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EVALUATION OF ECOLOGICALLY ACCEPTABLE FLOW FOR ALPINE STREAMS IN SLOVENIA

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CONTENTS


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SLOVENIA
Ljubljana
I
HR
Adriatic Sea

1. INTRODUCTION

Intensive economic development and land use

→ The need for water is rising fast

→ **water abstraction** from the alpine running waters:
drinking water, energetic use, fish-farming, technological purposes

Determination of EAF is an extraordinary difficult task, because of direct confrontation between

ECOLOGY : ECONOMY

→ interdisciplinary approach and each section of the stream should be treated separately

2. DEFINITION AND BASIS FOR DETERMINATION OF EAF

ECOLOGICALLY ACCEPTABLE FLOW

is the quantity and quality of water which preserve ecological balance in the stream and in the riparian zone

- **the importance of preservation and protection running waters, their habitats with flora and fauna and diversity of organisms**
- **Special attention should be paid to rare and endangered species respectively the groups important for the preservation of the ecological balance.**

- **EAF should be determined before each impact in the river or in the area, which could have an influence on the structure and function of the river as the ecosystem.**
- **The necessary of all existing hydraulic, hydrological and ecological parameters on the sections concerned should be checked.**
- **For each change of quality and quantity of water in the river a new determination of EAF is required.**

3. CRITERIA AND METHODS

Hydrological, hydraulic, morphological and ecological criteria

HYDROLOGICAL METHOD

→ Basic hydrological and hydraulic parameters

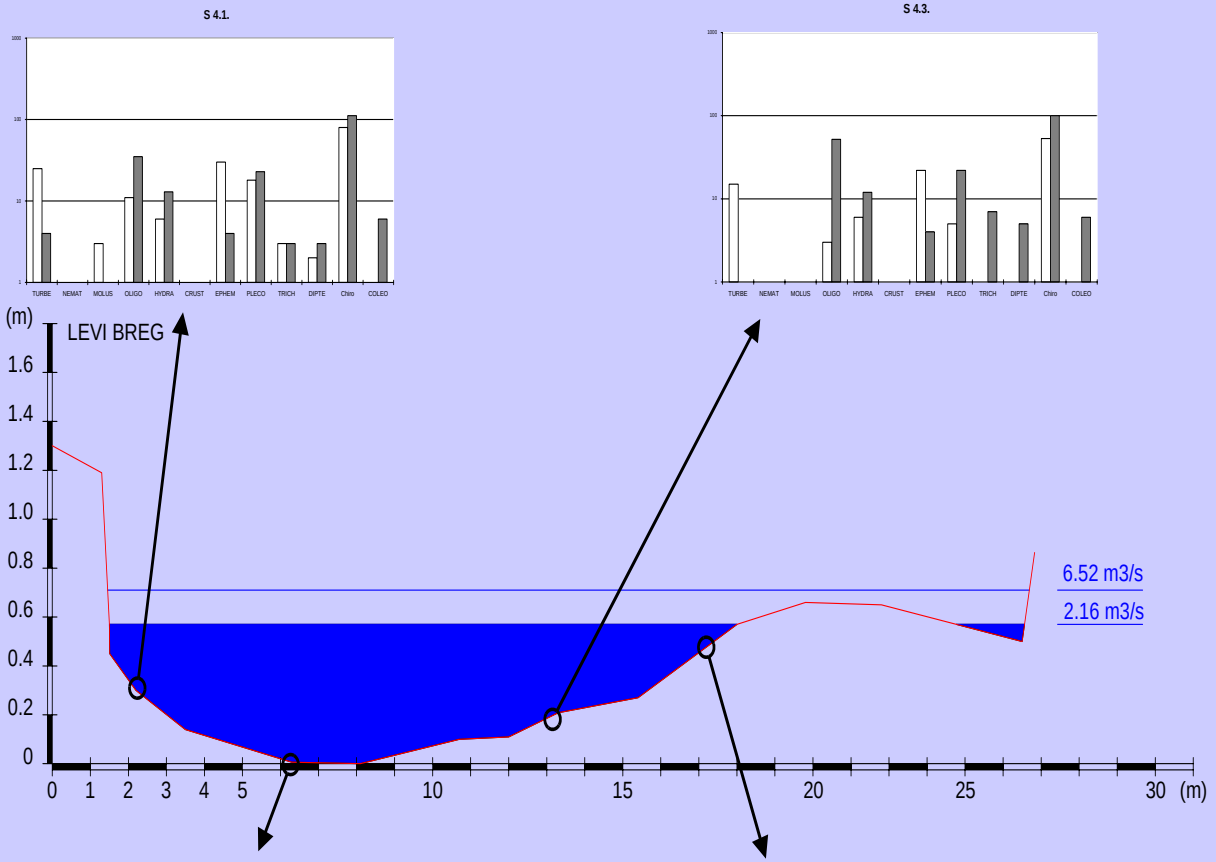
→ Ecological estimation, inventory of habitats

→ Morphological estimation (substrata)

ECOLOGICAL METHOD

→ Inventory of water organisms: zoobentos, phytobentos, macrophytes, fish

→ Seasonal dynamics


S 4.1.
S 4.3.
TURBE NEMAT MOLUS OLIGO HYDRA CRUST EPHEM PLECO TRICH DIPTE Chiro COLEO
(m)
LEVI BREG
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0 1 2 3 4 5 10 15 20 25 30 (m)
6.52 m3/s
2.16 m3/s
S 4.2.
S 4.4.

The EAF is determined according to biotic and abiotic parameters that the ecological balance is preserved

Decission → results of experts

The values vary for different seasons

4. APPLICATION OF DETERMINATION OF EAF

From 1992 the EAF was determined on more than 100 parts of alpine running waters in Slovenia and mostly for existing water users – the tolerance limit of the user economy was consider

→ The most water users abstract too large quantities of water in low flow periods;

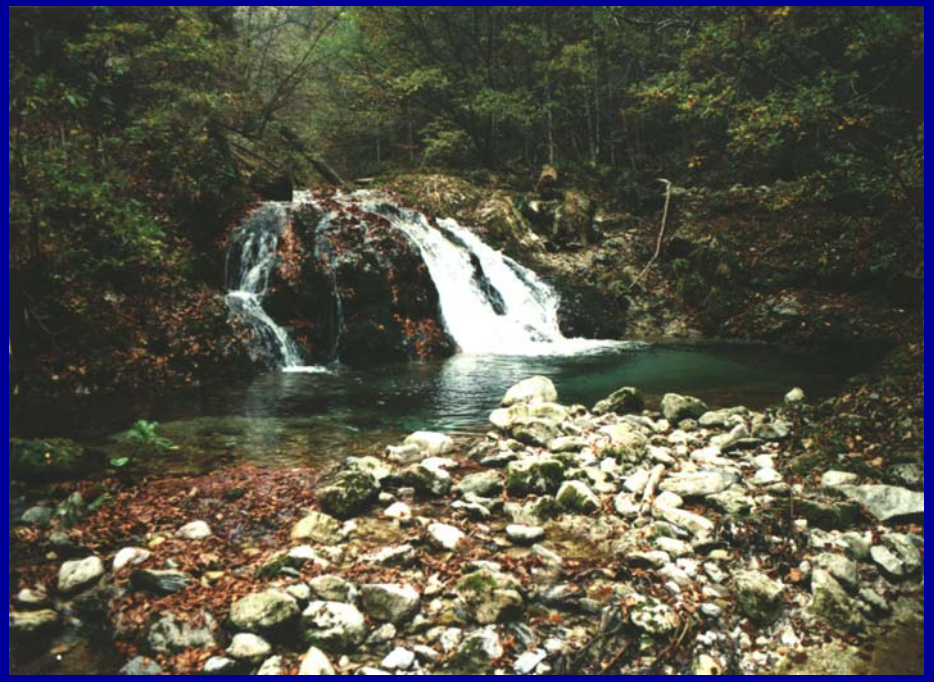
IMPACT: changes in physical, chemical, hydrological and morphological parameters of water → natural balance was disturbed

Q = 1600 l/s

Q = 0 l/s

Q = 25 l/s

Q = 65 l/s



5. CASE STUDY: THE SOCA RIVER

- The first hydropower plants were built 1930-1932
- The Doblar and Plave power plants were constructed in 1939 and 1940

- As a consequence of power utilisation, there is no natural flow regime downstream of the Podsela Dam to the Italian border.

THE PURPOSE:

Determination of EAF

The Soca River

power plant Doblar and Plave, (90) 180 m^3/s

4320 m, 7950 m,

1996 - 2001 SO1 – SO4

Qmin Doblar = 0.2 m^3/s, Qmin Plave = 0.5 m^3/s

MATERIAL AND METHODS

- Periphyton and periphyton biomass, zoobentos in different aquatic habitats
- Hydrological parameters: flow, current velocity
- Flow duration curve with and without abstraction
- Temperature, oxygen, saturation, conductivity
- The Wolman Count of sediment samples was performed
- Flora and fauna in the riparian zone
- Landscape evaluation – increasing flow downstream the dam (test)

RESULTS

Table 1: Flows in the River Soca in 1998.

Cross section	Q W98 (m^3/s)	Q S98 (m^3/s)	Q S98 (m^3/s)	Q W98 (m^3/s)
SO1	11.3	11.3	16.9	16.3
SO2	0.26	0.27	0.26	0.23
SO3	0.26	0.27	0.26	0.23
SO4	2.23	0.86	/	1.25

Downstream of the dam Podsela:

Physicochemical parameters

High seasonal oscillation in water temperature and concentration of oxygen

Water temperature: in the summer higher, in the winter lower

Concentration of oxygen: in the summer lower, in the winter higher

Differences among aquatic habitats

Species composition

***Cladophora glomerata* – high biomass**

High temperature, limited movement of substrata, constant low flow

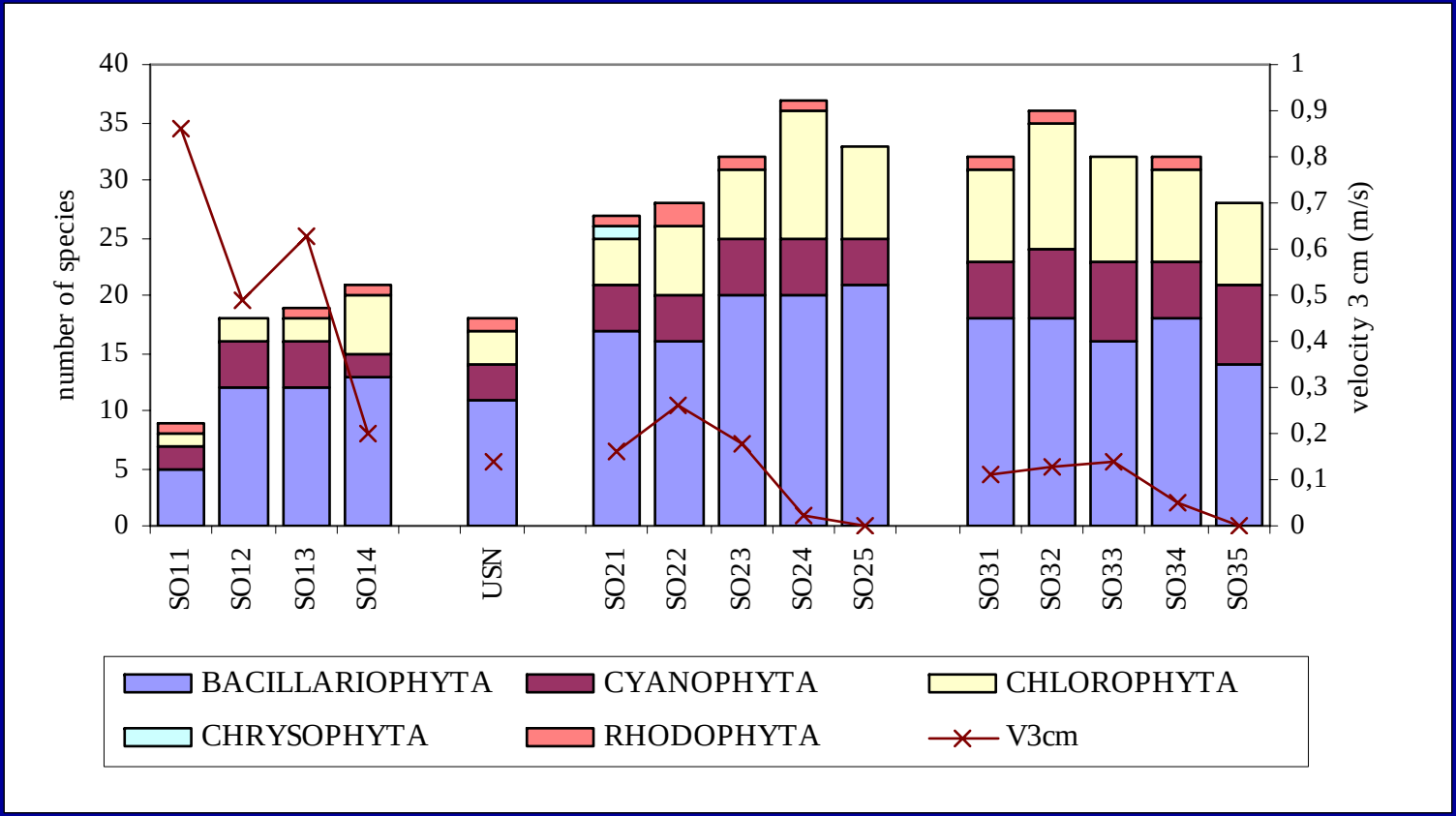
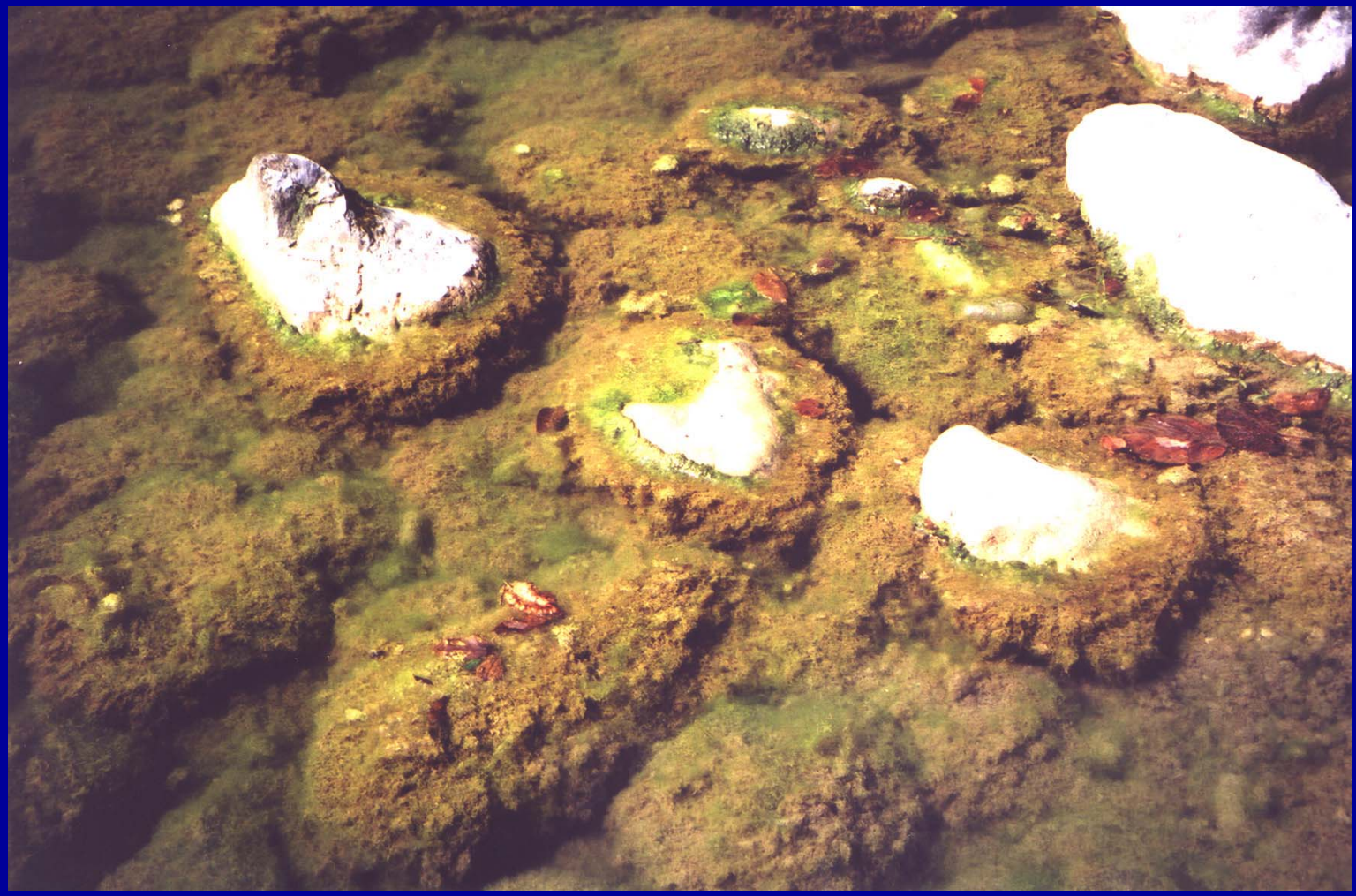


Figure 1. The periphyton composition at sampling sites in the river Soca and stream Usnica, 25th of August 1998.

Periphyton biomass

- The highest values in summer in the sections with low water level and low current velocity,

- Low flow, favourable light conditions and sediment structure were factors which made proliferation of algae possible



TEST: Increasing flow downstream the dam

Table 2. Velocity and depth according to increasing flow

Cross section	Parameter	0,26 m^3/s	0,6 m^3/s	1,1 m^3/s	1,6 m^3/s
SO2	*v* (m/s)	0,20	0,48	0,52	0,61
	$Depth_{max}$ (m)	0,36	0,39	0,47	0,53
SO3	*v* (m/s)	0,17	0,34	0,38	0,42
	$Depth_{max}$ (m)	0,27	0,29	0,37	0,44

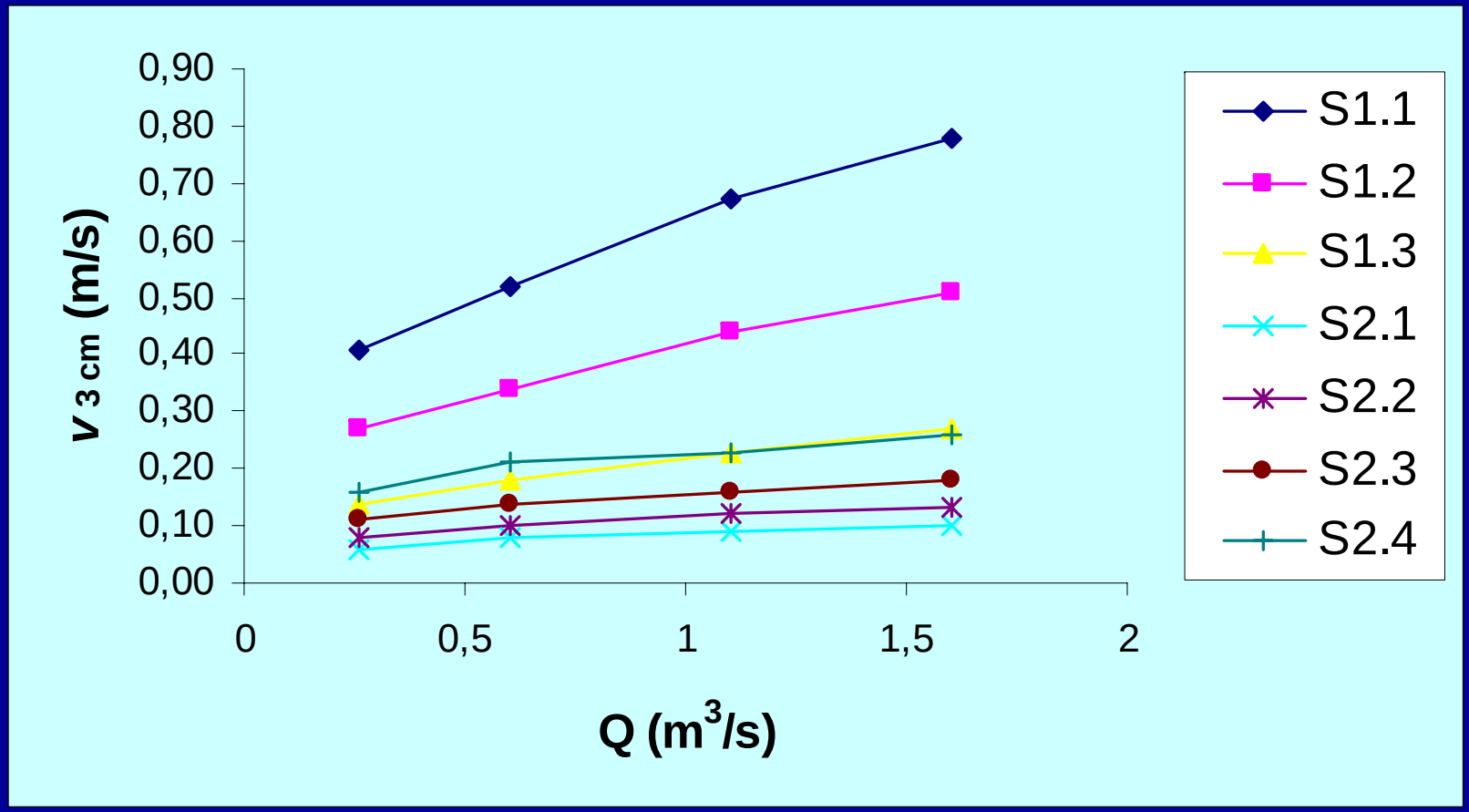


Figure 2. Test: Increasing flow in comparison with velocity 3 cm above the bottom

Q = 200 l/s

Q = 1100 l/s

EAF DETERMINATION FOR THE SOCA RIVER

The impact of abstractions, especially in the time of low flows shows big changes in hydrological, physicochemical and biological parameters downstream of the dams

- **Improve the habitats: the number and diversity**
- **Take into account: existing water abstraction for (60 years)**
- **According to analyses of abiotic and biotic parameters**

⇩

The EAF below the Podsela dam = 1.0 m^3/s (before 0.2 m^3/s)

The EAF below the Ajba dam = 2.5 m^3/s (before 0.5 m^3/s)

6. CONCLUSIONS

- In last 10 years there has been strong efforts to improve ecological characteristics of the Slovenian alpine running waters with determination and assurance of EAF
- The water should be abstracted only on the sections where this is ecologically and economically acceptable