Using Environmental Flow to Evaluate Water Resources Management Policies

By

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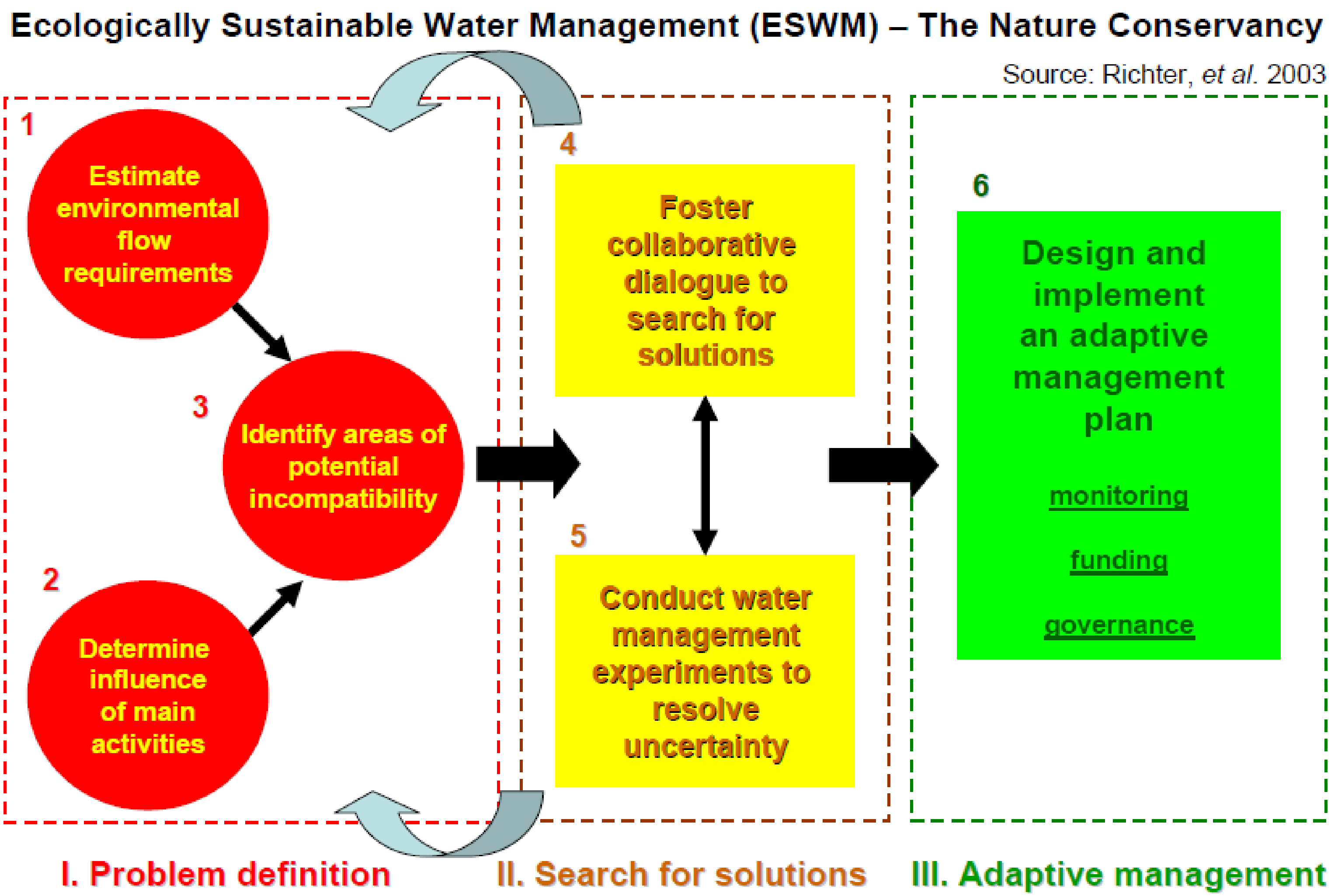
Presentation Contents

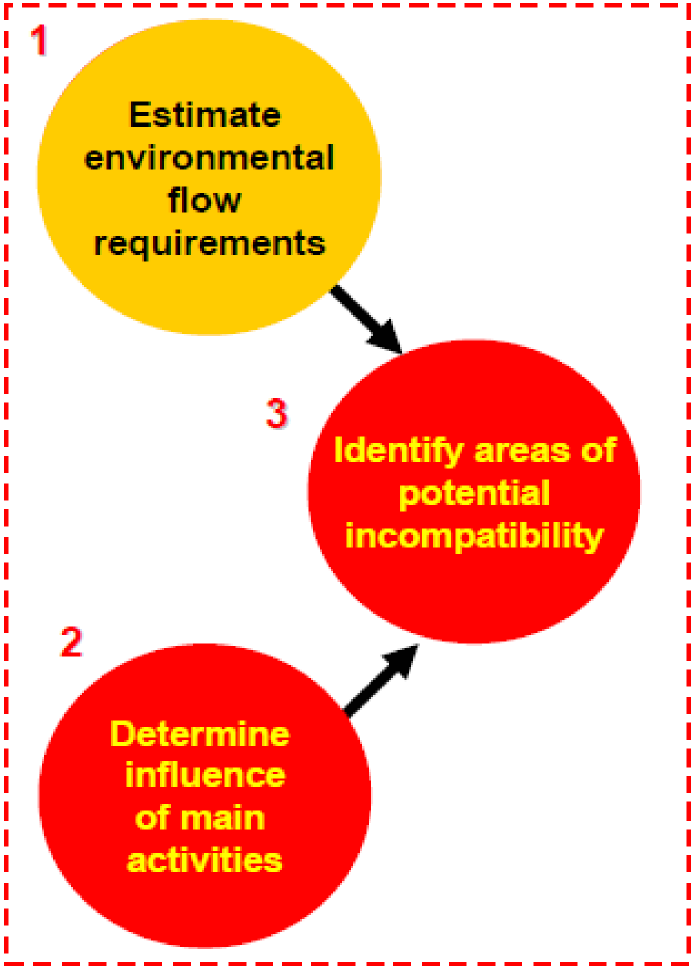
- Overview of the different components of the Holistic Method for EF
- Application of Microhabitat Methodology in calculating EF in Vomano River Basin in Italy
- Limitations in the use of Microhabitat Methodology

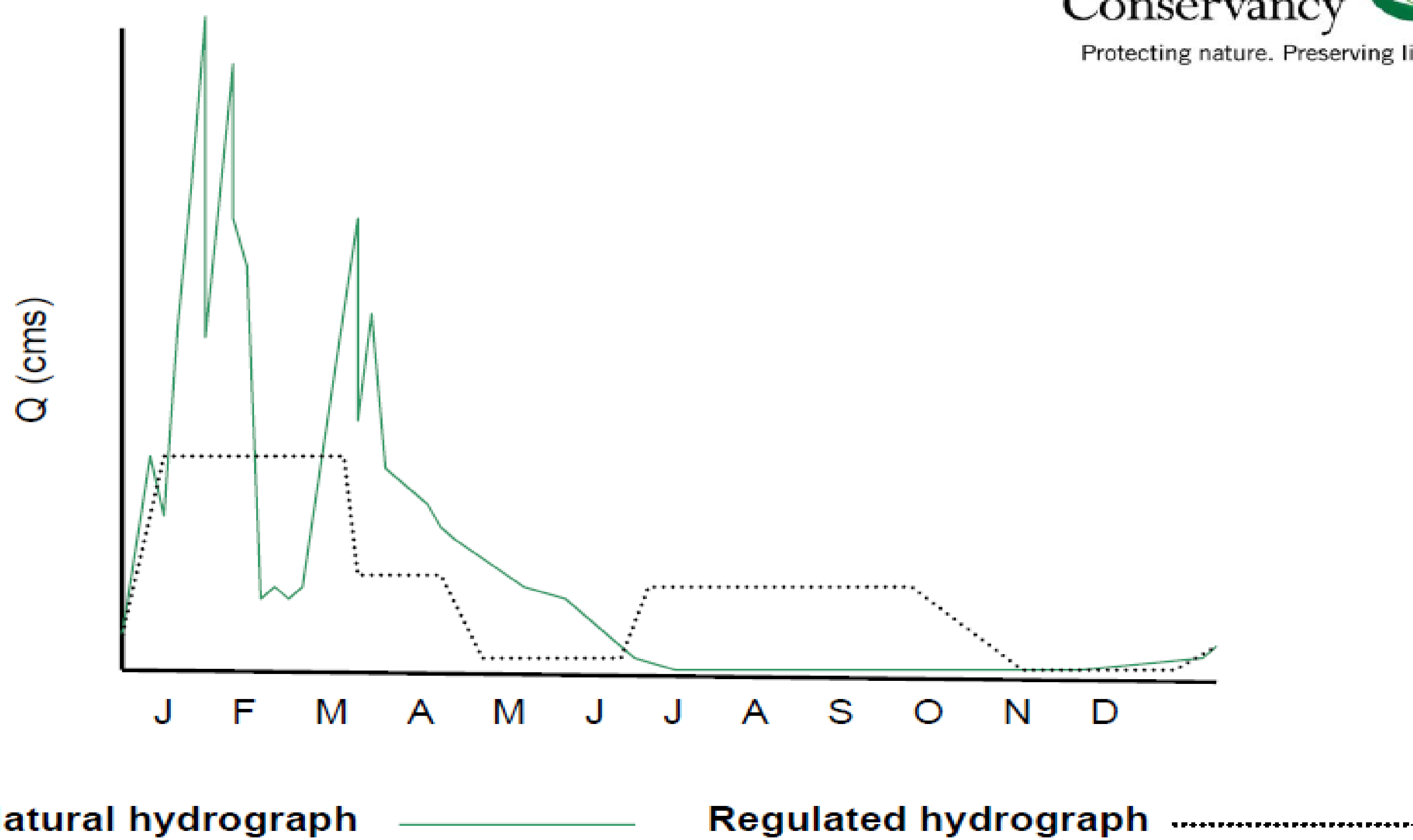
The Holistic method application



1. Estimate ecosystem flow requirements

- Gathering historical hydrological flow data series (*hydrological desk top analysis*)
- Characterization of the natural flow regime (*hydrological and hydraulic analysis*)
- Identification of critical flow events (peak flow, dry season..)
- Development of simulation models to assess how biodiversity is related to the natural flow regime (*habitat modeling ex. PHABSIM*)

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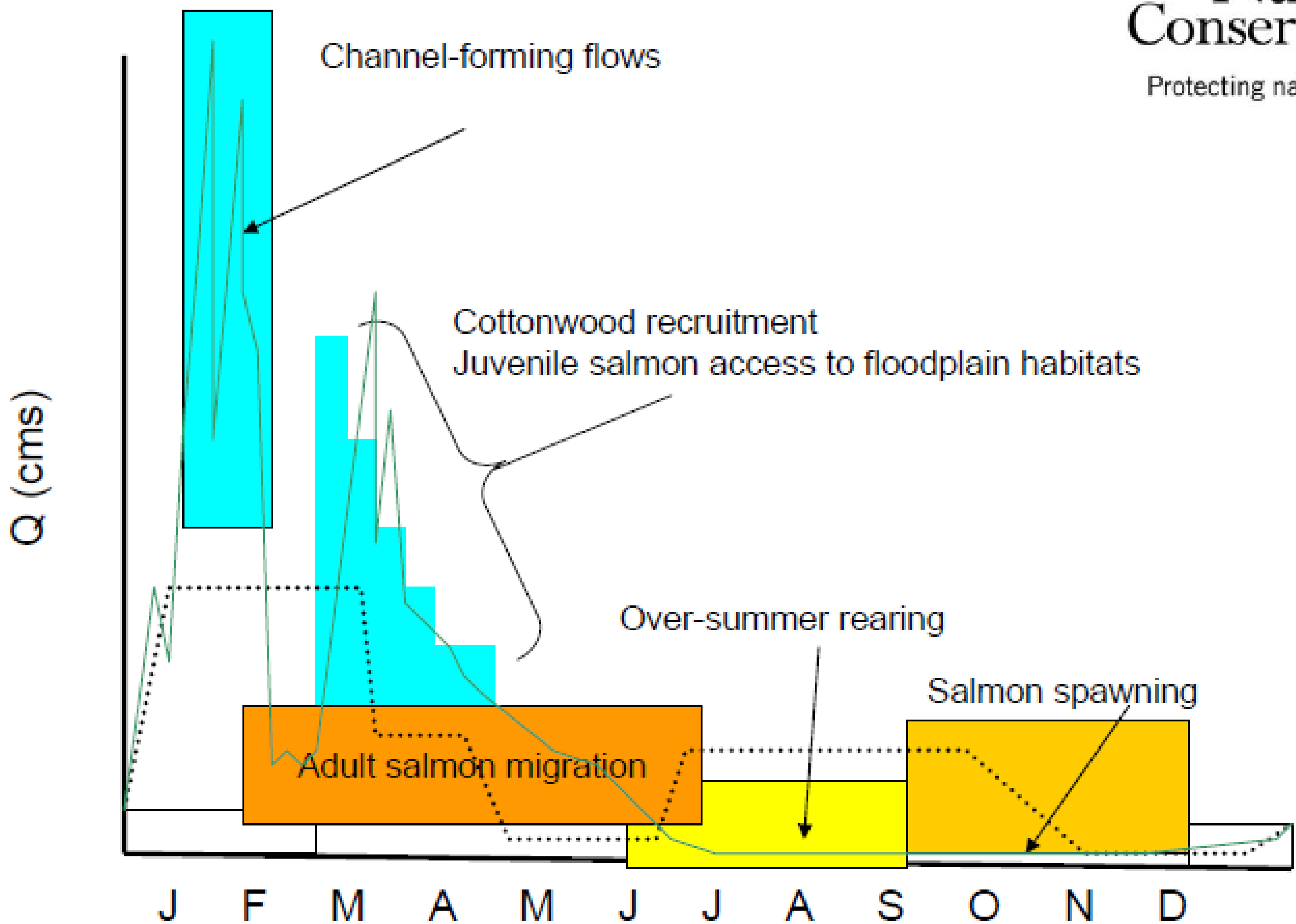
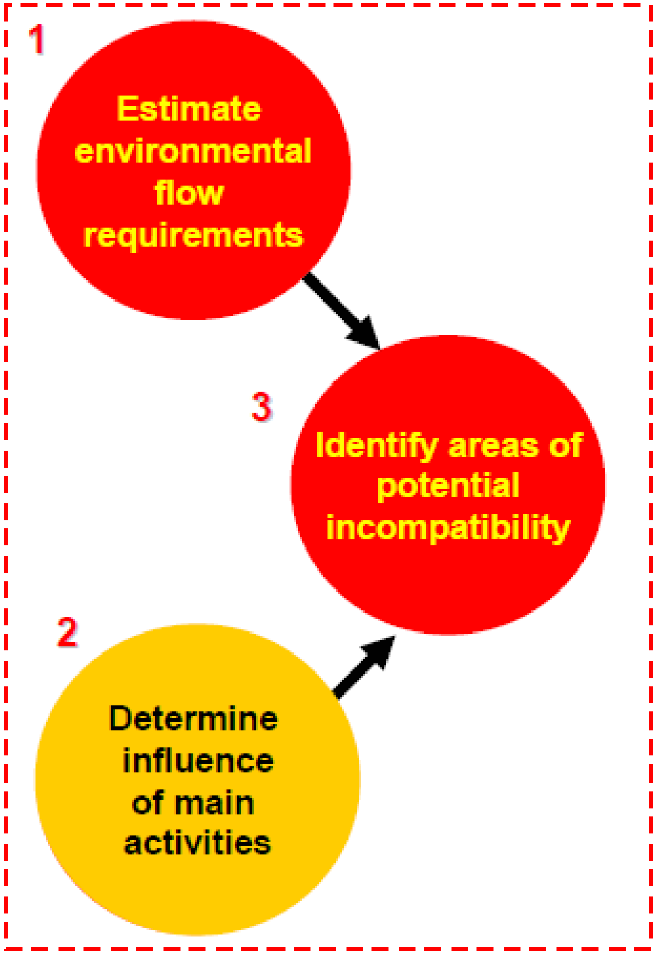
J F M A M J J A S O N D
Natural hydrograph
Regulated hydrograph



Determining flow needs for various ecosystem processes

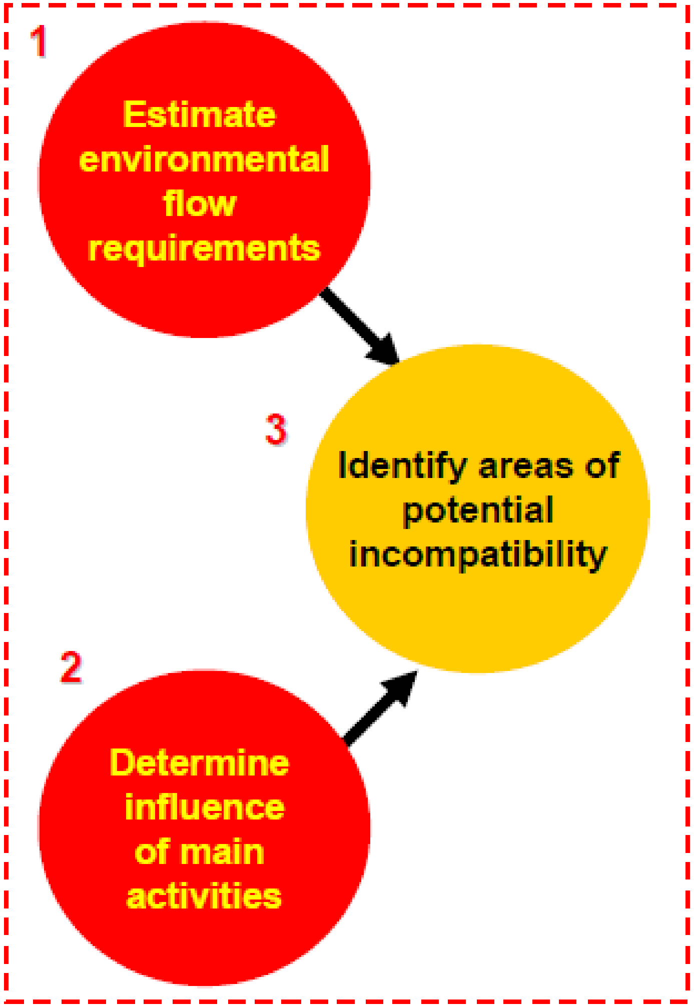
2. Determine influence of human activities

- How much the human presence is influencing the natural flow regime and the critical flow events?
- Hydrological models (ex. Water budget analysis)
- Water withdrawals, evaporation, transpiration, rainfall, etc

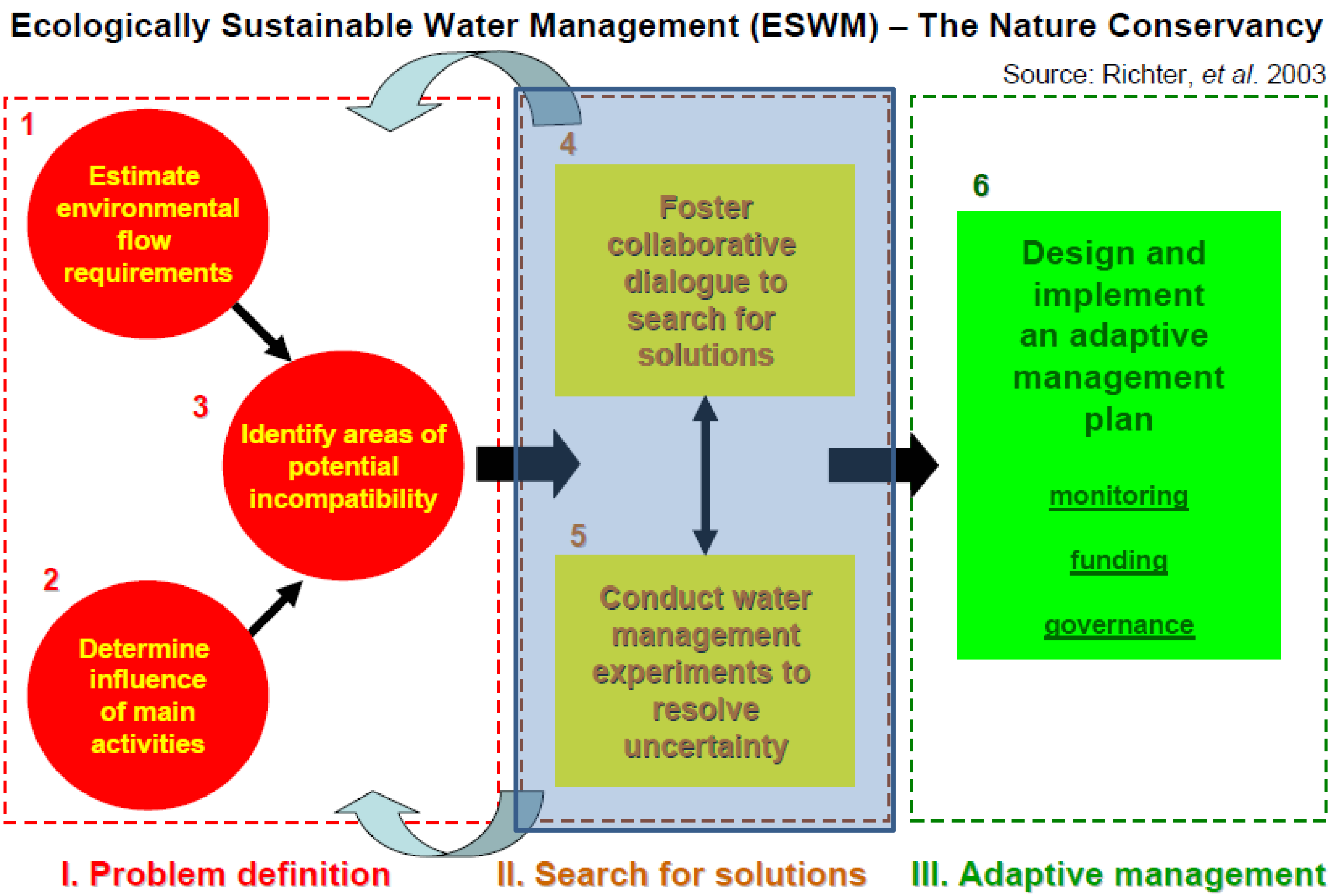


3. Identify Areas of Potential Incompatibility

- Hydrological alteration analysis (ex. IHA software)
- Range of Variability Approach (RVA)
- Flow recommendation workshop / multi disciplinary teams
- Understand the natural and altered flow regimes
- How the biodiversity and socio economy is impacted
- Scenario analysis and hydrogram prescriptions (spatial and temporal analysis)



The Holistic method application



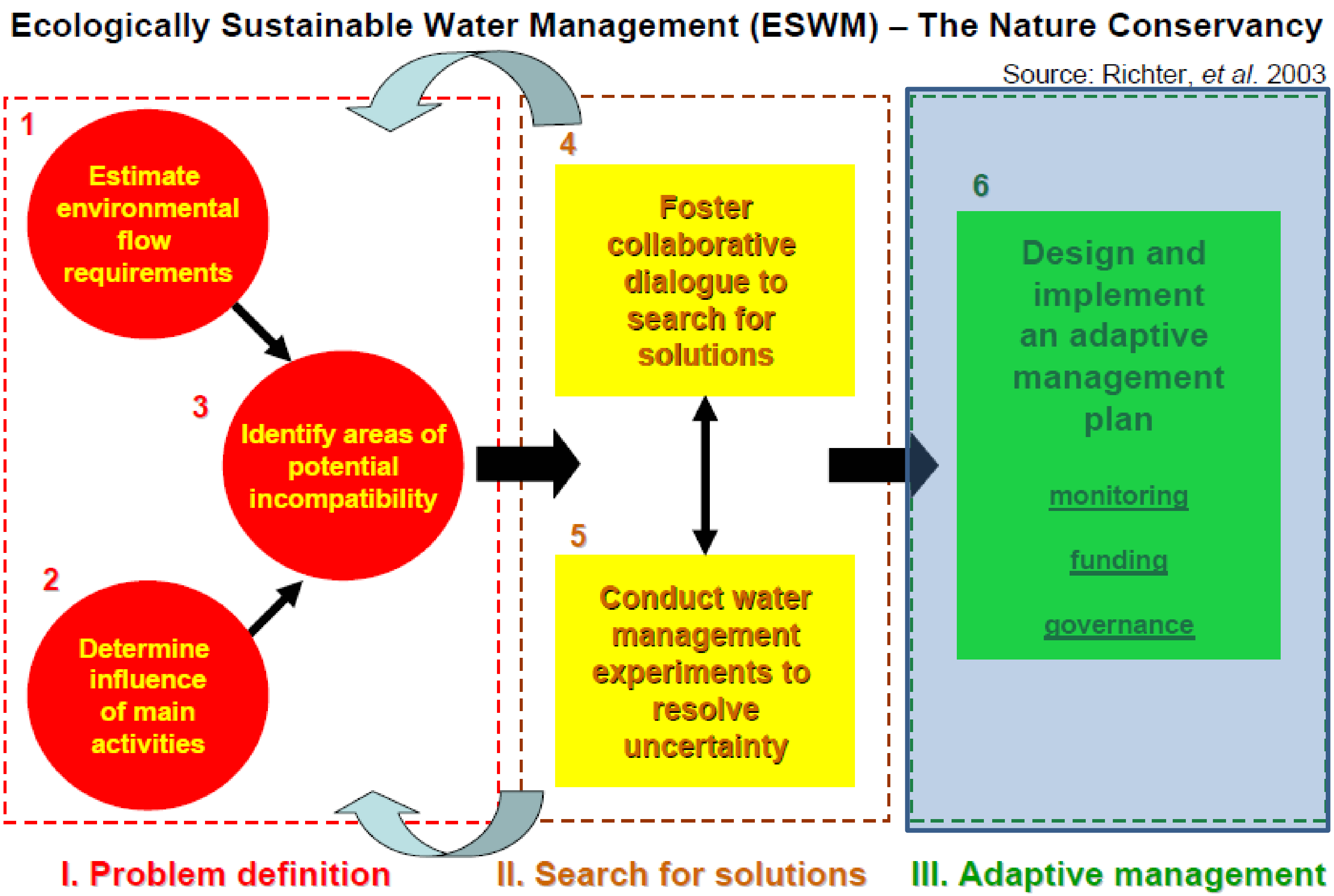
4. Foster collaborative dialogue to search for solutions

- Participatory meetings and workshops to assess the scenarios and flow recommendations
- Search for the accomplishment of distinct objectives
- Trade off analysis engaging decision makers, users, local communities, etc.
- Discuss “win win” solutions

5. Conduct water management experiments to resolve uncertainty

- Experimental implementation of the best scenario(s) (“win – win” situations)

The Holistic method application



6. Design Adaptive Management Plan

- Design and implement an adaptive management plan using the knowledge gained in steps from 1 to 5
- The adaptive management program should facilitate the long term ecologically sustainable water management
- This adaptive program includes:
  - monitoring,
  - funding
  - governance

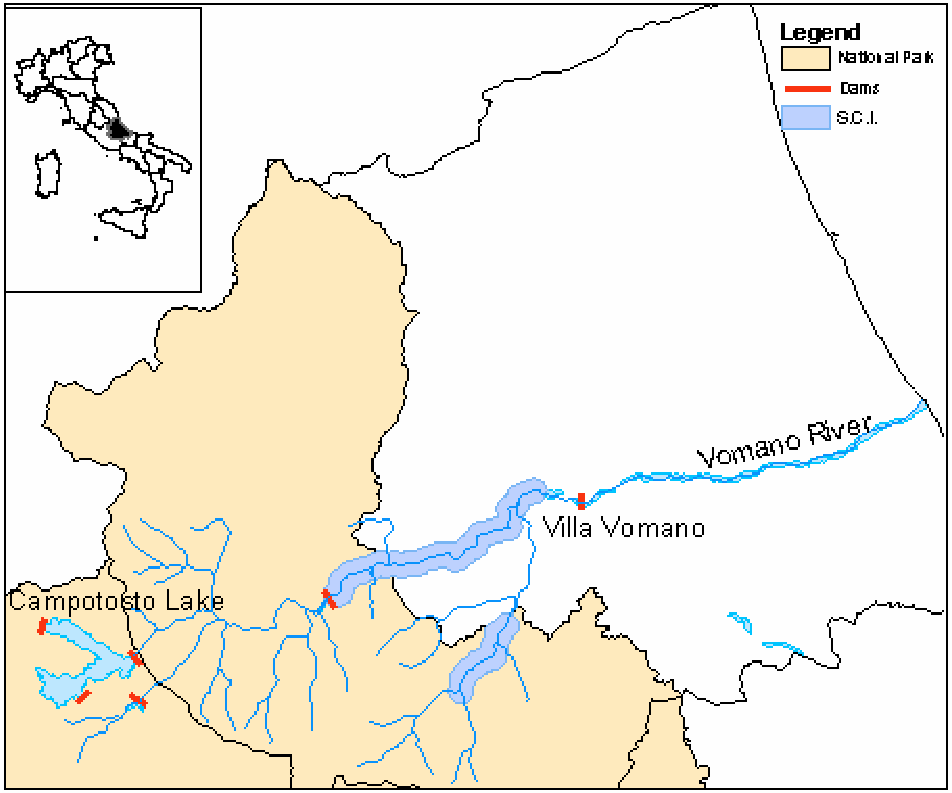
Environmental Flows and Integrated Water Resource Management: the Vomano River case study

Evolution in Defining MIF in different Italian regulations

- “a minimum residual flow in order to assure fish life” (1978)
- “the flow necessary to life in rivers so that ecosystem equilibrium will not be damaged” (1994)
- “The quantitative protection of the water resource contributes to the achievement of quality targets by means of uses planning meant to avoid impacts on water quality and to permit a sustainable water exploitation” (1999)
- “the flow that must be maintained downstream water diversions in order to maintain vital conditions of ecosystem functionality and quality” (2002)

THE VOMANO WATER SYSTEM

- The Vomano River is located in Central Italy
- its watershed is 782 km2 wide
- Average low flow of 5.6 m3/s
- While it has an average high flow of 19.2 m3/s.
- The low flow usually occurs in August while the high flow occurs in April
- The quality of water in the Vomano has been assessed as good
- Several protected areas are present in the Vomano watershed
- The Vomano hydropower plants produce 700 MW



River Water Use

- Waters from the Campotosto Lake and other reservoirs produce electric power in four main hydropower stations
- the only water release from the hydraulic conduits is at Montorio al Vomano, in the medium course of the river, where a 1.2 m3/s flow is maintained.
- After a 1200 m fall passing through four hydropower stations, the water is eventually returned to the river at Villa Vomano,
- where once again it is partially diverted for consumptive use to supply an irrigation district

Basin Environmental Problems

- The hydrological regime of the Vomano has been heavily modified by many hydraulic structures and by public works.
- The following environmental problems have been identified:
  - river bank erosion and habitat loss caused by hydro-peaking,
  - The steep variations of flow due to daily modulation of hydropower production;
  - impacts of flow diversions in the protected areas, and
  - water-mixing across different watersheds.

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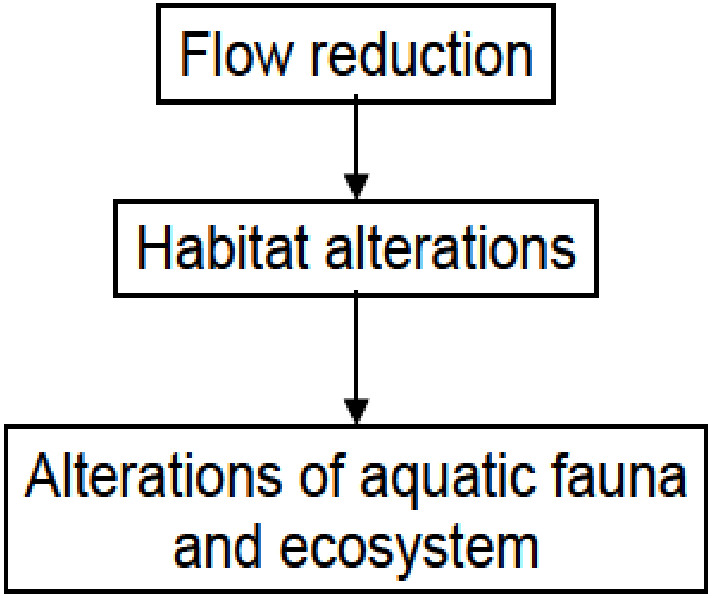
Relevant events and activities

- 1934: The hydro electrical development of the Vomano River Basin and the construction of Campostosto Lake dams are proposed
- 1939: The building of the dams that will form the Campotosto lake begins
- 1949: Power production begins in Provvidenza hydropower plant (downstream Campotosto Lake)
- 1983: River Basin Authorities are introduced in Italy
- 1999: The Italian Water Protection Act is approved
- 2000: The Water Framework Directive is approved by EU Commission
- Present: Regione Abruzzo is planning its Regional Water Protection Plan and is developing criteria for the estimation of environmental flows

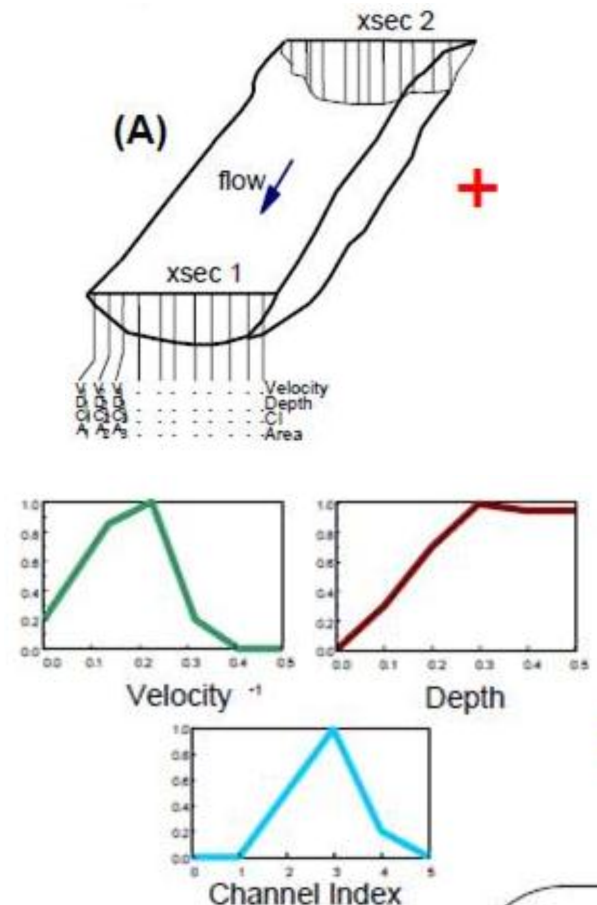
Methodology to Define MIF

- The aim was to develop an index connected to instream flow to evaluate the performance of various management options
- Microhabitat methodology adopts a deterministic approach for simulating the fish response to a water diversion
- A microhabitat simulation using PHABSIM program was used to estimate EF



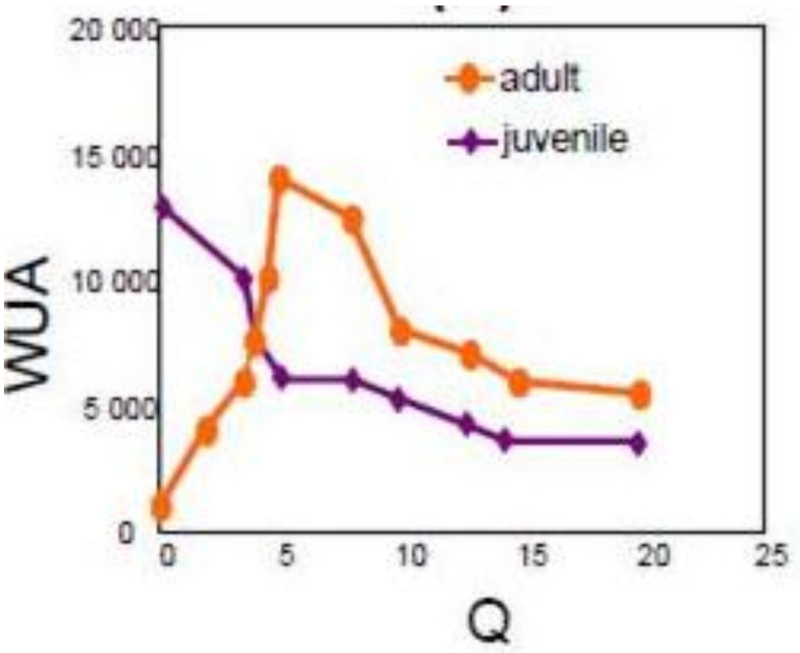
Methodology to Define MIF

- The simulation has two steps:
  - The Hydraulic simulation for microhabitat response to flow variation
  - The suitability of the new habitat conditions is computed by means of a set of suitability curves.



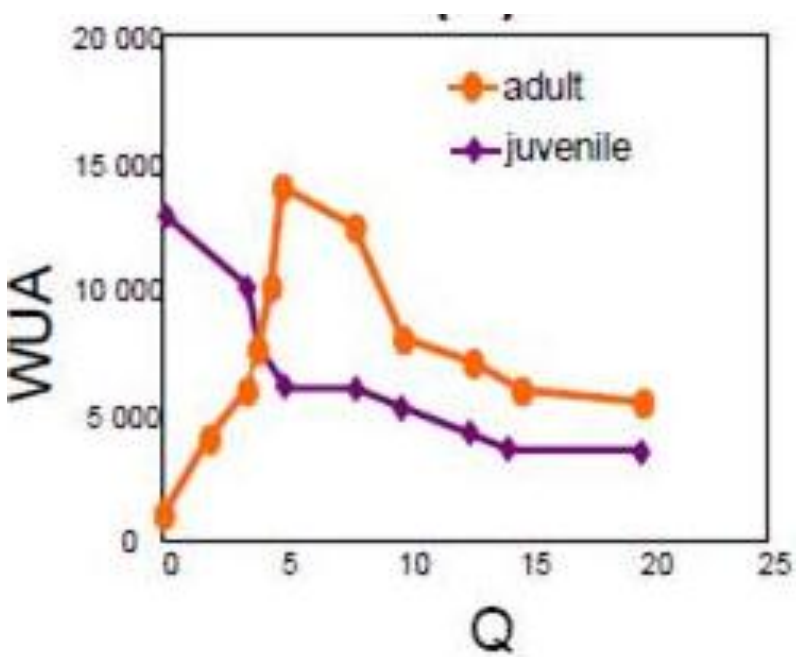
Methodology to Define MIF

- The result is an index, called Weighted Usable Area (WUA), with the dimension of an area (m2).
- It represents an area weighted for the fish preference.
- It is an index of the capacity of a stream reach to support the species and life stage being considered
- it is not a physical and measurable quantity, rather it must be considered to be an index.
- It transforms the hydrologic information into biological information



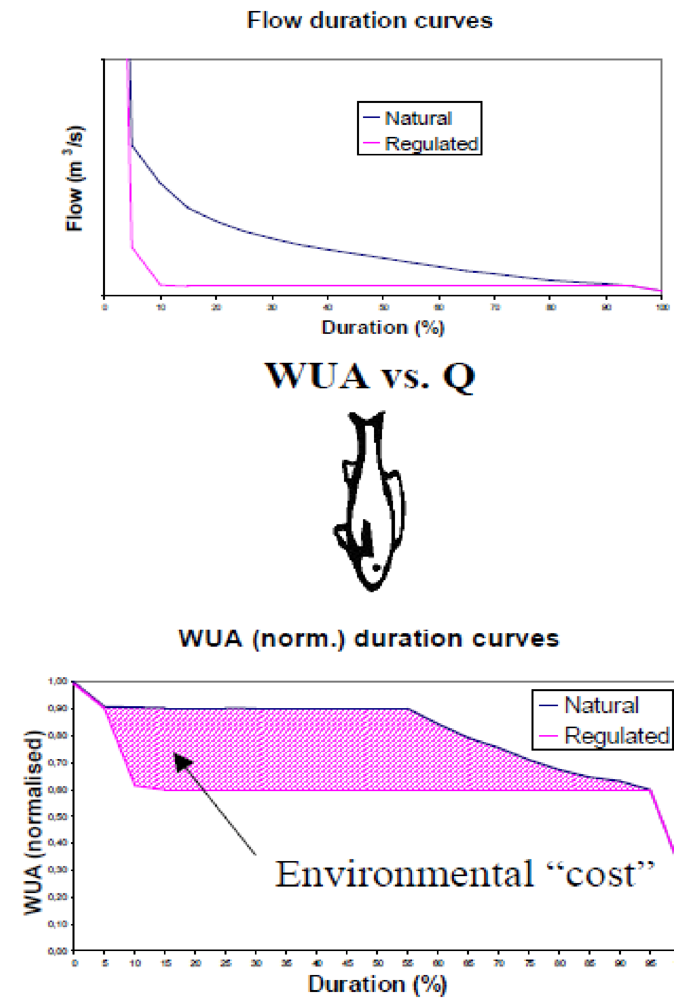
Microhabitat Methodology

- The main aim of microhabitat methodology is not the definition of a value for MIF
- It is an estimation of the response of the aquatic ecosystem to different flows
- It is suitable for development environmental performance index of various water management policies



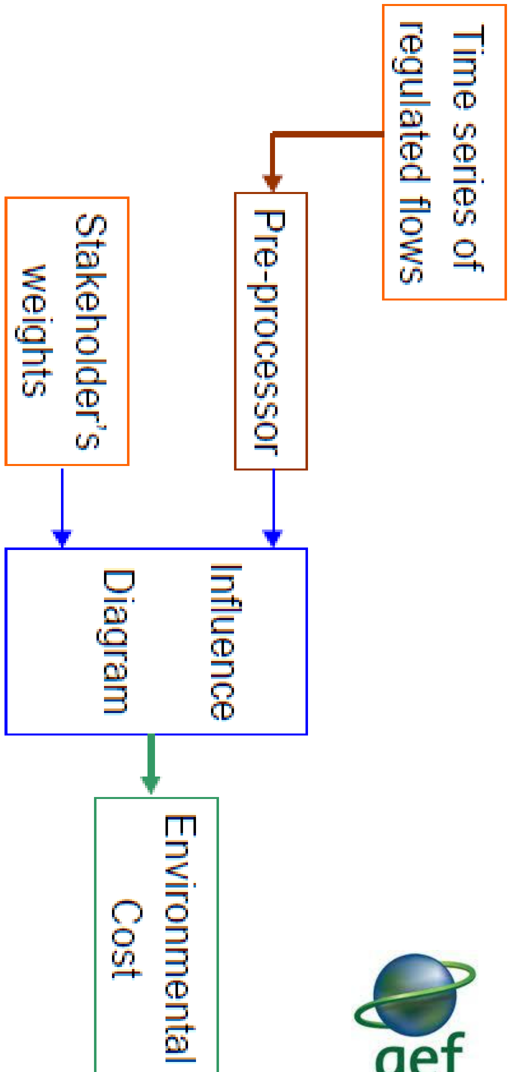
The estimation of the Environmental Cost

- Natural and regulated time series were considered
- Translation of the hydrologic forcing factors into a biological response using WUA versus flow curve
- The environmental cost of a water management policy is the distance between natural and regulated WUA duration curves
- The higher the value is, the worse the environmental impact results



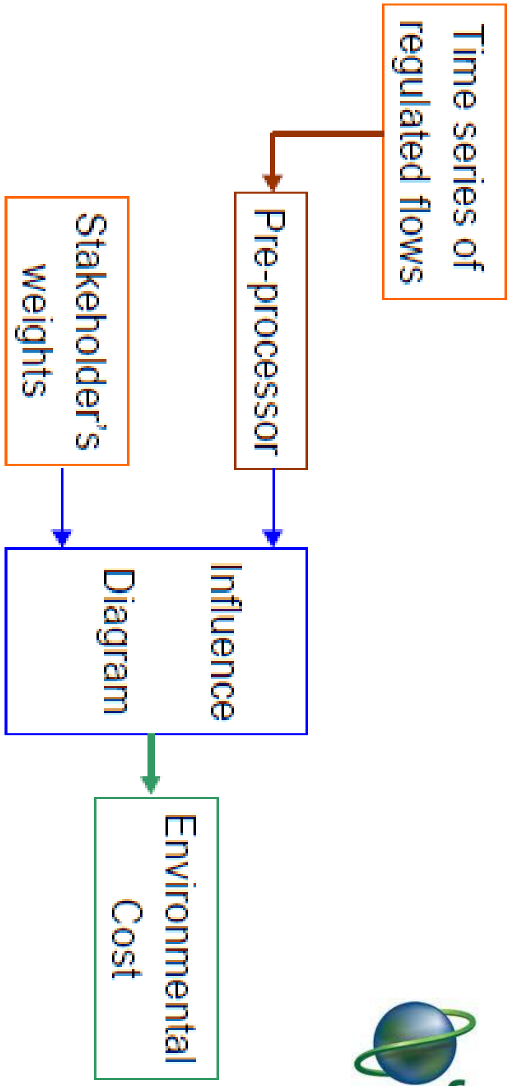
The Use of Bayesian Belief Networks

- BBN Modeling causes and effects
- In BBN, the system is represented as a set of nodes, linked in a way to represent cause and effect within the system.
- The inputs to the model are:
  - the time series of regulated flows
  - the weights assigned by the stakeholder.



The Use of Bayesian Belief Networks

- The result is an environmental cost of the management policy that has produced the regulated flows.
- it allows stakeholders to assign their own weights
- It reflects the fact that different groups do not perceive environmental value in the same way



Limitation of the Microhabitat Methodology

- The availability of the WUA curves.
- They are site-specific
- Their determination needs some intensive experimental surveys

Thank you

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