

# Connectivity Solution for Huchen *Hucho hucho* (L.) in Human-altered Habitats

<sup>1</sup>Predrag Simonović, <sup>2</sup>Danilo Mrdak, <sup>3</sup>Marina Piria, <sup>4</sup>Metka Povž,  
<sup>5</sup>Karol Hensel

<sup>1</sup> University of Belgrade, Faculty of Biology, Studentski trg 16, Belgrade, Serbia

<sup>2</sup> University of Montenegro, Faculty of Science and Mathematics, Džordža Vašingtona bb., Podgorica, Montenegro

<sup>3</sup> University of Zagreb, Faculty of Agriculture, Svetošimunska cesta 25, Zagreb, Croatia

<sup>4</sup> Zavod Umbra, U. b. Učakar 108, 1000 Ljubljana, Slovenia

<sup>5</sup> Comenius University, Department of Zoology, Bratislava, Slovakia

LIFE, „Ljubljana Connect“, Ljubljana, 16 – 17 October 2015

## GENERAL REMARKS



Huchen is out-of-doubt the largest salmonid fish species, attaining the size up to 60 kg in weight and 1,83 m in length.<sup>1</sup>

It is endemic, as being native in headwaters of the River Danube basin, in the mountain and sub-montane zones in rivers of all sizes, sharing as a top predator the habitat with nase *Chondrostoma nasus*, chub *Squalius cephalus*, Danubian blageon *Telestes agassizii*, barbel *Barbus barbus*, Danubian roach *Rutilus pigus* and grayling *Thymallus thymallus*, who are all huchen's preying fish species.

According to the IUCN Red List, huchen is globally endangered species **EN B2ab(ii,iii)**<sup>2</sup>, as assessed according to reduction in population size and decrease of geographic range in their natural dispersal area, both in its extent and of quality of habitats within it. They are threatened the most severely by high dams construction that destroys their natural habitat and habitat of fish species in their ecosystem<sup>3</sup>.

Considering everything stated above, there is a strong and urgent need for stopping of huchen strong recent decline, especially in their natural area.

<sup>1</sup> Baruš, V. & O. Oliva (1995). *Mihulovci Petomyzontes a ryby Osteichthyes*. Academia Nakladatelství Akademie věd České republiky, Praha,  
<sup>2</sup> <<http://www.iucnredlist.org/details/10264/03>>, downloaded on 3 Oct 2015

<sup>3</sup> Freyhof, J., S. Weiss, A. Adrović, M. Čaleta, A. Duplić, B. Hrašovec, B. Kalamujić, Z. Marčić, D. Milošević, M. Mrakovčić, D. Mrdak, M. Piria, P. Simonović, S. Šljuka, T. Tomljanović, & D. Zabrc. 2015. The Huchen *Hucho hucho* in the Balkan region: Distribution and future impacts by hydropower development. RiverWatch & EuroNatur, 30 pp.

## CURRENT STATUS<sup>3</sup>

- Historically huchen was widely spread across the Danube basin
- Since the late 19th century populations declined by two thirds
- Recently, 1842 river km of 43 rivers supporting self-sustaining populations of huchen are identified in the Balkans region (SLO, CRO, BIH, MNE, SRB)
- Six rivers of +100 km in length (Sava, Kupa, Una, Sana, Drina and Lim) are global huchen habitats
- 1072 km of the total habitat is found in Bosnia-Herzegovina, 456 km in Slovenia, 391 km in Serbia, 240 km in Montenegro, and 228 km in Croatia
- Population trend information was recorded for 34 (1630 km) of the 43 river sections (Table 1). Of these, approximately 42% (688 km) were considered to support populations that were stable, 22% (354 km) increasing and 36% (588 km) decreasing



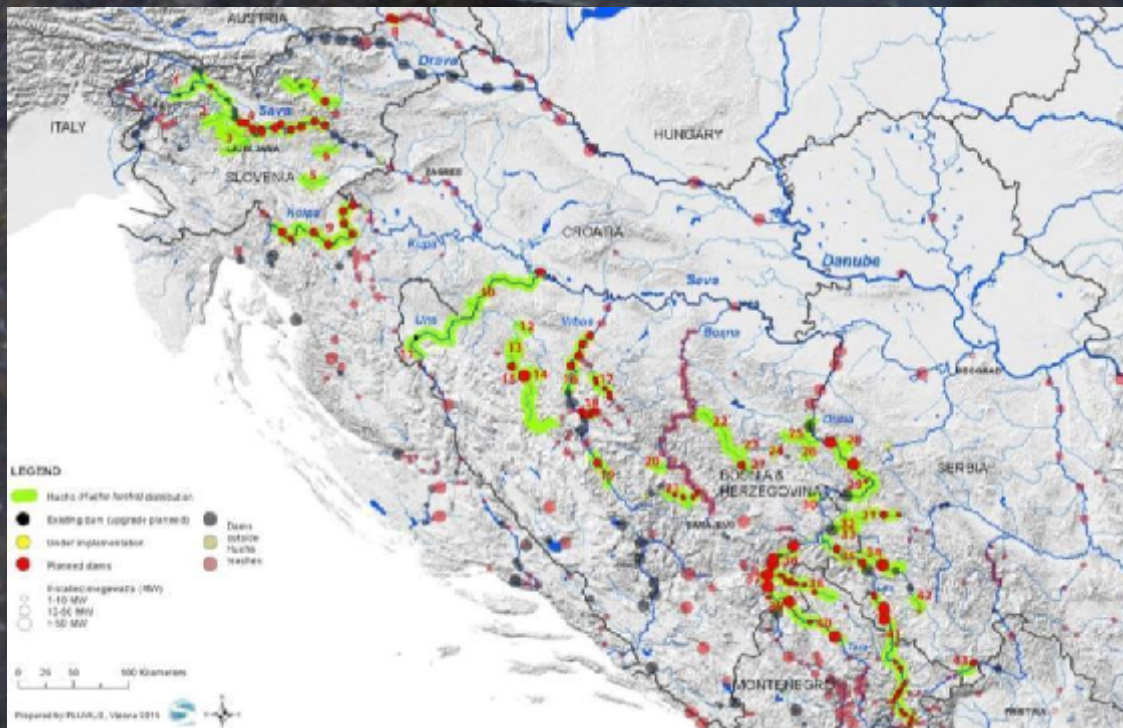
# THREATS AND THEIR EFFECTS

Major threats:

- river obstruction
- water quality deterioration
- overfishing and poaching

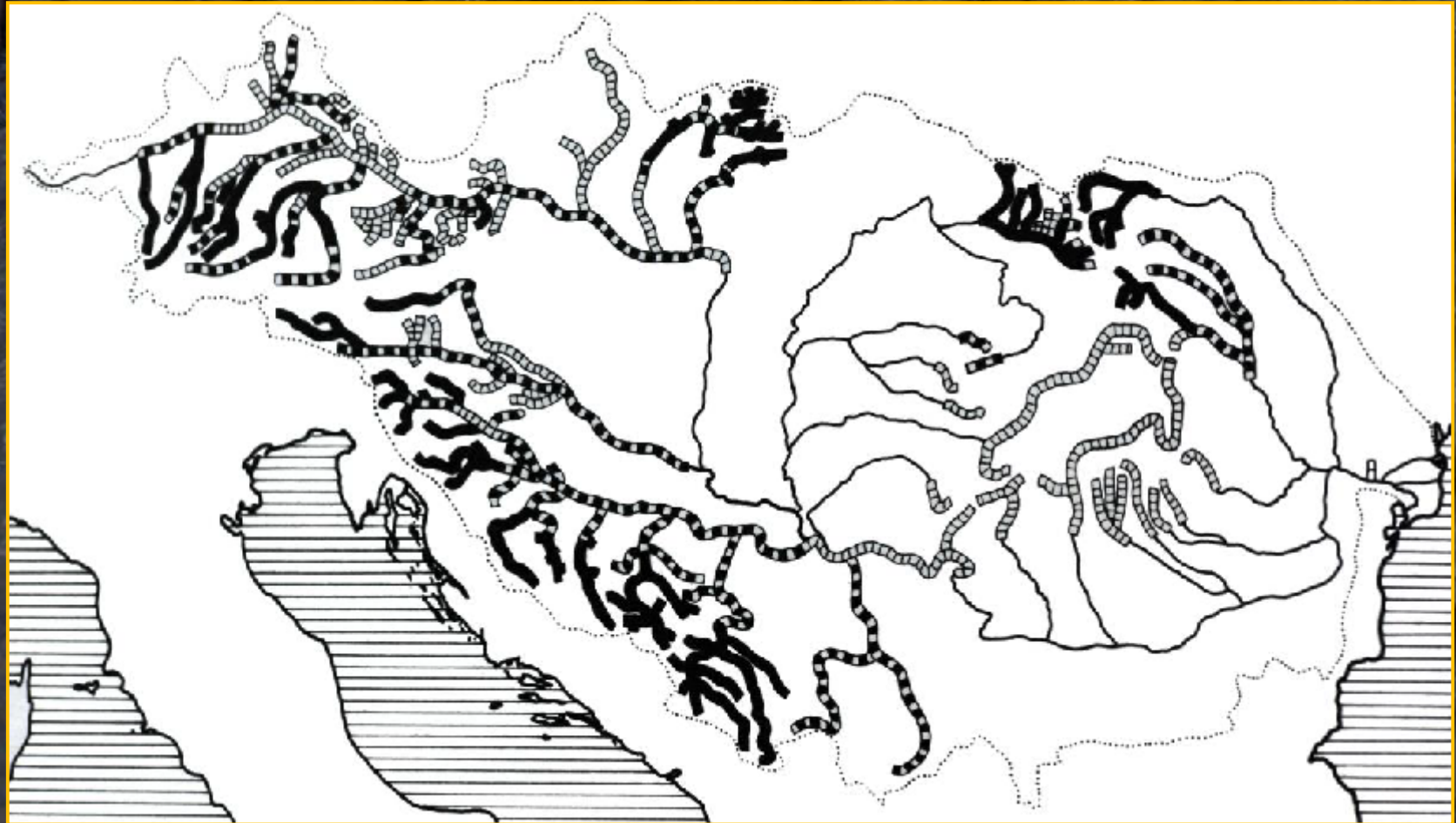
In reality, adverse effects of all threats **except constructing the dams** are reversible: they can vanish if the threat would be solved out.

- Huchen need riverine environment with clean water
- Numerous micro-facilities planned in tributaries of huchen rivers will block their access to spawning grounds
- Larger storage plants with dams planned to be built in a river's main channel
- 93 hydropower schemes are newly planned
- Varying in size: 42 plants from 1-10 MW peak load, 38 from 10-50 MW and 13 less than 50 MW.



## THREATS AND THEIR EFFECTS

- Prediction>: at least 60-70% of the Balkans population (about 35-40% of the global) of huchen would be lost
- Remaining populations small and severely fragmented, no longer able to long-term survival



## THREATS AND THEIR EFFECTS

**Dams** result in direct degradation or destruction of riverine habitat at the dam and for the length of the reservoir behind the dam:

- transform a river into a reservoir, with unnatural water level fluctuations
- massively reduce bottom invertebrate fauna
- severely reduce rheophilic fish species in numbers
- establish a migration barrier for fishes

**Hydropeaking** – the fluctuating release of different volumes of water:

- decreases aquatic fauna
- severely degrades reproduction and early life-history stages of fishes
- causes washing of gravel bars and sand banks, as well as sinking of the river bed bottom level
- flushing of reservoirs heavily impacts fish downstream and clogs interstitial spaces in the river bed substrate, deterioration bottom fauna and eliminating fish spawning grounds

**Reservoirs:**

- not considered viable habitat for complete life history cycle of huchen
- susceptible to periodical deterioration in water quality
- no sufficient abundance of the prey fish species in the reservoir
- incapable to spawn in lotic environment

## MIGRATION<sup>4</sup>

There is really a strong contradiction in available reports about the huchen migratory behavior.

**Spawning behavior** to smaller tributaries is well known, in contrast to the knowledge about the length huchen migrate to approach them.

While Ivaška (1946) assumed long migrations of up to 190 km from River Danube to River Vah in Slovakia, Nieslanik consider them much shorter (up to 25 km), especially when large brood fish (> 15 kg) are in concern, the smaller ones (up to 7 kg) being observed migrating in longer distances at higher water levels. Vokač (1959) reported only transversal shifts of breeding huchen in the upper River Drava, from one bank to the other.

Related to that, there are no reliable records are migrations in huchen coupled with the **homing effect**.



<sup>4</sup>Holčík, J., Hensel, K., Nieslanik, J. & L. Skácel (1988). *The Eurasian Huchen, **Hucho hucho**, Largest Salmon of the World*. Dr. W.Junk Publishers, Dordrecht, Boston, Lancaster.

## MIGRATION<sup>4</sup>



In contrast to lack of any consistent knowledge about the spawning migrations, it is well known that many **disturbances** (e.g., water level, turbidity and temperature fluctuation, angling, hydraulic works, water pollution) induce huchen **shifting away** from the source of disturbance, usually in a **short distance** up to 3 km, either **upstream** (predominantly smaller ones) or **downstream** (larger huchen).

**Foraging migrations** of huchen were noticed in rivers where anadromous or potamodromous prey fish species undertake regular seasonal migrations.

Juvenile huchen migrate downstream to the larger pools at the onset of winter to overwinter there, which can also be partly related to the movement of their preying fish species in their wintering habitats.

Transversal diurnal foraging shifts from deeper mainstream habitats (pools) more inshore are common in huchen.

In conclusion, huchen are of the much less powerful regular (e.g., spawning) migrating instinct than that occurring in other salmonids (e.g., sea-run salmon, char and trout species).



## MIGRATION<sup>4</sup>

Huchen have major problems with most fish pass facilities, being either **unable to use** them at all, or at a **very low efficiency**.

It seems that most standard fish pass facilities fail to provide huchen migration, due to the

- **behaviour** of the fish and
- their **large size**

For most larger dams, fish pass facilities can't be effectively constructed due to the **competition for water** between hydropower and fish pass.

Scarce, but consistent own records about almost complete **lack of huchen in the fish ladder** facilities (period 2000 – 2008) support the opinion of those who consider fish ladders **of little importance** for the conservation of huchen in dammed rivers.



It would be beneficial to consider fishways in a light of huchen characteristics that advocate and restrain the use of fish ladders in the resolving of the disrupted connectivity in dammed huchen rivers.

FAO <sup>5</sup> published recommendation for characteristics of the fish pass considered appropriate for huchen:

Channel widths and slopes in Denil passes	Channel width	Recommended slopes (%)	Recommended Slopes (1:n)	Q in m <sup>3</sup> /s for $h^*/b_a = 1.5$
	1.0 - 1.2	16.0 - 13.0	1 : 6.25 - 1 : 7.7	0.82 - 1.17

Recommended dimensions for pool passes	Pool dimensions (m)			Dimension of submerged orifices (m)		Dimension of the notches (m)		Discharge trough the fish pass (m <sup>3</sup> /s)	Max. difference in water level $\Delta h$ (m)
	Length (lb)	Width (b)	Water depth (h)	Width (bs)	Height (hs)	Width (ba)	Height (ha)		
	2.5 – 3	1.6 – 2	0.8 – 1.0	0.4 – 0.5	0.3 – 0.4	0.3	0.3	0.2 – 0.5	0.20

<sup>5</sup> Anonymous (2002). Fish passes – design, dimension and monitoring. FAO, in arrangement with Deutscher Verband für Wasserwirtschaft und Kulturbau e.V. (DVWK), Rome.



Kellerberg, Drava, Austria

**Minimum dimensions (in m) for slot passes with one slot only  
(According to Gebler, 1991, and Larinier, 1992a)**

<b>Slot width</b>	<b>s</b>	<b>0.60</b>
<b>Pool width</b>	<b>B</b>	<b>3.00</b>
<b>Pool length</b>	<b>l<sub>b</sub></b>	<b>5.00</b>
<b>Length of projection</b>	<b>c</b>	<b>0.40</b>
<b>Stagger distance</b>	<b>a</b>	<b>0.30</b>
<b>Width of deflecting block</b>	<b>f</b>	<b>0.84</b>
<b>Water level difference</b>	<b>h</b>	<b>0.20</b>
<b>Min. depth of water</b>	<b>h<sub>min</sub></b>	<b>1.30</b>
<b>Required discharge</b>	<b>Q in m<sup>3</sup>/s</b>	<b>1.40</b>

## TERRITORIALITY <sup>4</sup>

- Out of spawning season, huchen are territorial, the territory for dozens of huchen is a sizeable pool
- The largest ones in a head, the smallest ones in a tail of a pool, in a sort of shoal
- A particular huchen will invariably occur in one and the same place

If :

- neither migrating instinct in huchen is proved, nor long-distance migrations
- homing effect is not evident, not supporting long-distance migratory behavior
- diurnal and seasonal movements evident and occur in a small distance
- strong territoriality supports residential character of huchen

it seems the connectivity will not be effectively re-established in huchen by construction of fish pass facilities.

Special matter of concern should be the problem of efficiency of fish passes as a downstream-migrating facilities occurring in many fish species.

Costs that additional activities undertaken to compensate this ineffectiveness (e.g., collection of fry, juveniles and adults in floating collectors, cassettes, traps, etc., or ramps and directing constructions, and their transportation, e.g., using trucks downstream, below the dams) stimulate further research in fish passes.

# FISH PASSAGE FACILITIES AND NON-MIGRATING SALMONIDS

- Huchen are more **resident** and **territorial** than migratory fish and relying on that their **instinct** would rise the effectiveness of fish ladders may be misleading.
- (S) Over 40% of the post-spawners of brown trout and Atlantic salmon died after spawning or during winter, while over 50% died trying to pass the eight dams. <sup>6</sup>
- (ID) Stocked redband (rainbow) trout in the Snake River basin of Idaho > 35 cm SL established fluvial life-history and used vertical-slot ladder. <sup>7</sup>
- (CH) Both non-natural and natural by-pass has only a marginal importance as a corridor for downstream migrating fish. <sup>8</sup>
- (OR) A greater proportion of cutthroat trout exhibit migratory behavior as watershed size or connectivity increases. Depending on channel size, movement was restricted during low-flow periods. <sup>9</sup>

**Structure (i.e., a type) of fish ladder, slope, flow rate and quality of feeding water and way to attract both juvenile and adult huchen (i.e., an appropriate hydraulic signal) to enter into the ladder in downstream and upstream directions**

## ***International Conference on Engineering and Ecohydrology for Fish Passes (2010 – 2015)***

*June 25-27, 2013, Oregon State University, Portland, Oregon, USA.*

<sup>6</sup> Greenberg, L.C., Bergman, C.O. & E. Nyquist (2013). Post-Spawning Behavior Of Brown Trout And Atlantic Salmon In Two Regulated Rivers.

<sup>7</sup> **Brink, S.R. (2013). Malad River Fish Passage – Restoration Of A Fluvial Life History For Resident Rainbow Trout.**

<sup>8</sup> Peter, A., Eglhoff, N., Kaufmann, S. (2013). The Importance Of Near-Natural Bypass Channels As Compensatory Habitat And Migration Corridors At Hydropower Plants.

<sup>9</sup> Bateman, D.S., Gresswell, R.E. & D.P.Hockman-Wert (2013). Headwater Cutthroat Trout Movement Behaviors And Timing .

## HATCHERIES

1. Only a small number of rivers throughout the range of the species (e.g. Sava, Kolpa / Kupa, Una, and Drina rivers) are large enough to be considered long-term viable gene pools for the species.
2. The must for avoiding long-term inbreeding is a minimum of 500 breeders (new studies consider even 1000 breeders) (Frankham et al. 2014)<sup>10</sup>

Huchen hatcheries rarely have more than 15 breeders.

Being:

- deficient compared to the recommended minimum (1)
- stocking is not considered an adequate tool to manage or conserve natural populations of huchen, making them usually feral, instead of native, i.e., a self-sustaining fish species (2)
- an action that causes more harm than good in terms of (1)
  - genetic alterations,
  - increased competition or predation pressure,
  - introduction of diseases.

Large-scale stocking operations in areas where huchen reproduce naturally is **to be discouraged**<sup>4</sup>.

<sup>10</sup> Ihut, A., A. Zitek, S. Weiss, C. Ratschan, G. Holzer, T. Kaufmann, D. Cocan, R. Constantinescu & V. Miresan. 2014. Danube salmon (*Hucho hucho*) in Central and South Eastern Europe: A review for the development of an international program for the rehabilitation and conservation of Danube salmon populations. Bulletin UASVM Animal Science and Biotechnologie, 71: 86-101.

# CRITERIA AND PRECONDITIONS

Constructors of future high dams and those who run the recent ones should fulfil:

- minimal length of flowing riverine stretches
- the least number of tributaries there appropriate for huchen natural spawning
- the management measures that are to be applied to minimize the harmful effects of high dams :
  - accessibility to spawning sites in tributaries
  - providing of sufficient amount of the water of appropriate quality in them during the spawning season
  - catch of young-of-the-year huchen and the way of their dispersal throughout the catchment in concern
  - etc.



# LJUBLJANICA RIVER



## (Re-) Establishing connectivity

1. between what?
2. through what?
  1. Are respective upstream and downstream stretches of the Ljubljana River in a shape and status sufficiently good? Is the Sava River it the area viable huchen-holding water?
  2. Appart of urban, aesthetic and other amenity values of the Ljubljana River
    - the city stretch should be thoroughly investigated, in order to assess the status of river's habitat (ecological and chemical status/potential)
    - restorative solutions should be proposed in order to enhance environment recovery