Living Neretva-Towards EU standars in the Neretva river basin (BiH)

Environmental Flow Working Group (WFD-WG1):

EF METHODS AND THE EVALUATION OF GEP METHOD

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CONTENTS

DEFINITION

Environmental Flow (EF) is the water regime provided within a river, wetland or coastal zone to maintain ecosystems and their benefits where there are competing water uses and where flows are regulated (Dyson et al, 2003).

EF: maintain structure and function of aquatic and riparian ecosystem at least at good ecological status

Methods for EF determination:

1. Hydrological methods

   look up tables, indices

2. Hydraulic rating methods

   fieldwork, rapid desk - top analysis, combination hydrology, hydraulics, ecology

3. Habitat simulation

   relation flow: habitat

4. Holistic methodologies

   functional analysis, panels of experts

GEP

1. Methods addressing flow requirements for geomorphological purposes
2. Methods addressing flow requirements for wetland, riparian and floodplain vegetation
3. Methods addressing flow requirements of fish
4. Methods addressing flow requirements on aquatic invertebrates

(Arthington, Zalucki, 1998)

Historically, the focus of instream flow studies has been on determining the low flow conditions required to maintain particular instream values, because low flow periods are the time of greatest competition for the limited amount of water that is available, and a time when the river ecosystem is most understress. However, several aspects of a river's flow regime may influence its ability to maintain particular instream values. These may be summarised as follows (Jowett and Biggs 2006):

- Large floods
- Smaller floods and freshets, with a frequency of a few times each year
- Low flows
- Annual flow regime
- Flow variability

River management requires scientifically-sound operational tools for EF (Environmental Flow) evaluation to meet instream, riparian and floodplain needs (Petts and Maddock, 1995). The basic components of EF strategy should include the following flows (Petts, 1996, Erskine et al, 1999):

- channel maintenance flows
- habitat maintenance flows
- minimum flows, which preserve aquatic and riparian ecosystem
- minimum acceptable flows, which enable maximum habitats for target species
- flows, which enable the seasonality of flood flows.

Table I. Ecological functions performed by different river flow levels (adapted from Postel and Richter, 2003)

Flow component	Ecological roles
Low (base) flows	Normal level • Provide adequate habitat space for aquatic organisms • Maintain suitable water temperatures, dissolved oxygen, and water chemistry • Maintain water table levels in floodplain, soil moisture for plants • Provide drinking water for terrestrial animals • Keep fish and amphibian eggs suspended • Enable fish to move to feeding and spawning areas • Support hyporheic organisms (living in saturated sediments) Drought level • Enable recruitment of certain floodplain plants • Purge invasive, introduced species from aquatic and riparian communities • Concentrate prey into limited areas to benefit predators
High pulse flows	• Shape physical character of river channel including pools, riffles • Determine size of stream bed substrates (sand, gravel, cobble) • Prevent riparian vegetation from encroaching into channel • Restore normal water quality conditions after prolonged low flows, flushing away waste products and pollutants • Aerate eggs in spawning gravels, prevent siltation • Maintain suitable salinity conditions in estuaries
Floods	• Provide migration and spawning cues for fish • Trigger new phase in life cycle (e.g., insects) • Enable fish to spawn on floodplain, provide nursery area for juvenile fish • Provide new feeding opportunities for fish, waterfowl • Recharge floodplain water table • Maintain diversity in floodplain forest types through prolonged inundation (i.e. different plant species have different tolerances) • Control distribution and abundance of plants on floodplain • Deposit nutrients on floodplain • Maintain balance of species in aquatic and riparian communities • Create sites for recruitment of colonizing plants • Shape physical habitats of floodplain • Deposit gravel and cobbles in spawning areas • Flush organic materials (food) and woody debris (habitat structures) into channel • Purge invasive, introduced species from aquatic and riparian communities • Disburse seeds and fruits of riparian plants • Drive lateral movement of river channel, forming new habitats (secondary channels, oxbow lakes) • Provide plant seedlings with prolonged access to soil moisture

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Richter et al, 2006

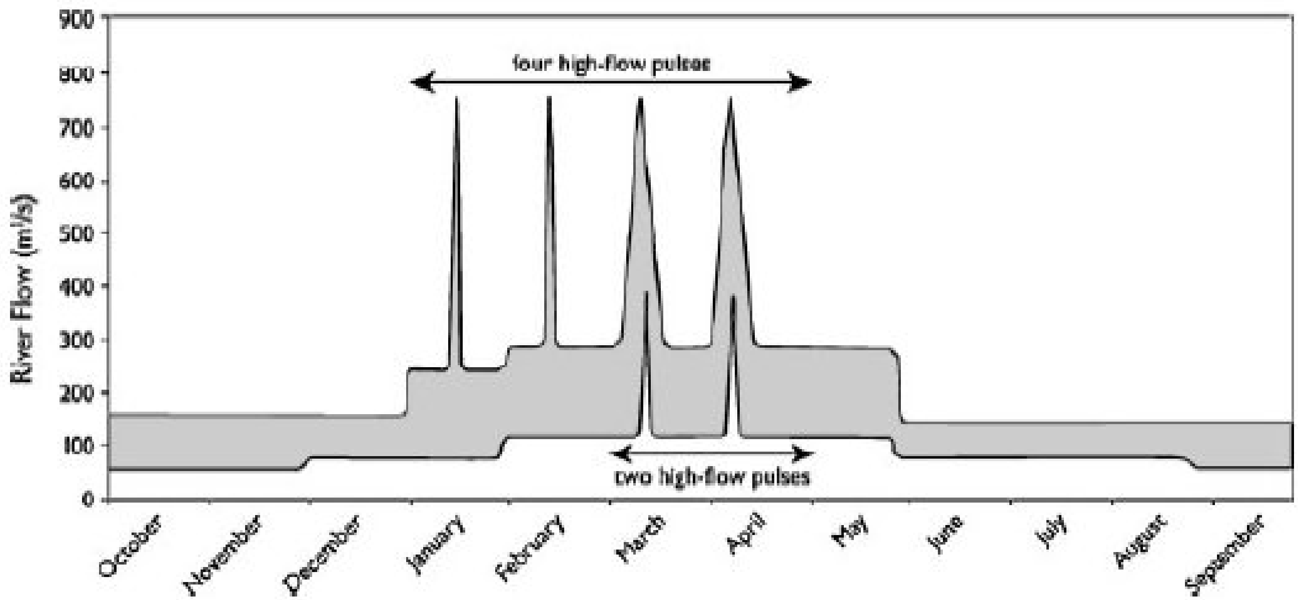

Figure 4. The flow recommendations developed during the Savannah River environmental flow workshop were specified for three different types of water years (dry, average, wet) and three different river reaches. The shaded band represents a synthesis of the flow recommendations across all three water year types for the Augusta Shoals reach. In dry years, water managers would follow the lower band range; during wet years, flows would be closer to the upper band limit. The shaded band reflects desired flow conditions during low flow periods as well as high flow pulses needed during the winter and spring (January–April)

Richter et al, 2006

Ecologically relevant components of flow regime:

1. Magnitude of discharge
2. Frequency of occurence
3. Duration of a given flow conditions
4. Timing or predictability flows
5. Flashiness of flows

Table 4. **Flow-related processes and flow components (with hydraulic surrogates) and timings for each objective.**

Objective	No.	Flow Process	Draft Flow Objective	
			Flow Component	Timing
Biodiversity Processes				
Maintain or Restore self-sustaining populations of Mountain galaxias, Flatheaded gudgeon, Southern pygmy perch	1a	Habitat availability	Low Flow and High Baseflow (depth >0.2m)	All year
	1b	Localised fish movement between habitats	Low Flow, High Baseflow and/or Freshes (>0.12 m over shallowest point)	Anytime, but especially August to September
Maintain or Restore self-sustaining populations of River blackfish	2a	Habitat availability	Low Flow and High Baseflow (pool >0.4m)	All year
	2b	Localised fish movement leading up to breeding	High Baseflow (>0.2 m over shallowest point)	Spring
Maintain or Restore self-sustaining populations of Common galaxias	3a	Habitat availability	Low Flow and High Baseflow (depth >0.2m)	All year
	3b	Localised fish movement between habitats	Low Flow, High Baseflow and/or Freshes (>0.12 m over shallowest point)	Anytime, but especially Low Flow Season
	3c	Spawning trigger and migration (downstream spawning migration by adults in Autumn, juvenile upstream migration in spring-summer)	Low Flow Fresh, High Baseflow and Freshes (>0.12 m over shallowest point)	Autumn Spring/early Summer
Maintain or restore macroinvertebrate community	4	Habitat availability	Low Flow and High Baseflow (depth >0.1m)	All year
Restore or maintain in-stream vegetation	5	Habitat availability	Low Flow and High Baseflow (depth <0.3m)	All year
Maintain/restore Riparian Forest vegetation community and structure, with zonation up the bank	6a	Habitat inundation – provision of moisture	High Baseflow, High flow Fresh	High Flow Season
	6b	Habitat inundation – variability to provide zonation	High flow variability (High Flow Freshes to Overbank Flow)	High Flow Season
	6c	Habitat regeneration - deposition of sediments	High Flow Freshes to Overbank Flow	High Flow Season
	6d	Habitat disturbance - bank/bench inundation to provide regeneration niches	Overbank Flow	High Flow Season
Ecosystem Processes				
Maintain litter/carbon cycling inputs to river	7a	Bank/bench inundation to provide inputs of dissolved and/or fine organic matter	High Flow Freshes	Autumn to Spring
	7b	Periodic inundation of banks, occasionally with power to entrain woody debris	High Flow Freshes to Overbank Flow	High Flow Season
Maintain stream substrate condition	8a	Substrate scour to remove accumulations of fine sediment	Freshes	Any time
	8b	Scour biofilms	High Flow Freshes	High Flow Season
Improve water quality	9	Re-filling and flushing of stagnant pools	Low Flow Freshes	Low Flow Season
Maintain channel form diversity	10	Disturbance	High Flow Freshes to Overbank Flow	Any time

Crook et al, 2003

4. Environmental Flow Recommendations

The flow recommendations for each reach are presented below in a standard format with four individual sections:

- A Summary of the Reach Condition. These are a very brief summary of the geomorphology, macroinvertebrate, fish and vegetation condition in the reach. These are taken from information presented in the Issues Paper (SPDEFTP, 2003).
- The Flow Recommendations. A discussion and justification of the various flows chosen for recommendation. A number of cross-section plots are presented for each reach with the flows recommended shown. These demonstrate where each flow would be expected to occur in the channel cross-section.
- Summary Tables. The recommendations are presented in the FLOWS format which identifies the various flow processes from Table 4 associated with each recommendation. Additionally, a seasonal table format developed by the Loddon River Environmental Flows Scientific Panel (LREFSP, 2002) is given that presents the recommendations in a more easily visualised manner.
- Supporting Recommendations. These indicate non-flow related issues that require attention in order that the flow recommendations will achieve their intended objectives.

Flow recommendations are made for different flow seasons during the year. From the Issues Paper (SPDEFTP, 2003), the predicted seasonality of the natural flow regime is shown in Table 5.

Table 5. Seasonality of flows adopted for the Steels, Pauls and Dixons Creek catchments.

Season	Months
Low Flow Season	December to April
Transitional: Low to High	May to June
High Flow Season	July to October
Transitional: High to Low	November

Crook et al, 2003

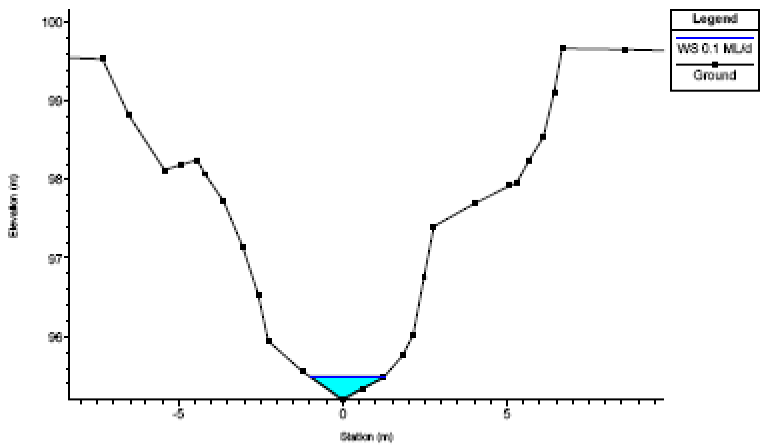

Figure 10. Water surface at zero flow in the main pool in the middle of the Dixons Creek reach.

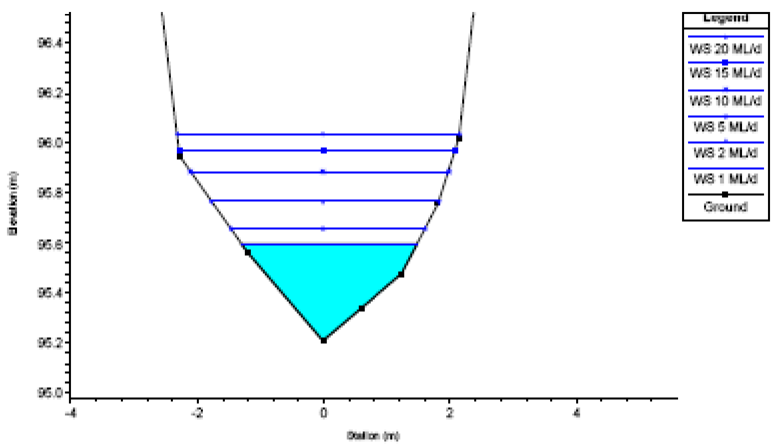

Figure 11. Detail of the pool area with flows between 1 and 20 ML/d.

Table 11. Proportion of pool transect with depths greater than 0.4 m.

Flow (ML/d)	Surface water width (m)	Width (m) of depth >0.4 m	% with depth >0.4 m
2	3.08	0.42	14
5	3.61	1.30	36
10	4.09	2.18	53
15	4.38	2.68	61
20	4.48	2.98	66

Crook et al, 2003

CHARACTERISTICS OF GEP METHOD

GEP method has characteristics of the following groups of methods:

→ Montana –Tennant method

→ modified Tennant method

→ method of wetted perimeter and

→ some statistics elements of low flows (Đorđevič, Dašić)

HYBRID OF EXISTING TECHNIQUES,
HYDROLOGICAL METHOD

MAIN ADVANTAGES OF GEP METHOD

→ simple, fast and cheap method
→ the method is general and it should be useful for different types of rivers (lowland, karst, Mediterranean) and it is not site specific
→ based on existing hydrological data
→ based on existing, world-wide used methods
→ the need of analyses of low flows
→ the use of long term probability of low flow
→ the need of analyses of river morphology
→ considering the basic relation between river hydrology and morphology as abiotic characteristics for fish habitats
→ include the basic requirements for fish habitats
→ inside EF evaluation, it is possible to make corrections of prescribed flows according to the river, from case to case
→ the use of river bed wetted perimeter method for fish habitats in the time of low flow
→ if there is an ecological value or recreational value of the river, the EF could be for 15 % higher in the cold period and 30 % higher in the warm period

MAIN **ADVANTAGES** OF GEP METHOD - cont.

→ at the outlet from reservoir the characteristics of physico-chemical parameters of water should be as much as similar like they are in the river
→ monitoring fish population
→ the use of experience from other methods

MAIN DISADVANTAGES OF GEP METHOD

→ the GEP method has not clearly established procedure how to evaluate EF
→ it has not define the analyse of critical parameters in the EF evaluation and objectives which should be achieved with EF evaluation
→ EF is evaluated only for two periods in the year: the cold and the warm period and does not take into account the dynamics of natural flows and flood flows
→ the method take into account mostly the values of low flows
→ the use of low number of parameters for EF evaluation
→ not totally include site-specific linkages between flow, morphology and ecology
→ does not include the proportion between minimum flow, mean annual minimum flow and mean daily flow
→ the values of assessed EF can be too low to achieve at least good ecological status of the river
→ depending on the river type and its location, cold period is not always between October –March

MAIN DISADVANTAGES OF GEP METHOD – cont.

→ the EF for cold period is a constant one, only in March can be values higher because of fish spawning (not all fish species spawn in this month)

→ the use of literature for GEP method does not include world-wide methods after 1990 – after this year much more were done on holistic approach

→ not include requirements for other aquatic organisms (algae, macrophytes, invertebrata) and riparian flora and fauna

→ the flow regime do not include timing, magnitude, duration and frequency of different flows

MISSING CRITERIA OF GEP METHOD – cont.

→ in the GEP method there are not included other very important criteria for EF evaluation, like:

Habitat requirements for different groups of aquatic flora and fauna,
water velocity,
water depth,
geology,
the structure of river sediments,
the presence of fish spawning grounds,
habitat mapping,
water quality
landscape picture,
tributaries in the river section with water abstraction,
the quantity and duration of water abstraction,
river connection with riparian zone,
habitats connectivity,
the length of the river reach affected by water abstraction,
other water uses that may effect the river section