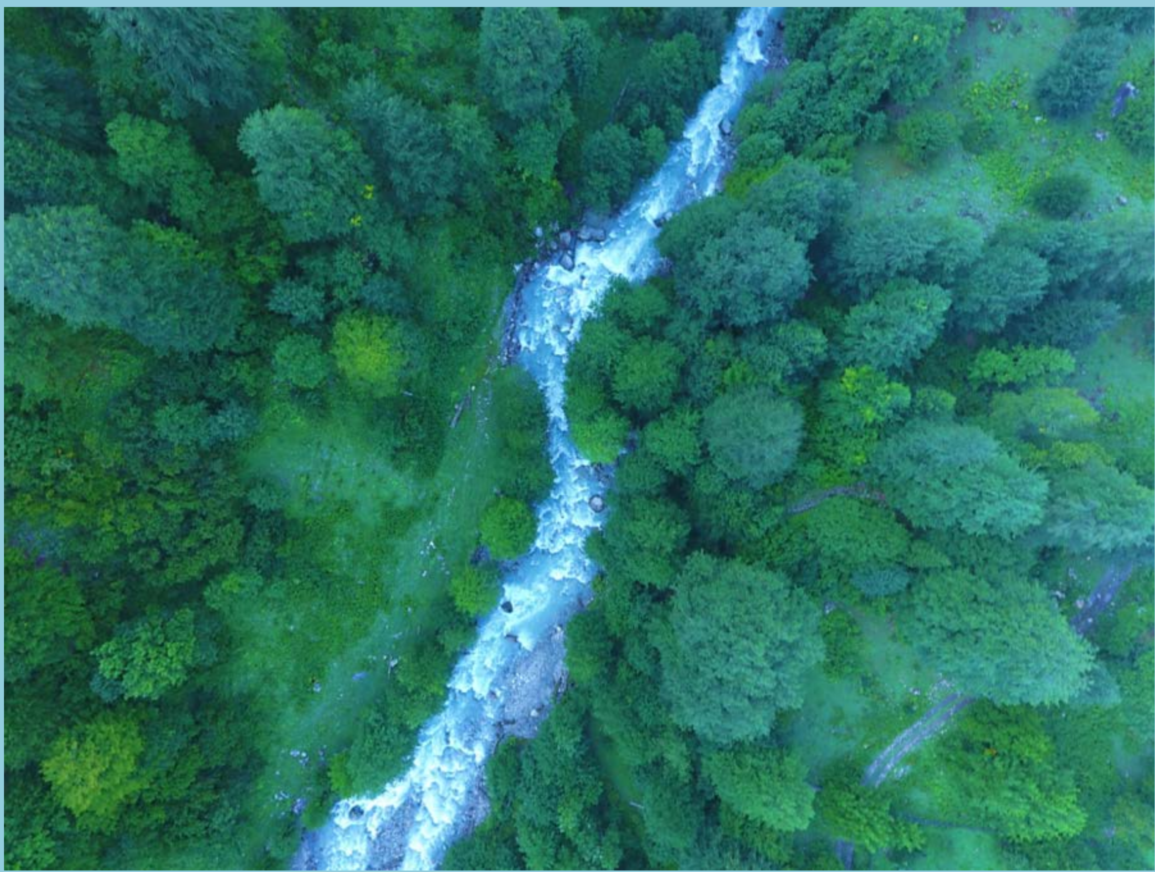
Blue Rivers®

Environmental Consulting

NENSKRA HYDROPOWER PROJECT, GEORGIA

Fish, Invertebrates and Otter Monitoring

Surveys N1



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Executive summary

This Report presents the results of the autumn 2017 survey on fish, invertebrates and otter monitoring in Nenskra and Nakra River basins.

The results of the survey of the fish diversity showed:

- Brown trout (*Salmo trutta*) lives in both rivers within the Project Area. This species is listed as vulnerable on the Georgia Red List, but of least concern on the IUCN red list.
- The highest density of the brown trout was found in the area of the future impoundment structure location on the Nenskra River.
- Two invasive fish species were identified during the site surveys: rainbow trout (*Oncorhynchus mykiss)* and carp (*Cyprinus carpio*), out of which rainbow trout can be further spread in conditions of low flow.
- Anecdotal evidence from fishermen provided information on a species they called “oraguli”. The exact species of this fish could not be confirmed.

The results of the survey of the invertebrates’ diversity showed:

- 17 taxonomic groups of macroinvertebrates are identified. Out of these, no large invertebrates with conservation status were identified.
- There is a sufficient food basis for the fish in the rivers, decreasing from the upper reaches of the rivers to the mouths.
- By biological status, both Nakra and Nenskra rivers have high status, except downstream Chuberi Bridge where it reduces to good one.

The results of the otter (*Lutra lutra*) surveys confirmed the presence of the otter in both rivers. The number of signs recorded was limited made by a small number of ranging/transient individuals.

The riverbed and river banks visual survey showed the rich diversity of the habitats, favourable for aquatic organisms. Out of the two riverbed channel types (single and braided); the latter is more vulnerable in conditions of environmental flow because of possible shallowings.

There are consequences of the landslides visible at both rivers. In conditions of low flow, the capacity of the both rivers to move stones should be preserved otherwise it could lead to establishment of natural unpassable barriers for the fish upstream migration.

During the surveys the proposed monitoring network were investigated in details and the conclusions will be taken into account for next survey in spring 2018.

Introduction

The entity "Blue Rivers® Environmental Consulting" (further "Consultant") signed a contract with JSC Nenskra Hydro (further "Client") for the implementation of the Fish, Invertebrates and Otter Monitoring for Nenskra Hydropower Project**.**

The scope of work includes:

- Fish monitoring in the Nenskra and the Nakra rivers
    - Objectives: Provide brown trout population and use estimates pre and post construction to identify if any brown trout population or behaviour changes occur in the river.
    - Indicators: fish (number, condition, age and sex of the fish). Monitoring for otter presence will also be undertaken at the same time as the fish surveys.
    - 10 stations: six on the Nenskra River, four on the Nakra River, which include sampling locations upstream and downstream of the impoundment structures. The areas cover gorges, braided channels, areas with vegetated banks, bolder cloaked channels and cobble riverbed with stock grazed semi eroded banks.
    - Frequency: twice per year (spring and autumn), start in autumn 2017 and a second survey in spring 2018.
    - Method: Recruit specialist fish surveyors. Replicable survey techniques will be required, using set survey points as well as standardised survey techniques (e.g. box traps, casting net, fishing rods, trotlines and seine netting, drift traps and cone traps). Fish quantity in the river, or at each survey point, can be represented as catch per unitary effort (CPUE).
    - Reporting within annual E&S report.

- Invertebrate surveys in the Nenskra and the Nakra rivers
    - Objectives: (i) Obtaining data about the natural composition and structure of aquatic macro-invertebrates, their quantitative distribution by main habitats, (ii) Assessment of biological status of Nenskra and Nakra rivers prior Nenskra HPP commencement and during operation, (iii) Calculation of food basis for the trout based on indicators of abundance and biomass of water macroinvertebrates communities.
    - Stations and Frequency: Sampling during the same survey periods and at the same stations as the fish surveys, so that the food basis for fish can be defined.
    - Method: invertebrates sampling in line with European Union standard methods (EN ISO 5667-3, ISO 7828, EN ISO 8689). Homogeneities will be identified using the EU scheme "AQEM/STAR". Collection of drifting macroinvertebrates will be undertaken during each season. Identification of the invertebrates captured will be undertaken in a specialist laboratory.
    - Reporting within annual E&S report.

These two activities are supplemented by hydromorphological survey in the fish and invertebrates monitoring sites.

The Consultant followed the approach presented in the Short work plan (2017).

According to the methodology, two surveys are planned: in autumn 2017 and in spring 2018. The current report presents the findings of the first autumn 2017 survey.

1. Overview of the Project area and the monitoring locations

The Nenskra River is a right bank tributary of the Enguri River. It enters Enguri at 97 r-km from the source. The total length of the river is 42 km; the catchment area is 623 km^2. The project area covers the Nenskra catchment area 222 km^2, the annual average flow here is 16.8 m^3/s.

The Nakra River is a right bank tributary of the Enguri River. It enters Enguri upstream confluence with Nenskra at 76 r-km from the source. The total length of the river is 22 km; the catchment area is 152 km^2. The project area covers the Nakra catchment area 87 km^2, the annual average flow here is 9.3 m^3/s.

The field surveys were conducted in the period from 4 to 9 September 2017. Surveys covered Nenskra River from confluence with Enguri up to 1.4 km upstream of the proposed impoundment structure location, (18 km from the source) and Nakra River from confluence with Enguri up to 0.8 km upstream of the proposed impoundment structure location (12 km from the source) (Figure 1).

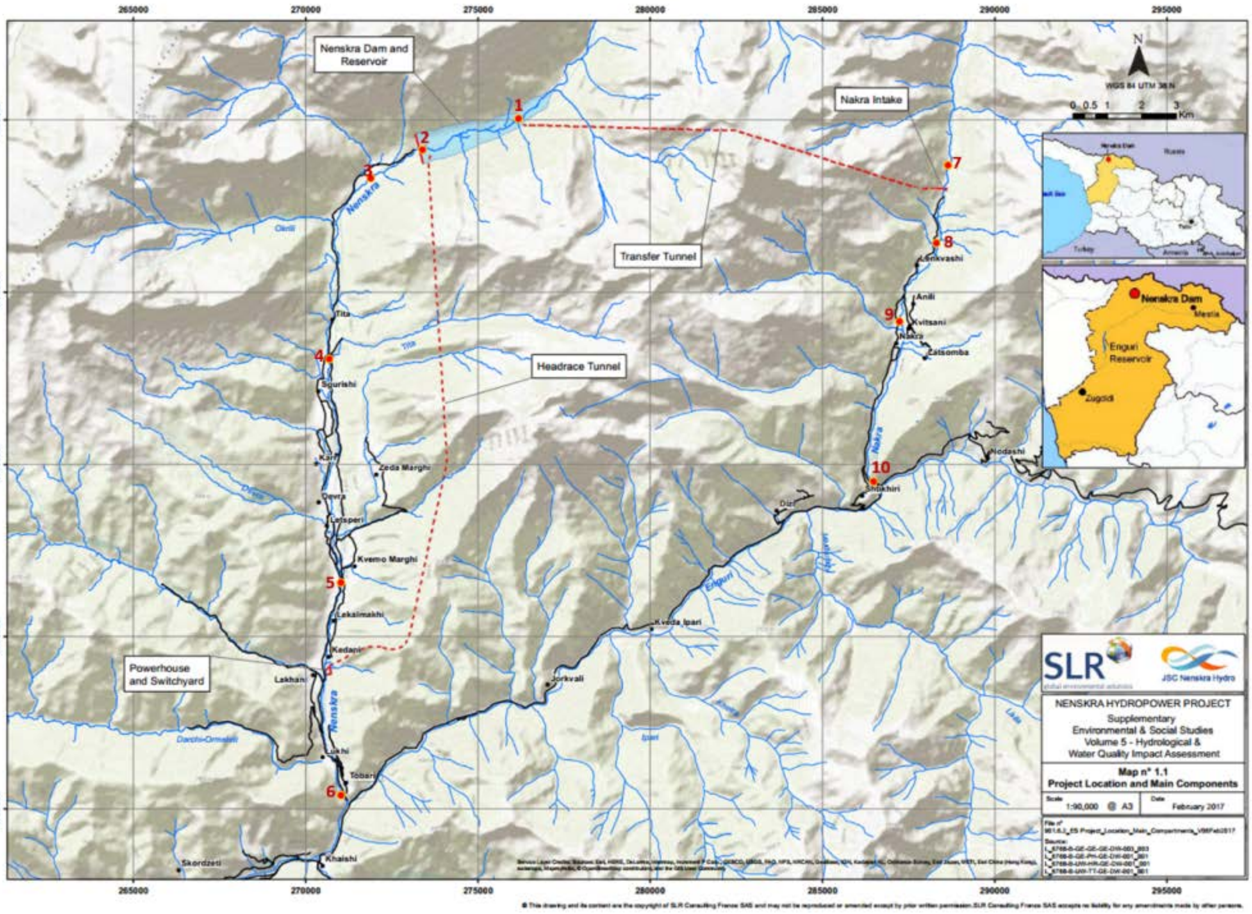


Figure 1. Nenskra and Nakra monitoring stations

The location of the monitoring stations is provided in the Table 1.

Ten monitoring stations were identified by the ToR as well as the stretches for them. Blue Rivers selected the monitoring locations within the stretches taking into account planned constructions and flow alterations. In order to understand to which extend upstream brown trout migrate, a special attention was paid to the area upstream the impoundment structure.

Table 1. List of the monitoring stations

Number[1]	Description	Coordinates	Number on the Map 2-1[2]
	Nenskra River		
1	water reservoir	43°08'10.38" 42°14'03.99"	none
2	impoundment structure (dam)	43°08'27.81" 42°14'57.23"	none
3	downstream of the impoundment structure	43°07'26.41" 42°11'49.20"	none
4	downstream confluence with Tita River	43°05'59.73" 42°11'06.42"	NE6
5	Chubevi bridge	43°01'00.09" 42°11'23.18"	NE3
6	at the confluence with Enguri River	42°57'33.31" 42°11'43.22"	NE0
	Nakra River		
7	upstream of the impoundment structure	43°07'47.99" 42°24'03.74"	none
8	downstream the impoundment structure	43°07'19.82" 42°24'01.61"	NA3a
9	upstream confluence with Lakverari River	43°04'40.35" 42°23'60.44"	NA2b
10	at the confluence with Enguri River	43°02'47.32" 42°22'52.89"	NA0

Notes:

- The locations of the stations were identified within the reaches mentioned in the Short Work Plan;
- 2 monitoring stations (at the mouth of Nenskra and Nakra/confluence with Enguri) (# 6 and #10from Table 1 above) were not reachable because of canyon shape of river valley and high water level, so no further description is provided;
- For the spring survey, it is planned to continue at 9 stations out of 10. Concerning Nenskra station # 6 "at the confluence with Enguri" a proper location will be searched, but definitely not too close to the confluence because of inaccessible deep canyon.

[1] See Figure 1.
[2] 901.8.1_ES Nenskra_ Vol 5_Hydrology_Water quality_Feb 2017 (p.9)

2. Results of field surveys

2.1 **River stream, bed and banks survey**

2.1.1. **General description**

River stream, bed and banks survey, conducted in autumn 2017, aimed to define the hydromorphological features at selected monitoring stations. The spring 2018 river stream, bed and banks survey will also include mapping at the monitoring stations (spawning, fattening and overwintering habitats if identified).

Equipment

- Frame 1 m^2 - for visual assessment of the percentage composition of sediments: boulder (256 mm – 2048 mm), cobble (64 mm – 256 mm), pebble (17 mm – 64 mm), gravel (2 mm – 17 mm) and sand (0.06 mm – 2 mm)
- GPS 60C Garmin – for coordinates measurements
- DJI Phantom 4 drone – for filming.

Weather and water levels

The weather during the field works was warm. The day time air temperature was +20…+33°C. The night time air temperature was +13…+16°C. On 6-7th of September, it was raining (more than 7 mm precipitation for Kveda Marghi)[3] the whole night and the half of the day. It caused significant raise of water level.

Channel types

- Within project area, two channel types are defined at the both rivers: single and braided. The identified channel types have different morphology, size of sediments, hydraulic flow structure etc.
- At Nenskra River (with the length 24 km from monitoring station #1 to confluence with Enguri) the total length of the single channel is 17 km, braided – 7 km (Table 2, Figure 2).
- At Nakra River (with the length 10.3 km from monitoring station # 7 to confluence with Enguri), the total length of the single channel is 7.3 km, braided – 3 km (Table 2, Figure 3).

Table 2. Lengths and % of the different channel types

Channel type	**Length**	
	km	**%**
Nenskra River		
single	17	71
braided	7	29
Nakra River		
single	7.3	88

[3] https://www.accuweather.com/ru/ge/kveda-marghi/806197/september-weather/806197?monyr=9/1/2017&view=table

Channel type	Length	
	km	%
braided	3	12

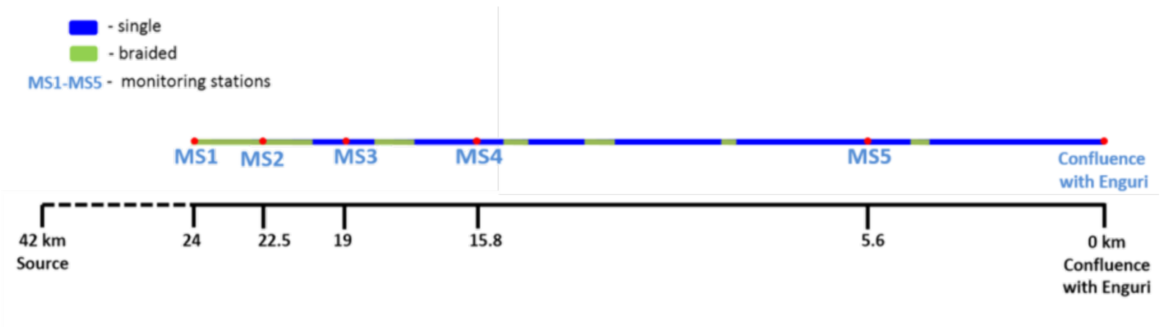


Figure 2. Channel types at Nenskra River

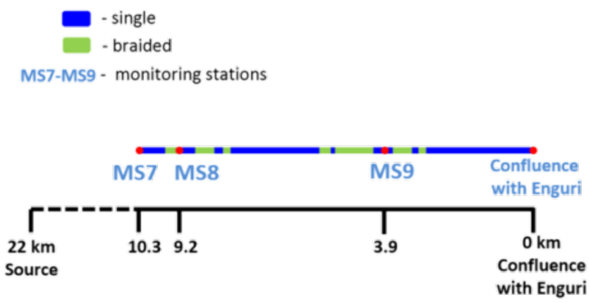


Figure 3. Channel types at Nakra River

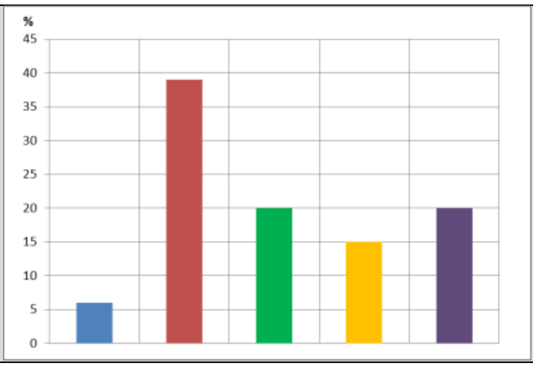
2.1.2 Description of monitoring stations

Monitoring station #1 – Nenskra water reservoir

Figure 4. Monitoring station 1 (Nenskra river, 06.09.2017)

- It is located 24 km upstream confluence with Enguri and 18 km from the source. The catchment area - 200 km^2, the elevation - 1380 m. The form of valley is U-shape (Figure 4).
- The channel type is classified as braided. Bed elements - bars, islands, and riffles.
- Flow types included chaotic and broken standing waves.
- The right and the left banks are steep, both forested with trees and bushes.
- Islands are divided river into two main and few temporary arms. The average width of the main arms was 13 m, and varied from 10 to 21 m. The average width of the temporary arms was 10 m, and varied from 7 to 12 m.
- The riverbed covered mainly by cobble (39%), pebble (20%) and sand (20%).

Substrate types	% of sediments
Boulder	6
Cobble	39
Pebble	20
Gravel	15
Sand	20

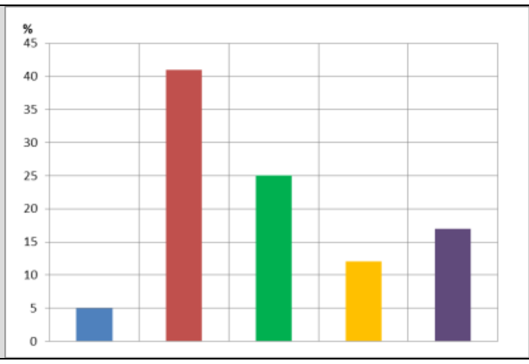


Monitoring station #2 – Nenskra impoundment structure (dam)

Figure 5. Monitoring station 2, (Nenskra river, 05.09.2017)

- It is located 22.5 km upstream confluence with Enguri and 19.5 km from the source. The catchment area is 215 km^2. The elevation is 1337 m. The form of the valley is U-shape (Figure 5).
- The channel type classified as a braided.
- Bed elements included bars, islands, and riffles.
- Flow types included broken standing waves and unbroken standing waves.
- The left bank is flat; right bank is steep. Both banks are forested with tree and bushes.
- Islands are divided river into two main and few temporary arms. The average width of the main arms was 18 m, and varied from 10 to 27 m. The average width of the temporary arms was 12 m, and varied from 10 to 17 m.
- The riverbed covered mainly by cobble (41%) and pebble (25%).

Substrate types	% of sediments
Boulder)	5
Cobble	41
Pebble	25
Gravel	12
Sand	17

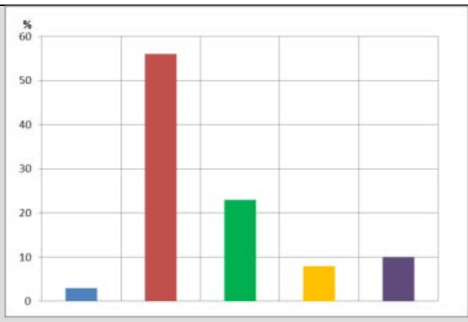


Monitoring station # 3 – Nenskra downstream of the impoundment structure

Figure 6. Monitoring station 3 (Nenskra river, 05.09.2017)

- It is located 19 km upstream confluence with Enguri and 23 km from the source. The catchment area is 220 km^2. The elevation is 1260 m. The form of the valley is V-shape (Figure 6).
- The channel type classified as a single.
- Bed elements included rapids, rocks and step pool.
- Flow types included chaotic and broken standing waves.
- Both banks are steep and forested with trees.
- The average width of the river was 16 m, and varied from 10 to 22 m.
- The riverbed covered mainly by cobble (56%) and pebble (23%).

Substrate types	% of sediments
Boulder	3
Cobble	56
Pebble	23
Gravel	8
Sand	10



Monitoring station # 4 – Nenskra downstream confluence with Tita River

Figure 7. Monitoring station 4 (Nenskra river, 05.09.2017)

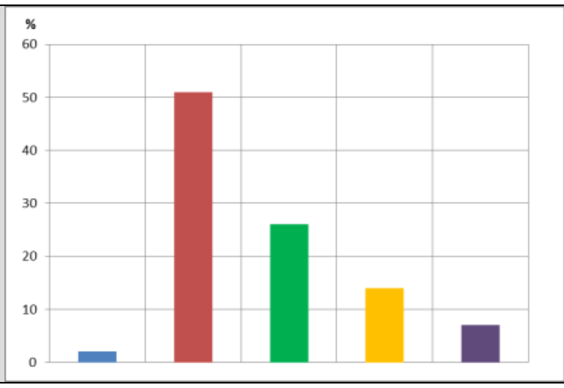
- It is located 15.8 km upstream confluence with Enguri and 26.2 km from the source. The catchment area is 290 km2. The elevation is 1136 m. The form of the valley is V-shape (Figure 7).
- At the right bank, there is an automatic hydrological station setup by JSNCH with hydrometric rod for water level measurements located (Figure 8).

Figure 8. Automatic hydrological station (Nenskra river)

- The channel type is classified as a single.
- Bed elements included riffles, rapids and rocks.

- Flow types included chaotic, broken and unbroken standing waves.
- Both banks are steep and forested with trees.
- The average width of the river was 15 m, and varied from 12 to 18 m.
- The riverbed covered mainly by cobble (51%) and pebble (26%).

Substrate types	% of sediments
Boulder	2
Cobble	51
Pebble	26
Gravel	14
Sand	7

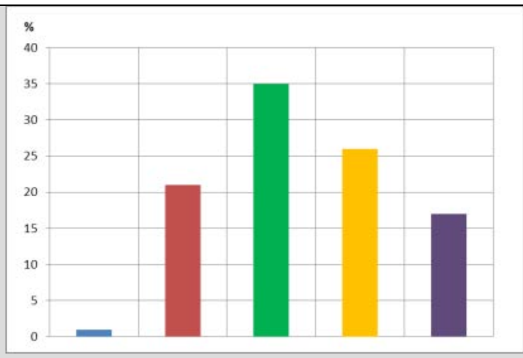


Monitoring station # 5 – Nenskra Chubevi Bridge

Figure 9. Monitoring station 5 (Nenskra river, 08.09.2017)

- It is located 5.6 km upstream confluence with Enguri and 36.4 km from the source. The catchment area is 390 km^2. The elevation is 782 m. The form of the valley is U-shape (Figure 9).
- The channel type is classified as a single.
- Bed elements included rapids and riffles.
- Flow types included broken and unbroken standing waves.
- The right bank is flat; left bank is steep. Both banks are forested with trees. Some bank protections are made of gabions.
- The average width of the river was 20 m, and varied from 18 to 26 m.
- The riverbed covered mainly by pebble (35%) and gravel (26%).

Substrate types	% of sediments
Boulder	1
Cobble	21
Pebble	35
Gravel	26
Sand	17

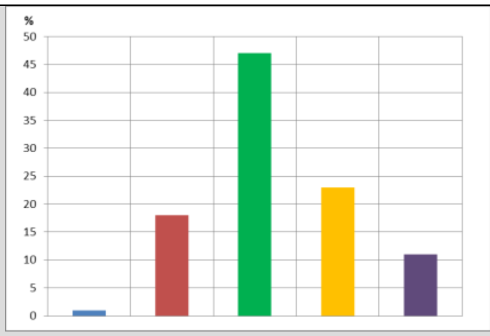


Monitoring station # 7 – Nakra upstream of the impoundment structure

Figure 10. Monitoring station 7 (Nakra river, 09.09.2017)

- It is located 10.3 km upstream confluence with Enguri and 11.7 km from the source. The catchment area is 87 km^2. The elevation is 1590 m. The form of the valley is U-shape (Figure 10).
- The channel type is classified as a single.
- Bed elements included bars and riffles.
- Flow types included chaotic and broken standing waves.
- The right is flat and the left bank is steep. Both banks are forested with trees.
- The average width of the river was 10 m, and varied from 7 to 15 m.
- The riverbed covered mainly by pebble (47%) and gravel (23%).

Substrate types	**% of sediments**
Boulder	1
Cobble	18
Pebble	47
Gravel	23
Sand	11

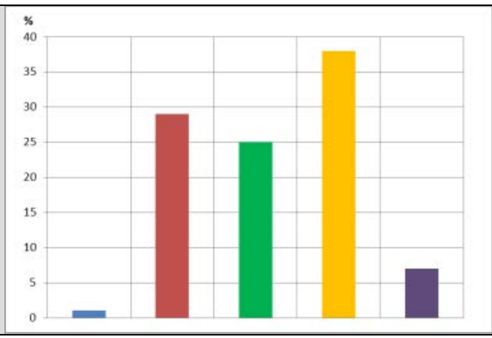


Monitoring station # 8 – Nakra downstream the impoundment structure

Figure 11. Monitoring station 8 (Nakra river, 09.09.2017)

- It is located 9.2 km upstream confluence with Enguri and 12.8 km from the source. The catchment area is 100 km^2. The elevation is 1520 m. The form of the valley is V-shape (Figure 11).
- The channel type is classified as a single.
- Bed elements included rapids, rocks and step pool.
- Flow types included chaotic, broken and unbroken standing waves.
- Both banks are steep and forested with trees.
- The average width of the river was 12 m, and varied from 10 to 18 m.
- The riverbed covered mainly by gravel (38%), cobble (29%) and pebble (25%).

Substrate types	% of sediments
Boulder	1
Cobble	29
Pebble	25
Gravel	38
Sand	7



Monitoring station # 9 – Nakra upstream confluence with Lakverari River

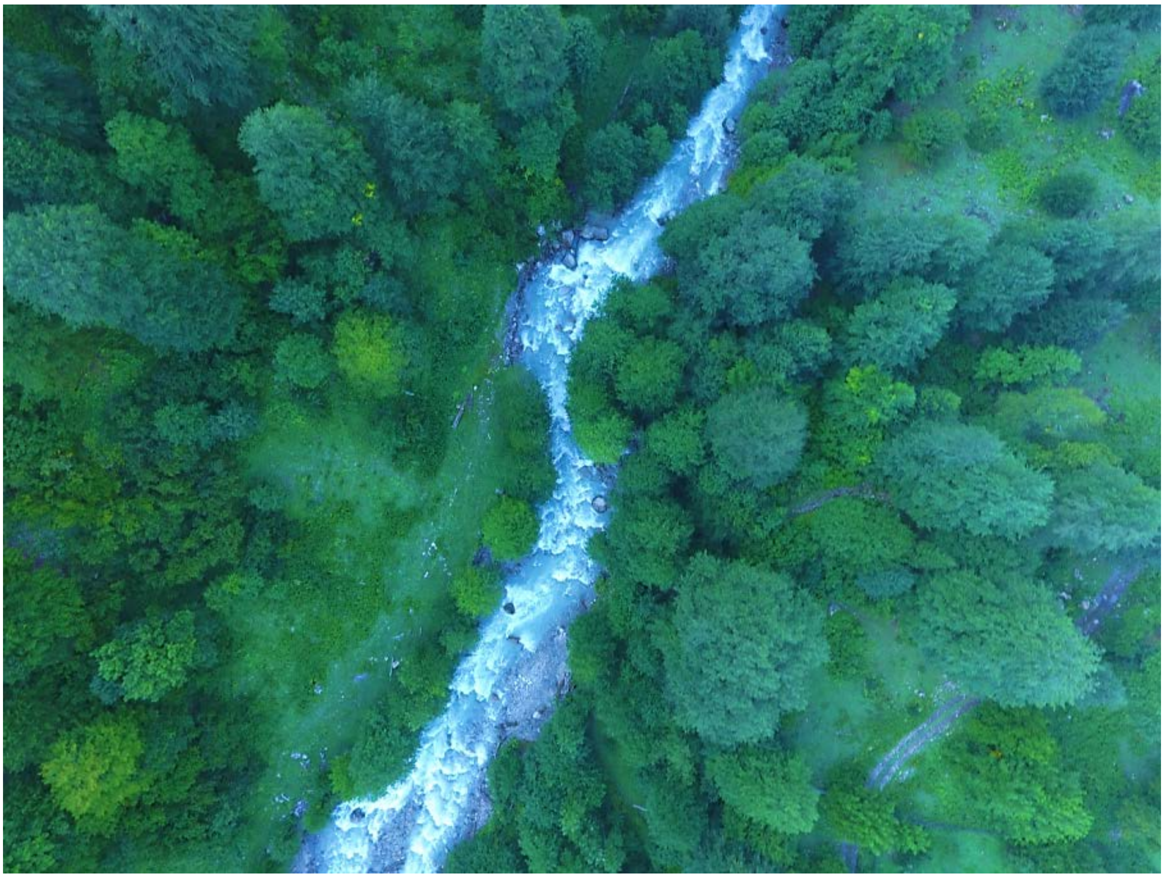
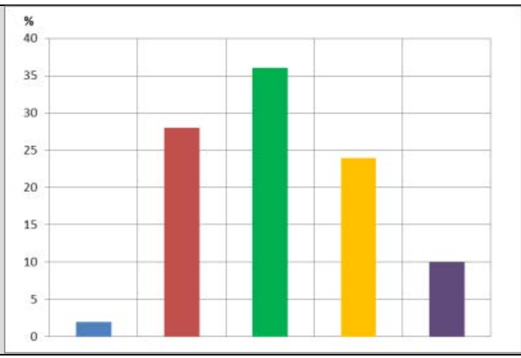


Figure 12. Monitoring station 9 (Nakra river, 09.09.2017)

- It is located 3.9 km upstream confluence with Enguri and 18.1 km from the source. The catchment area is 127 km^2. The elevation is 1149 m. The form of the valley is wide U-shape (Figure 12).
- The channel type is classified as a single.
- Bed elements included rapids, rocks and step pool.
- Flow types included chaotic, chute and broken standing waves.
- Both banks are flat. Both banks are forested with trees and bushes.
- The average width of the river was 14 m, and varied from 10 to 20 m.
- The riverbed covered mainly by pebble (36%), cobble (28%) and gravel (24%).

Substrate types	% of sediments
Boulder	2
Cobble	28
Pebble	36
Gravel	24
Sand	10



Landslide

At both rivers, there are locations, where powerful natural landslide appears with significant consequences. In 2011, such a natural landslide occurred at Lekverari River and transported a significant amount of sediment downstream to the confluence with the Nakra River, and blocked the Nakra by creating a natural dam. One can see its consequences till now (Figure 13).

Figure 13. Landslide on Lekverari river (Nakra river basin)

In Nenskra basin, its right-side tributary upstream Tita village also brings a significant amount of sediments and transports them downstream, to the confluence with Nenskra (Figure 14.) In conditions of natural flow, both rivers can move the jams, created by the naturally occurring landslides.

Figure 14. Landslide (Nenskra river basin)

Conclusions:

The surveys provided the hydromorphological description of 8 monitoring stations at 10 preliminary selected reaches. Two of the stations were unreachable because of high water level. The hydromorphological description has created a background for further mapping of spawning, fattening and overwintering habitats for trout (if identified) to be conducted in spring 2018. In spring the proposed network of the monitoring stations will be checked for the representativeness in conditions of low water level and reconfirmed.

The riverbed and river bank visual survey, showed the rich diversity of the habitats, favourable for aquatic organisms. Out of the two riverbed channels (single and braided one), the latter is more vulnerable in conditions of environmental flow because of possible shallowings. It is worth noting, that the surveys were conducted in the period of high water, so the presence of the riverbed channels should be reconfirmed during the low flow.

There are consequences of the naturally occurring landslides visible at both rivers. In conditions of low flow, the capacity of the rivers (both Nenskra and Nakra) to move stones is reduced. Without high flow events, landslides could lead to establishment of natural unpassable barriers for the trout upstream migration.

2.2 Invertebrates composition and abundance survey

All samples of invertebrates were taken using the method "kick and sweep" (Schmidt–Kloiber, 2006) with further application of the software "AQEM/STAR". Five integrated samples were taken at Nenskra and 3 integrated samples – at Nakra (each integrated sample includes 20 samples). In order to identify large and rare species of macroinvertebrates, the sampling was also conducted in microhabitats (e.g. underwater branches, temporary ponds cut from the main course of the river etc.). Besides, quantitative samples of invertebrates were taken by means of washing of stones at sites of 0.5 x 0.5 m; the sites were selected as the most typical habitats based on the dominant sediment composition.

2.2.1 Natural composition and structure of aquatic macro-invertebrates' communities

The diversity of mountain landscapes, microclimatic conditions and freshwater habitats, has led to rich diversity of amphibian insects. As far as Ice age was quite mild in Caucasus, it became a "safe place" for many species. This all continued to formation of rich biodiversity of Caucasus by endemic species.

In total, 17 taxonomic groups of macroinvertebrates were registered in Nenskra and Nakra basins.

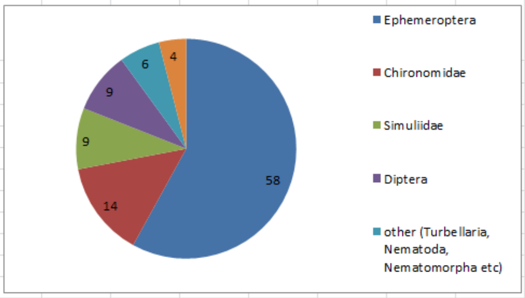


Figure 15. Composition of invertebrates communities in the Nenskra River

In the Nenskra River, the dominant invertebrates' community was *Ephemeroptera* – 58% from the total number, *Chironomidae* – 14%, *Simuliidae* and *Diptera* by 9%, *Plecoptera* – 4%. The rest 5% was shared by *Turbellaria, Nematoda, Nematomorpha, Oligochaeta, Ostracoda, Cyclopoida, Araneida, Acarina, Collembola, Heteroptera, Lepidoptera, Trichoptera, Coleoptera* (Figure 15).

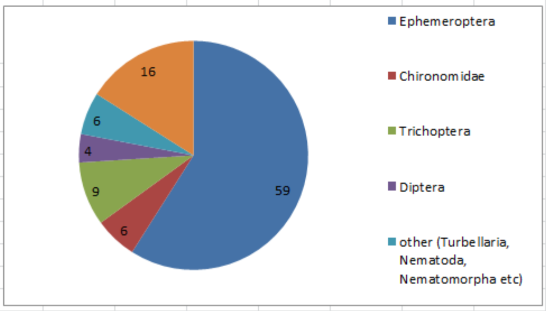


Figure 16. Composition of invertebrates communities in the Nakra River

In the Nakra River, the dominant invertebrates' community was *Ephemeroptera* – 59% from the total number, *Plecoptera* – 16%, *Trichoptera* – 10%, *Chironomidae* - 6% and *Diptera* 4.2%. Other groups (*Turbellaria, Nematoda, Nematomorpha, Oligochaeta, Ostracoda, Cyclopoida, Araneida, Acarina, Collembola, Heteroptera, Lepidoptera, Coleoptera*) cover 6% (Figure 16).

No large invertebrates with conservation status were identified.

2.2.2 Assessment of biological status of Nenskra and Nakra

General information

Biological indication of water quality and biological status assessment was done using express methods of assessment using biotic indexes (Afanasyev 2002, 2006). For the assessment, the Consultant selected the following two indexes:

- **Trent Biotic Index (TBI)**[4] as far as it is the basic for most of modern biotic indexes. It is based on an examination of key groups of benthic macro-invertebrates. According to how many species and individual organisms are present the water is given a score in the range 10 (unpolluted) to 0 (grossly polluted). For example, if sixteen or more species of key organisms are present, including more than one species of plecopteran, then the water scores 10. However, if there are no plecopterans and only two or three species of Chironomid and/or tubificid worms present, the water is heavily polluted and scores just 2. The advantages of this index are the follows:
    - Classifies the main characteristics of polluted waters
    - It does not require rigorous sampling technique
    - Difficulties of identification are reduced by the selection of key organisms only to examine
    - Gives a simple linear scale of index values
    - It is easily understood by non-biologists

- **Belgian Biotic Index (BBI)[5]** : an index that is based on the presence or absence of aquatic macro-invertebrates. It is used in the evaluation of the biological water quality. Macro-invertebrates are defined as larger invertebrates that can be seen with the naked eye such as insects (larvae), molluscs, crustaceans, worms, etc. The Belgian Biotic Index is defined by the relative sensitivity of specific indicator species to pollution and the diversity of species. The index value varies from 0 (extremely bad quality) to 10 (extremely good quality). It is worth to mention that, BBI is standardized in Belgium and France (French Indice Biotique), and is widely used in current monitoring in other EU countries.

As far as there is no identified reference values of biological descriptors for Caucasian rivers at present, the Consultant used as a baseline the standard assessment scale for the above mentioned biological indexes (Figure 17). After the spring surveys, the scale can be corrected specially for Nenskra and Nakra rivers, taking into account the peculiarities of the bottom sediments with a lot of mica which “cement” spaces between stones and preventing the development of the digging in invertebrates.

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[4] Woodiwiss, F.S. The biological system of stream classification used by the Trent River // Board.Chemy.Indust. – 1964. – 11. – P. 443–447. Metcalfe.J.L. Biological water quality assessment of running waters based on macroinvertebrate communities: history and present status in Europe.// Environmental pollution. – 1989. – 60. – P. 101–139

[5] N.De Pauw, G.Vanhooren. Method for biological assessment of water courses in Belgium// Hydrobiologia 100(1):153-168 · January 1983.

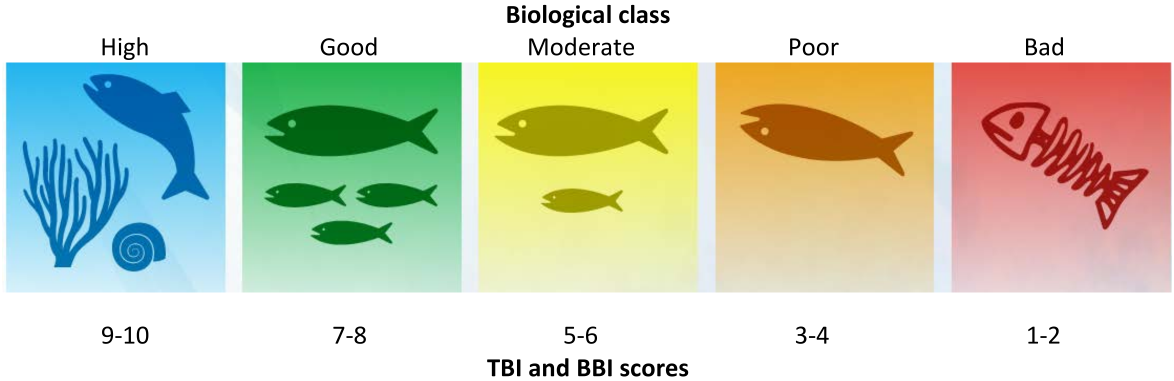

Figure 17. Assessment scale for TBI and BBI indexes and relevant biological class

Results

Based on the surveys conducted, homogeneous habitats were identified. At each survey location, hydrobiological samples of macroinvertebrates were taken as well as geobotanical and ichthyologic surveys conducted. The riverbed of the main river; its tributaries; and riparian zones with bushes and meadow plants were surveyed.

Each monitoring station is described according to the Field protocol (Annex 2). Part of collected data (like water temperature, turbidity) is considered as descriptive for the conditions of macroinvertebrates study (e.g. in high turbidity river, the confidence of the macroinvertebrates study is lower, comparing to the rivers with low turbidity). The core data are identification of the number of present indicator groups and visual fixation of one or more specie in the groups *Plecoptera, Ephemeroptera* and *Trichoptera*, which allow conducting the preliminary biological quality assessment directly at the river.

Monitoring station # 1. Nenskra at water reservoir

Distribution of habitats of bottom invertebrates: HS (hygropetric sites (water layer on solid substrates) – 10%, megalital – 40%, macrolital – 20%, mesolital– 20%, microlital– 5%, psammal– up to 5%.

Water transparency is up to 1 m. Water warmed up to + 9.8 ^{0}C, and oxygen saturation is more than 165%.

Algae were presented by stone barnacles by *Bacillariophyceae* and *Chlorophyta*, *Hydrurus*. The low algae development can be explained by rain flood.

Macrophytes were represented by floodplain plants; *Fontinalis sp.* covered 1% of the floodplain and some *Carex sp.*

May flies nymphs were dominant in the structure of bottom invertebrates; *Simuliidae*, *Chironomidae, Plecoptera* and other *Diptera* were represented to lesser extent. The nymphs of *Trichoptera* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria* and *Collembola*.

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 10 scores, which corresponds to “high status”.

High status

Monitoring station # 2. Nenskra, impoundment structure

Distribution of habitats of bottom invertebrates: megalital 35%, macrolital – 25%, mesolital– 25%, microlital– 10%, psammal– up to 5%.

The river had some turbidity after the rains and transparency up to 80 cm. Water warmed up to + 10.5 – 11 ^{0}C, and oxygen saturation is more than 160%.

Algae were presented by stone barnacles by *Bacillariophyceae* and *Hydrurus*.

Macrophytes were represented by floodplain plants; there were some *Fontinalis sp.* and some *Carex sp.*

May flies nymphs were dominant in the structure of bottom invertebrates; *Simuliidae*, *Chironomidae,* other *Diptera* were represented to lesser extent. The nymphs of *Trichoptera* and *Plecoptera* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria*, *Collembola etc.*

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 10 scores, which corresponds to “high status”.

High status

Monitoring station # 3. Nenskra, downstream the impoundment structure

Distribution of habitats of bottom invertebrates: HS – 20%, megalital - 30%, macrolital – 20%, mesolital– 15%, microlital– 10%, psammal– up to 5%.

The river had transparency up to 80 cm. Water warmed up to + 11.5 ^{0}C, and oxygen saturation is more than 165%.

Algae were presented by stone barnacles by *Bacillariophyceae* and *Hydrurus*. The low algae development can be explained by rain flood. Macrophytes were represented by floodplain plants; there were some *Fontinalis sp.*

May flies nymphs were dominant in the structure of bottom invertebrates; *Simuliidae*, *Chironomidae,* other *Diptera* were represented to lesser extent. The nymphs of *Trichoptera* and *Plecoptera* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria*, *Collembola etc.*

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 10 scores, which corresponds to “high status”.

High status

Monitoring station #4. Nenskra, downstream confluence with the Tita River

Distribution of habitats of bottom invertebrates: HS – 5%, megalital 45%, macrolital – 20%, mesolital– 20%, microlital– 7%, psammal– up to 3%.

The river had transparency up to 80 cm. Water warmed up to + 12^{0}C, and oxygen saturation is more than 160%.

Algae were presented by a few *Bacillariophyceae, Cyanobacteria* and *Chlorophyta*. The low algae development can be explained by rain flood.

Macrophytes were represented by floodplain plants; there were some *Fontinalis sp.* covering 1-1.5% and some *Carex* – 2 species.

May flies nymphs were dominant in the structure of bottom invertebrates; *Simuliidae*, *Chironomidae,* other *Diptera* were represented to lesser extent. The nymphs of *Trichoptera* and *Plecoptera* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria*, *Collembola etc.*

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 9 scores, which corresponds to "high status".	High status

Monitoring station #5. Nenskra, Chuberi Bridge

Distribution of habitats of bottom invertebrates: HS - up to 5%, megalital – 40%, macrolital – 25%, mesolital– 15%, microlital– 7%, psammal– up to 8%.

The river had transparency up to 50 cm. Water warmed up to + 9^{0}C, and oxygen saturation is more than 155%.

Algae were presented by stone barnacles by *Bacillariophyceae* and *Hydrurus*. The vegetation of *Cyanobacteria* and *Chlorophyta* has increased due to household wastewaters. Macrophytes were represented by floodplain plants; there were some *Fontinalis sp.* covering up to 5% and some *Carex*.

May flies nymphs were dominant in the structure of bottom invertebrates; *Simuliidae*, *Chironomidae,* other *Diptera* were represented to lesser extent. The nymphs of *Trichoptera* and *Plecoptera* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria*, *Collembola etc.*

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 8 scores, which corresponds to "good status".	Good status

Monitoring station # 7, Nakra, upstream of the impoundment structure 1.

Distribution of habitats of bottom invertebrates: megalital – 21%, macrolital – 20%, mesolital– 40%, microlital– 10%, psammal– up to 9%.

The river had transparency up to 25 cm. Water warmed up to + 8.8^{0}C, and oxygen saturation is more than 160%.

Algae were presented by stone barnacles by *Bacillariophyceae, Chlorophyta* and *Hydrurus*.

Macrophytes were represented by floodplain plants; there were some *Fontinalis sp.* covering up to 1-2% and some *Carex* (2 species).

May flies nymphs were dominant in the structure of bottom invertebrates; *Plecoptera*, *Chironomidae* and *Trichoptera* were represented to lesser extent. The nymphs of *Diptera* and *Simuliidae* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria*, *Collembola etc.*

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 10 scores, which corresponds to "high status".	High status

Monitoring station # 8. Nakra, downstream the impoundment structure 2

Distribution of habitats of bottom invertebrates: HS – 5%, megalital – 40%, macrolital – 25%, mesolital– 20%, microlital– 5%, psammal– up to 5%.

The river had transparency up to 30 cm. Water warmed up to + 9.2 ^{0}C, and oxygen saturation is more than 160%.

Algae were presented by stone barnacles by *Bacillariophyceae* and *Hydrurus*. There are some vegetation of *Cyanobacteria* and *Chlorophyta* due to wastewaters coming from tourist camp and cattle grazing.

Macrophytes were represented by floodplain plants; there were some *Fontinalis sp.* and some *Carex* (2 species).

May flies nymphs were dominant in the structure of bottom invertebrates; *Plecoptera*, *Chironomidae* and *Diptera* were represented to lesser extent. The nymphs of *Trichoptera* and *Simuliidae* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria*, *Collembola etc.*

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 9 scores, which corresponds to "high status".	High status

Monitoring station # 9. Nakra, upstream confluence with Lakverari River

Distribution of habitats of bottom invertebrates: HS - up to 5%, megalital – 35%, macrolital – 25%, mesolital– 25%, microlital– 7%, psammal– up to 3%.

The river had transparency up to 30 cm. Water warmed up to + 7.2 ^{0}C, and oxygen saturation is more than 150%.

Algae were presented by stone barnacles by *Bacillariophyceae*. There are some vegetation of *Cyanobacteria* and *Chlorophyta* due to wastewaters coming from the settlement and cattle grazing.

Macrophytes were represented by floodplain plants; there were some *Fontinalis sp.* covering up to 3-5% and some *Carex* (3 species).

May flies nymphs were dominant in the structure of bottom invertebrates; *Plecoptera*, *Simuliidae, Chironomidae* and *Diptera* were represented to lesser extent. The nymphs of *Trichoptera* were low in numbers. There were also a few *Hydrachnidia, Notonecta* and bugs, and some *Oligochaeta*, *Turbellaria*, *Collembola etc.*

Express assessment by hydrobiological parameters showed that indexes TBI and BBI got 9 scores, which corresponds to "high status".	High status

Conclusion: By biological status, both Nakra and Nenskra rivers has high status (extremely good quality), except downstream Chuberi bridge where it reduces to good one (good quality).

2.2.3 **Calculation of food basis for the trout**

The majority methods of calculation of food basis for fish are based on identification of the biomass of feeding units.

Biomass in samples

In order to implement this task, a quantitative sampling of invertebrates was done at 8 monitoring stations (Table 3). It shows that in Nenskra the highest amount of biomass is 16 g/m^2 and it reduces with the flow down to 4.5 g/m^2.

Table 3. Biomass calculation for Nenskra River

#	Monitoring station	Biomass, g/m^2
1	water reservoir	16
2	impoundment structure (dam)	14
3	downstream of the impoundment structure	13
4	downstream confluence with Tita River	10
5	Chubevi bridge	4.5

In Nakra River, the highest amount of biomass is higher than in Nenskra (22 g/m^2). In the same time, the tendency of biomass reduction to downstream remains (Table 4).

Table 4. Biomass calculation for Nakra River

#	Monitoring station	Biomass, g/m^2
7	upstream of the impoundment structure	22
8	downstream the impoundment structure	19
9	upstream confluence with Lakverari River	16.5

This tendency is explained by elevation zoning (Afanasyev, Letytska and Manturova) as well as increase of the man-caused impact of settlements.

In general the biomass values for the Project area and especially Nenskra River is lower than in Georgian rivers at the same elevation, even taking into account seasonal variation. It can be explained by presence of the large number of mica (Muscovite), the flat parts of which "cement" spaces between stones and reduce friability of sediments. This does not allow *Gammaridae* development. Microscopic research of composition of sediments and frying them showed that slowly sunk particles consists of not organic silt but mica (Table 5).

Table 5. Analysis of bottom sediments for presence of organic matter

Monitoring station	Weight of crucible (P_4), g	Weight of crucible with dry soil prior frying (P_5), g	Weight of crucible with burned soil after frying (P_6), g	Loses during frying $(P_5-P_6)/(P_5-P_4)*100$ %
MS 2	15.7	45.3	45.1	0.80
MS 3	14.2	46.4	46.1	1.05
MS 4	16.3	20.7	20.6	2.11

At the same time, Figure 18 shows that downstream Nenskra, sediments got crushed (increase of red line). In Nakra, mica is less present, so there are more organic matter and biomass correspondingly higher.

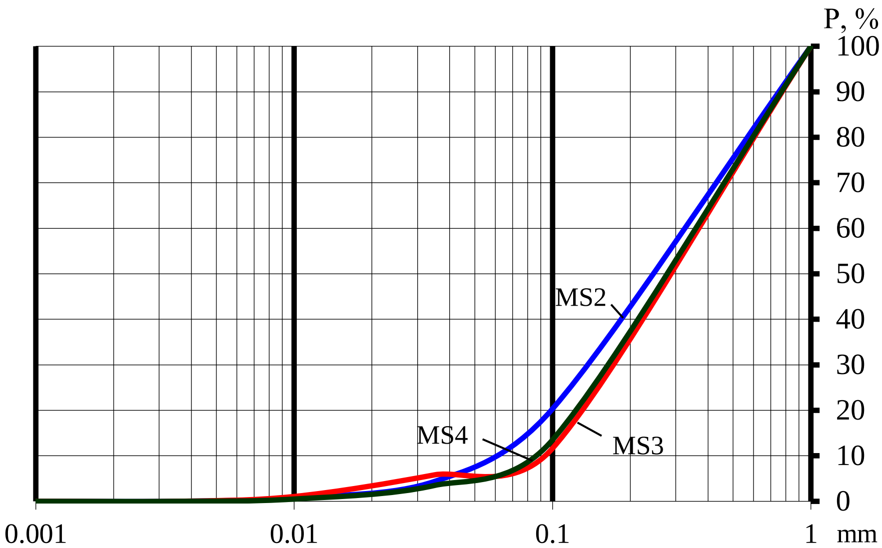

Figure 18. Fraction composition of bottom sediments at sediment meter of the Institute of Hydrobiology of National Academy of Sciences of Ukraine

Biomass by drifting

In order to calculate natural food basis of the river, one time sampling of macroinvertebrates is not sufficient, because it is necessary to calculate production capacities of bottom communities.

There are two ways to identify the production of invertebrates:

- Calculation based on dependencies between weight and speed of animal exchange [Hemmingsen 1960, Vinberg 1976, Alimov 1981], taking into account the temperature coefficient Q10 of van Goff,
- Method of Bouysen-Yensen (1919), where it is necessary to identify biomass in the beginning and end of one vegetation season.

In conditions of mountain rivers, where amphibiotic insect species with different terms of departure live as well as many species, for which there are no coefficient values between weight and exchange in the scientific literature, the first calculation method provides for significant mistakes[6]. Besides, taking into account significant daily variations of the water temperature it is hard to use coefficient Q10. In the same time, in conditions of one survey, it is impossible to use the method of Method of Bouysen-Yensen. In this case, the Consultant studied the accessibility of invertebrates for fish using drifting traps (Afanasyev, 2001). Taking biomass of animals at the bottom as a constant (in stable weather conditions), drift (the amount of bottom invertebrates moved by the flow) reflects production of a bottom community. Moreover, taking into account peculiarities of fish breeding in mountain rivers, especially trout, drifting invertebrates are the most accessible food for it.

There were comparatively low intensity of drift fixed, reflecting low abundance of invertebrates and time / season of drift placing (Figure 19).

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[6] А. А. Ковальчук. Первичная продукция и деструкция органического вещества донными сообществами реки Уж (бассейн Тисы), Гидробиологический журнал, том 47, 2011, № 6, с.3-10,
С. В. Кружиліна, О. В. Діденко, І. Й. Великопольський, А. І. Мрук. Живлення і трофічні взаємовідносини європейського харіуса та струмкової форелі у річках Закарпатського регіону Гидробиологический журнал, том 49, 2013, № 2

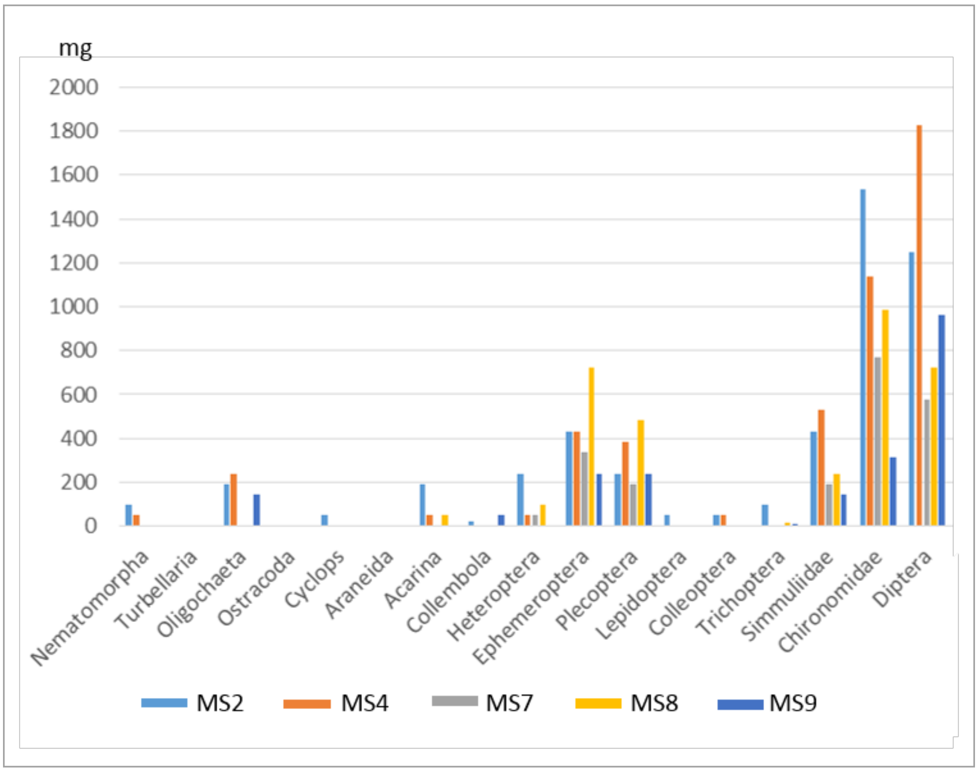

Figure 19. The number of drifting invertebrates (item / m^2) in a cross-section per 1 hour

It is well-known that drift of the main groups (may flies, *Plecoptera, Trichoptera*) is the most intensive in twilight and night time, where it is hard to place a drift trap. In the time of the surveys (12-14 hours), the maximum drift was fixed for *Diptera*, the group, which formed the most of food in the stomach of trout.

The results of the study of the contents of the trout stomach showed: food of all trout consists of five groups of invertebrates. Three out of five studied trout have ants as a main food (65-75%); two other fish had 70-75% of large dipteral insects. May flies, *Plecoptera* and *Trichoptera* made 17-28%, which showed selectivity of trout food choices.

Conclusion: In total, the surveys of the invertebrates showed good natural food basis for trout, reinforced by the surface insects, falling into the rivers.

2.3 Fish composition and abundance survey

Fish composition and abundance was studied using casting net, ichthyologic net and fishing rode. During the surveys, in total 47 fish specimens were caught at 8 monitoring stations. They belong to two species. 46 fish specimens were identified as *Salmo trutta,* out of these, 34 in Nenskra and 11 in Nakra. The biggest number of caught brown trout was in the place of the proposed impoundment structures at Nenskra, monitoring station 2. The sizes of brown trout caught varied from 7 to 25 cm, in Nakra from 9.5 to 14.5 cm (Figure 20).

Figure 20. The biggest specimen of brown trout caught in Nenskra

Figure 21. The only specimen of Oncorhynchus mykiss

The only specimen of rainbow trout (*Oncorhynchus mykiss*) was caught by ichthyologic net in the village Zemo Marghi (Lari Lari) (Figure 21). Most probably it had escaped from the private trout farm located in the pond upstream construction camp.

The caught fish once processed for measurements of the main morphometric characteristics were then released back in to the river. The only exemption was 3 brown trout specimens, which were fixed by formalin for further processing of the food in stomach and detailed identification in laboratory conditions. Besides this, local fishermen shared with the Consultant two caught brown trout specimen for study of food in the stomach.

Table 6. Caught fish species

#	Description	Fish species	Quantity	Length, cm	Height, cm
1	Nenskra, water reservoir	*Salmo trutta*	4	15.5	3.1
				15	3.1
				11.7	2.4
				9.5	1.9
2	Nenskra, impoundment structure (dam)	*Salmo trutta*	18	25	5.6
				17	3.9
				16.7	3.7
				16.5	3.6
				16	3.5
				15.3	3.2
				14.5	2.9

#	Description	Fish species	Quantity	Length, cm	Height, cm
				14	2.8
				13.5	2.8
				12.5	2.5
				11	2.4
				8.2	1.6
				8.2	1.6
				7.6	1.5
				7.5	1.4
				7.5	1.5
				7	1.5
				7	1.4
3	Nenskra, downstream of the impoundment structure	*Salmo trutta*	4	14.5	3.2
				12.5	2.6
				13.5	3
				8.5	1.9
4	Nenskra, downstream confluence with Tita River	*Salmo trutta*	3	14.3	3.2
				13.2	3
				13	3
		Oncorhynchus mykiss	1		
5	Nenskra, Chubevi bridge	*Salmo trutta*	4	12	2.4
				11.5	2.2
				11	2.2
				10.5	2
7	Nakra, upstream of the impoundment structure	*Salmo trutta*	6	14.5	3.2
				12.5	2.4
				12.3	2.5
				11.9	2.1
				11.7	2.3
				10.5	2.1
8	Nakra, downstream the impoundment structure	*Salmo trutta*	2	12.3	2.5
				9.5	1.9
9	Nakra, upstream confluence with Lakverari River	*Salmo trutta*	3	14	3
				12	2.6
				11.5	2.4

Figure 22. Specimen of potential Black Sea salmon, caught by locals

In addition to site survey, the Consultant also interviewed local fishermen. During the interviews, it was understood that sometimes in the river, the fishermen can catch a large (up to 9 kg) fish. The species cannot be clearly determined, but by description the most similar species would appear to be the Black Sea salmon (local name is "oraguli"). The Consultant obtained photo of the two caught specimens in Nenskra in September 2017 (Figure 22). But at present it is impossible to identify the species.

Also in the small right tributary of Nakra (1518 m asl), the Consultant found a pond, where locals breed carp (*Cyprinus carpio*) (Figure 23). Presence of juvenile specimen in the pond confirms the successful reproduction of this species in given climate (Figure 24). If this species was to invade the river, it is possible that it could find suitable habitats in braided arms with slow flow and oxbow arms.

Figure 23. Owner of the pond with carps in the Nakra basin

Figure 24. Juvenile carp

Conclusions:

- Brown trout (*Salmo trutta*) lives in both rivers within the Project Area. This species is listed as vulnerable on the Georgia Red List, but as least concern on the IUCN red list.

- The biggest concentration of the brown trout was found in the area of the proposed impoundment structure location.

- One potentially invasive species, rainbow trout (*Oncorhynchus mykiss)*, was found in the Nenskra River (only one individual). This species could spread further in conditions of low flow.

- Anecdotal evidence from fishermen described a fish species called "oraguli". It would be beneficial if further monitoring surveys could identify this fish species. If it is Black Sea salmon, then the Enguri dam will prevent migration to the sea, but it may still be present in the wider Enguri watershed.

2.4 **Otter survey**

Otter survey was conducted by route observations of banks in order to find typical habitats for otter (holes, caves, tree debris), traces and waste products (typical territorial marks).

It showed the following: there are a number of suitable habitats for otter at both Nenskra and Nakra rivers. The banks heavy accessible by humans have a number of natural shelters.

Life cycle of Otter
Otter has twilling-night way of life. It can live in different waters, but prefers lakes, oxbow lakes, and rivers with banks covered by shrubs, trees and reed. In Caucasus, the Consultant observed it in Dariali gorge above 1800 a.s.l. Its main food is fish, amphibians and shellfish. In spring it also consumes insects, Annelida and molluscs, sometimes reptiles, water birds and rodents. It can make food storages behind the bank sheds. Young animals feed on plants.

In total, the Consultant found traces of two otters: one at Nenskra and one at Nakra rivers (Figures 25-26).

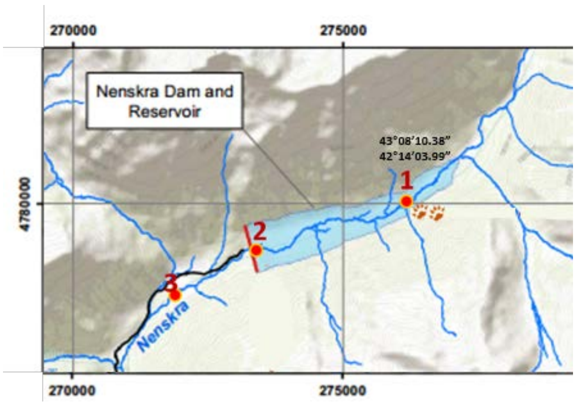

Figure 25. Location of otter traces found at Nenskra

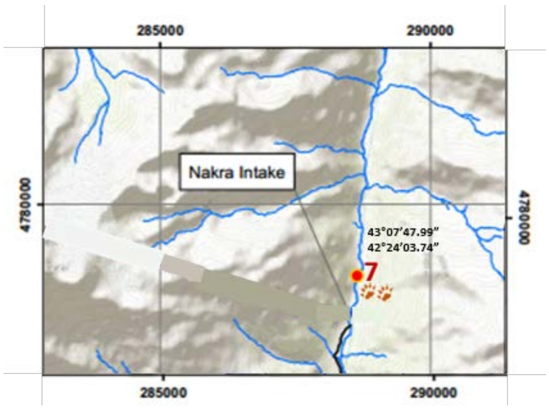

Figure 26. Location of otter traces found at Nakra

At Nenskra, upstream the future impoundment structure, the Consultant found unclear traces of young otter with typical "heel" (Figure 27).

Figure 27. Traces of hind legs of otter found at Nenskra

The interview with locals showed that otter is periodically seen in Nenskra basin near trout farm (Figure 28). According to the owner of the farm, otter periodically hunts the trout in the pond, which is especially visible by traces in winter time.

Figure 28. Rainbow trout farm at Nenskra

According to the owner of the pond with carps at Nakra, no traces of otter as well as less fish were fixed. However, during the detailed study of photos made in the upper Nakra, the Consultant found quite clear trace of foreleg of otter (Figure 29), which differ from present dog traces (at photo in shadow of the tree) by presence of five fingers. The trace of hind leg is also identifiable by five fingers, although the "heel" is outside of sand and there is no trace (down at the photo in the shadow).

Figure 29. Traces of otter at Nakra

In order to fix the otter presence, the Consultant used the method of infrared photo fixation using cameras LTL ACORN 5225BR Long Range. The cameras were placed near the trace at Nenskra as well as in five additional suitable habitats (Figure 30). Near the trace, the Consultant placed bait (fish). During the surveys, none of cameras fixed the otter presence.

Figure 30. Habitats where cameras LTL ACORN 5225BR Long Range were placed

Action photo cameras SJCAM 4000 (for underwater study) were also not effective.

Conclusion: Presence of otter traces as well as (anecdotal) confirmation by locals, leads to the conclusion that otter is present on both the Nakra and Nenskra Rivers. The number of signs recorded was limited; therefore it is considered that otter populations are low, or the signs recorded were made by a small number of ranging/transient individuals. *Lutra lutra* is subject to international protection: it has status of "near threatened" in the IUCN Red List[7], Appendix I of CITES, Appendix II of the Bern Convention, Annexes II and IV of the EU Habitats and Species Directives and it is also included in the Georgian Red List.

[7] http://www.iucnredlist.org/details/12419/0

Conclusions

The present study presents the first findings on the fish diversity and abundance, otter presence and invertebrates' diversity in the Project Area, supplemented by river stream, bed and bank survey.

- The study confirmed the presence of the brown trout (Salmo trutta), which is migratory species, two invasive fish species: rainbow trout (*Oncorhynchus mykiss)* and carp (*Cyprinus carpio*). Further spring surveys should be focused on identification of the spawning places / locations of the juvenile brown trout breeding and if possible identification of the fish called by locals "oraguli";

- The study showed the presence of the otter in both rivers. The number of signs recorded was limited made by a small number of ranging/transient individuals. Further spring surveys should focus on the detailed investigations of the found locations using photocamera and food baits

- The study identified the diversity of taxonomic groups of macroinvertebrates, further work should be focused on the development of the baseline scale specific for conditions of Nenskra and Nakra for express assessment of biological status of these rivers; and the further changes in their status;

- The study showed diversity of the habitats, favourable for aquatic organisms. For the spring surveys it is important to check these habitats and possible barriers in conditions of low flow.

The final goal of the aquatic biodiversity surveys is to monitor the current state of aquatic diversity and to determine if additional measures to manage impacts are required by the project and if this is the case, to provide recommendations to minimize impacts.

Annex 1. Parameters measured by the Consultant

№	Parameter
1. River stream, bed and bank survey	
1.1	Coordinates measurements
1.2	Width of river
1.3	Channel types
1.4	Bed elements
1.5	Flow types
1.6	Percentage composition of sediments
1.7	Bank slope type
1.8	Bank vegetation
2. Invertebrates composition and abundance survey	
2.1	Species
2.2	Parameters, mentioned in field protocol (Annex 2)
2.3.	Species composition of food in the fish stomach
3. Fish composition and abundance survey	
3.1	Species
3.2	Quantity
3.3	Length of the body
3.4	Height of the body

Annex 2. Template for Field protocol for express assessment of biological status of the river

Name of the water body	**Station number**
(photo)	Visual tags to the terrain: N – E – H –
Date	**Weather:**

DESCRIPTION BLOCK

Landscape and biotopic description:	
Geology	
Altitude category	
Type of water body	
Structure of the bank	
Width of the water body	
Depth	
Flow velocity (m/ s)	
Predominant type of substrate	
Water use	
Visible pollution	
Temperature C°	
Colour	
Transparency of Secchi depth	
pH	
O_2%	
Additional Information	

Biotsenotic description	
Survey method	
Macrophytes	
Macroalgae	
Macroinvertebrates	
Vertebrates	
Ichthyofauna	

ASSESSMENT BLOCK

<table>
<tr><td colspan="6">Plecoptera</td></tr>
<tr><td colspan="2">Ephemeroptera
(Baetis excluded)</td><td colspan="2">Trichoptera
(Ecnomus excluded)</td><td colspan="2">Gammaridae</td></tr>
<tr><td>Odonata</td><td>Bivalvia (Sphaeridae excluded)</td><td>Gastropoda</td><td colspan="3">Bryozoa</td></tr>
<tr><td>Spongia</td><td>Asellus</td><td>Hirudinea</td><td colspan="3">Sphaeridae</td></tr>
<tr><td colspan="2">Chironomidae</td><td colspan="4">Tubificidae</td></tr>
<tr><td colspan="6">Other</td></tr>
<tr><td colspan="3">Biotic indices</td><td>Periphyton</td><td>Benthos</td><td>General</td></tr>
<tr><td colspan="3">Trent Biotic Index</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Geobotanical indicators</td><td colspan="3"></td></tr>
</table>

INDICATOR SPECIES

<table>
<tr><td colspan="7">Benthic fauna</td><td colspan="7">Fish</td></tr>
<tr><td>Saprobity area</td><td>X</td><td>o</td><td>β</td><td>α</td><td>p</td><td>S</td><td>Saprobity area</td><td>x</td><td>O</td><td>β</td><td>α</td><td>p</td><td>S</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Phoxinus phoxinus</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Cottus gobio</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Salmo trutta</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Higher aquatic vegetation</td><td colspan="7">Other indicators</td></tr>
<tr><td>Saprobity area</td><td>X</td><td>o</td><td>β</td><td>α</td><td>p</td><td>S</td><td>Saprobity area</td><td>x</td><td>O</td><td>β</td><td>α</td><td>p</td><td>S</td></tr>
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</table>

Category of trophicity:

Comments: *category of water quality; class of biological status*