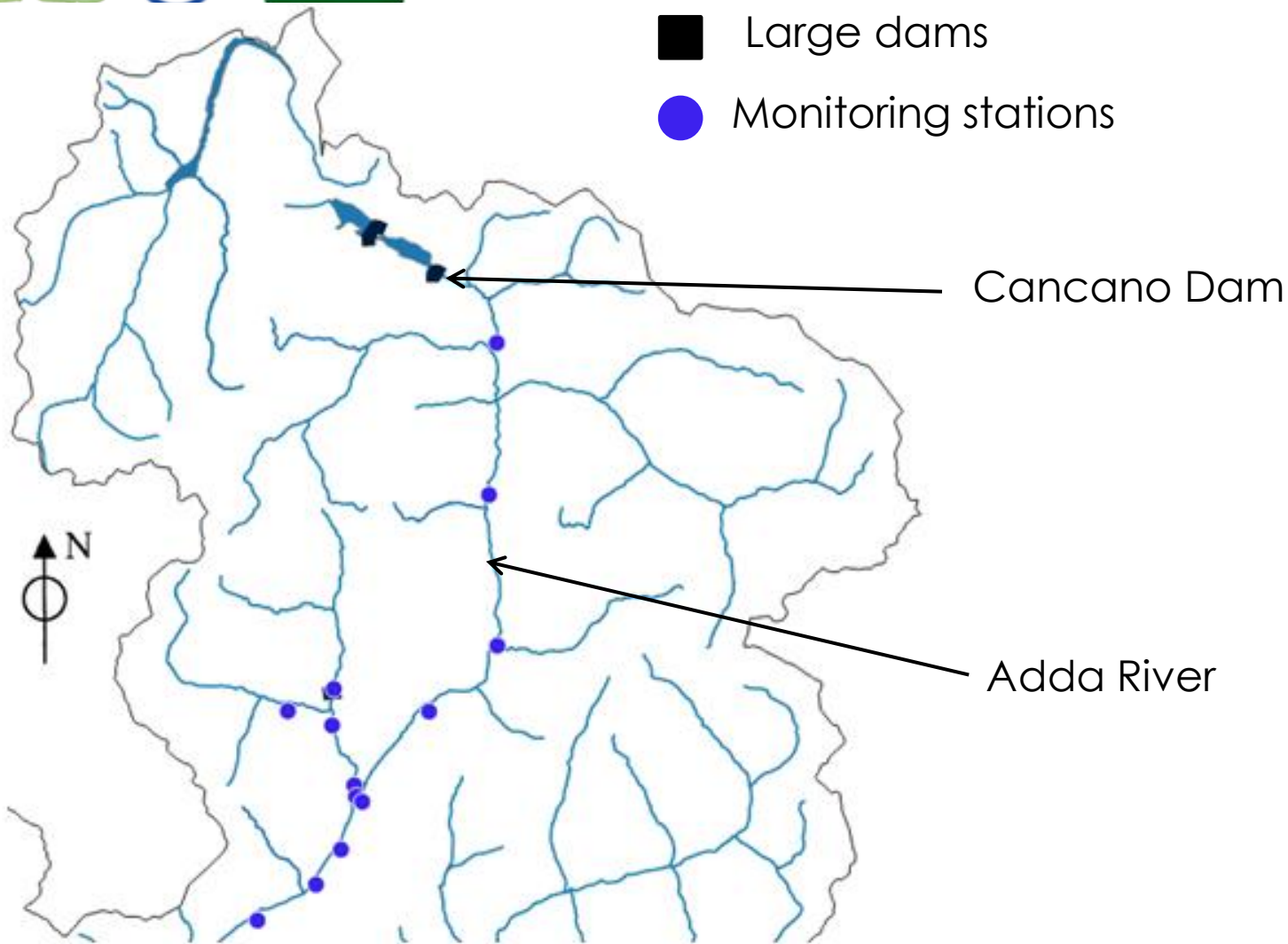
Macroinvertebrates study area



Macroinvertebrates



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Macroinvertebrates analyses on Adda river downstream Cancano Dam

- 4 flushing operations (2010-2011-2012-2013)
- 4 monitoring Stations: ADDA1-4
- \approx 100 samples considered in the analyses



Macroinvertebrate index officially in use in Italy for ecological status evaluation: STAR_ICMi (Buffagni et al., 2007; DM260/2010)

Intercalibration Common Metrics (ICMs) used in the STAR ICMi

Type	Metric type	Metric name	Taxa considered in the metric	Literature reference	weight
Tolerance	Index	ASPT	Whole community (Family level)	e.g. Armitage et al., 1983	0.333
Abundance/ Habitat	Abundance	Log ₁₀ (Sel_EPTD +1)	Log(sum of Heptageniidae, Ephemeridae, Leptophlebiidae, Brachycentridae, Goeridae, Polycentropodidae, Limnephilidae, Odontoceridae, Dolichopodidae, Stratyomidae, Dixidae, Empididae, Athericidae & Nemouridae)	Buffagni et al., 2004; Buffagni & Erba, 2004	0.266
	Abundance	1-GOLD	1 - (relative abundance of Gastropoda, Oligochaeta and Diptera)	Pinto et al., 2004	0.067
	Taxa number	Total number of Families	Sum of all Families present at the site	e.g. Ofenböch et al., 2004	0.167
Richness and Diversity	Taxa number	number of EPT Families	Sum of Ephemeroptera, Plecoptera and Trichoptera taxa	e.g. Ofenboch et al., 2004; Böhmer et al., 2004.	0.083
	Diversity index	Shannon-Wiener diversity index	$D_{S-W} = - \sum_{i=1}^s \left(\frac{n_i}{A} \right) \cdot \ln \left(\frac{n_i}{A} \right)$	e.g. Hering et al., 2004; Böhmer et al., 2004.	0.083

- Developed to assess general degradation in river site
- Requested identification level is family
- Some of the metrics require information about abundance of collected taxa

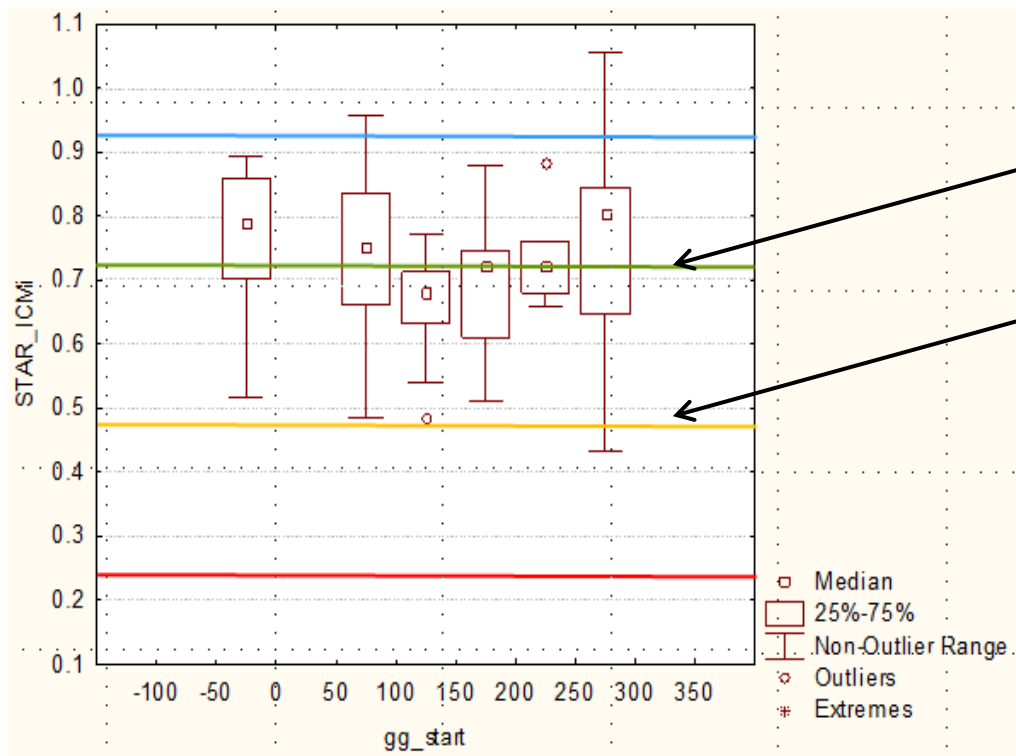




Macroinvertebrates

Multivariate analysis (MRT) based on days distance from flushing operations → 6 groups of sites identified: 1 group before operations – 5 groups after

Application of STAR_ICMi to the samples of each group:



Good status threshold

Moderate status threshold





Macroinvertebrates

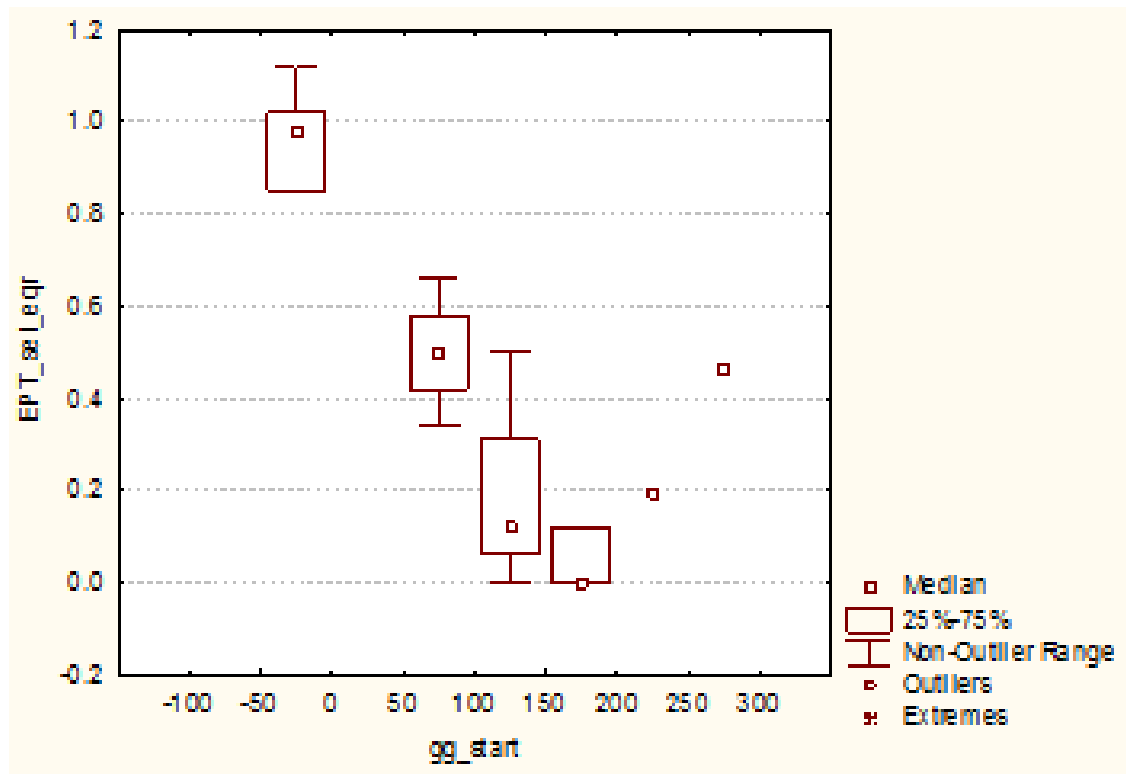
Selection of new metrics to downweight STAR_ICMi → detect the specific impact of the flushing events

Code (preliminary)	Taxa considered
EPT_sel	e.g. Heptageniidae Perlodidae
FOS_all	e.g. Empididae Limoniidae
1-CPOM_taxa (Coarse Particulate Organic Matter)	e.g. Elmidae Nemouridae





Selection of new metrics to downweight STAR_ICMi → detect the specific impact of the flushing events



EPT Sel

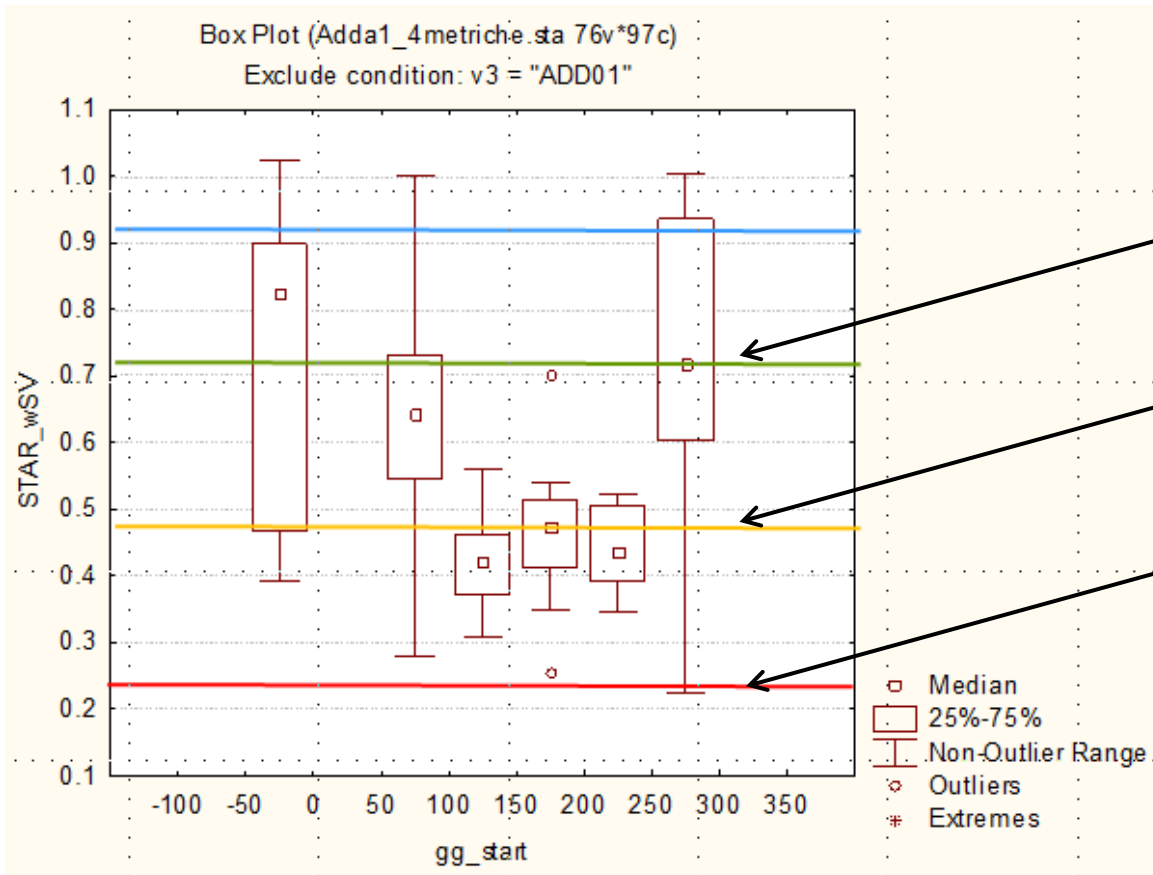




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Macroinvertebrates

Applications of new metrics → STAR_ICMi downweighted:



Good status threshold

Moderate status threshold

Poor status threshold





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Macroinvertebrates

- STAR_ICMi with downweight seems to detect the impact from flushing operations
- Results will be confirmed by applications in other basins
- The index could be a useful tool for evaluate past operations and planning the new operations





Thank you for your attention



d.demartini@protheagroup.com

