



POROČILO ZA ŠIRŠO JAVNOST

Obnovitev koridorja Ljubljanice in izboljšanje rečnega vodnega režima

LAYMAN'S REPORT

**Restoration of the Ljubljanica River Corridor and
Improvement of the River's Flow Regime**

LIFE NAT10/SI/142



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LAYMAN'S REPORT

for the project

LJUBLJANICA CONNECTS

Restoration of the Ljubljana River
Corridor and Improvement of the
River's Flow Regime

Edited by: Klaudija Sapač, Katarina
Zabret

Text: Katarina Zabret

Translation: Mojca Vilfan

Photographs: Klaudija Sapač, Matej
Sečnik, Nina Uršič, Andrej Vidmar,
Anja Vihar, Katarina Zabret

Printed by: Birografika BORI d.o.o.

Print run: 100 copies

Co-financed under LIFE, EU's finan-
cial instrument for the environment

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POROČILO ZA ŠIRŠO JAVNOST

projekta LJUBLJANICA POVEZUJE

Obnovitev koridorja Ljubljane in izboljšanje
rečnega vodnega režima

Urejanje: Klaudija Sapač, Katarina Zabret

Besedilo: Katarina Zabret

Lektoriranje: Mojca Vilfan

Fotografije: Klaudija Sapač, Matej Sečnik, Nina
Uršič, Andrej Vidmar, Anja Vihar, Katarina Zabret

Tisk: Birografika BORI d.o.o.

Naklada: 100 izvodov

Sofinancirano s pomočjo finančnega instrumenta
za okolje Evropske skupnosti LIFE

VSEBINA PROJEKTA

Ob Ljubljanici se pogosto sprehajamo in posedamo, le redko pa se zavedamo pestrega življenja v njej. V Ljubljanici namreč plava kar 26 avtohtonih vrst rib, tu pa prebivajo tudi vidre, nutrije, želve, žabe in race. Sodoben pristop k trajnostnemu urejanju vodotokov stremi tako k ohranjanju naravne pestrosti reke kot tudi k izboljšanju življenja prebivalcev Ljubljane.

V preteklosti je bilo na Ljubljanici zgrajenih več različnih objektov za zaščito mesta pred poplavami in vzdrževanje ustreznega vodnega režima. To so na primer Gruberjev kanal z zapornicami, jez pri Fužinskem gradu in zapornice na Ambroževem trgu. Ti objekti na reki ovirajo gibanje rib, zmanjšujejo njihov življenjski prostor in možnosti za razmnoževanje.

Da bi izboljšali povezanost reke Ljubljanice in njeno prehodnost za ribe, smo se s projektom osredotočili na zapornici na Ambroževem trgu in jez na Fužinah. V sklopu teh ovir sta bili ribji stezi v preteklosti že zgrajeni, vendar nista več delovali, kar smo z obnovo in izboljšavami sedaj zagotovili. Uspešnost obnove stez preverjamo z akcijami izlova in označevanja rib ter s podvodnimi kamerami v obnovljenih ribjih stezah. Poleg tega smo izboljšali tudi zastareli sistem za regulacijo zapornic na Ambroževem trgu, z obnovitvijo praga v Zalogu pa smo zagotovili stalen dotok sveže vode v mrtvico.

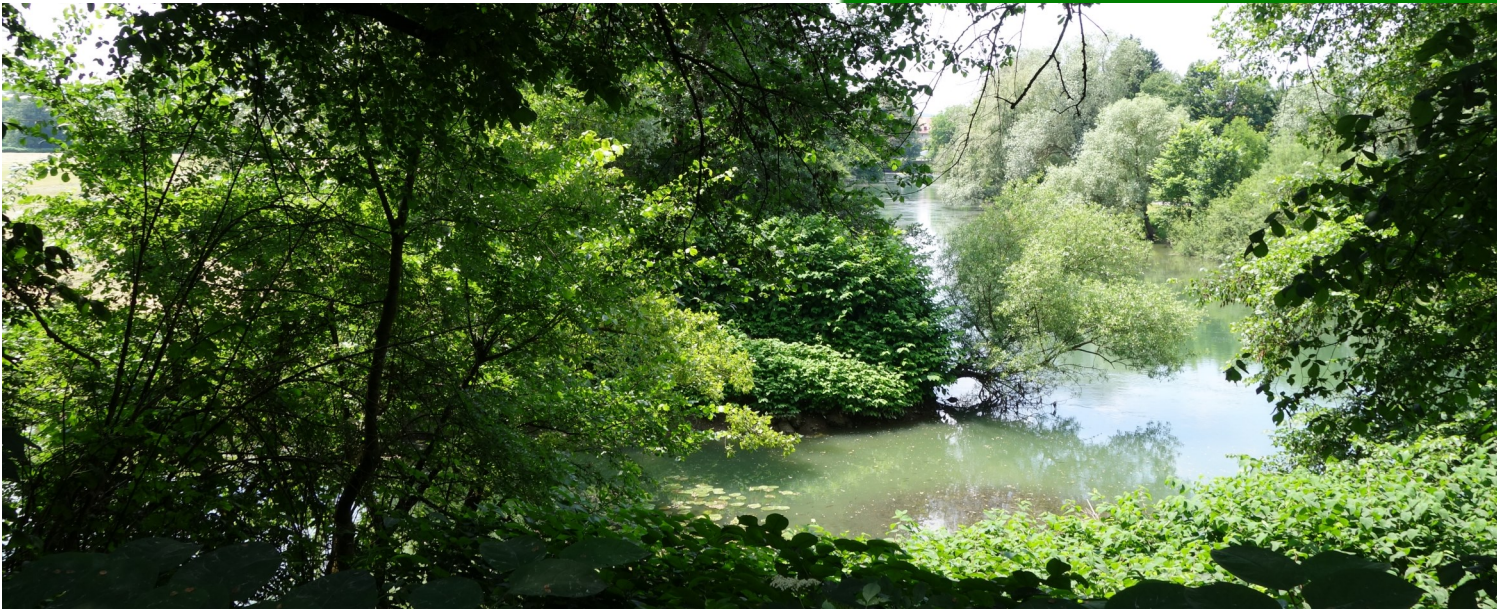
Poleg izboljšanja povezanosti Ljubljanice je dodana vrednost projekta obveščanje javnosti in širjenje zavedanja o Ljubljanici kot pomembnem in vitalnem elementu okolja v mestu.

CONTENT OF THE PROJECT

We often walk and sit along the Ljubljanica River, but we rarely recognise the diversity of life in it. There are as many as 26 native fish species in the Ljubljanica, and home to otter, nutria, turtle, frog, and duck. A modern approach to sustainable hydrological engineering is directed at conservation of natural river diversity as well as improvement of the quality of life of inhabitants of Ljubljana.

Various structures for protection of the city against floods and maintenance of the appropriate flow regime were built in the past. These are, for example, the Gruber Canal with gates, the weir at the Fužine Castle, and the gates at Ambrožev trg. These structures obstruct the migration of fish, decrease their habitat and reproduction possibilities.

The project's focus was the gates at Ambrožev trg and the weir at Fužine with a view to improve the connectivity of the Ljubljanica and the passability for fish. In the past, these two barriers already included fish passes, but they were no longer operational; now these fish passes were restored and improved. The success of fish pass restoration is checked with fish catch and fish tagging campaigns and underwater cameras in the restored fish passes. Besides, we improved the obsolete system for gate regulation at Ambrožev trg, while the restoration of the weir at Zalog allowed for a permanent inflow of fresh



water into the oxbow.

Besides setting up the connectivity on the Ljubljanica, an added value of the project is its publicity and awareness-raising about the Ljubljanica as an important and vital element in the urban environment.

PROJECT OBJECTIVES

The main project objective is the improvement of the ecological function, connectivity and passability of the Ljubljanica River reach from the city of Ljubljana downstream. The Ljubljanica river is an important habitat for target Natura 2000 fish species: Danube salmon (*Hucho hucho*), Danube roach (*Rutilus pigus*), and striped chub (*Leuciscus souffia*).

Other project objectives are improving the ecological status of rivers with relatively simple restoration measures, ecohydrological studies, setting-up of a hydrological model to improve our knowledge about the Ljubljanica, and awareness-raising among the general public, which, due to the past water management, still regards Ljubljanica as a threat rather than an essential element of environmental quality.

PROJECT SITES

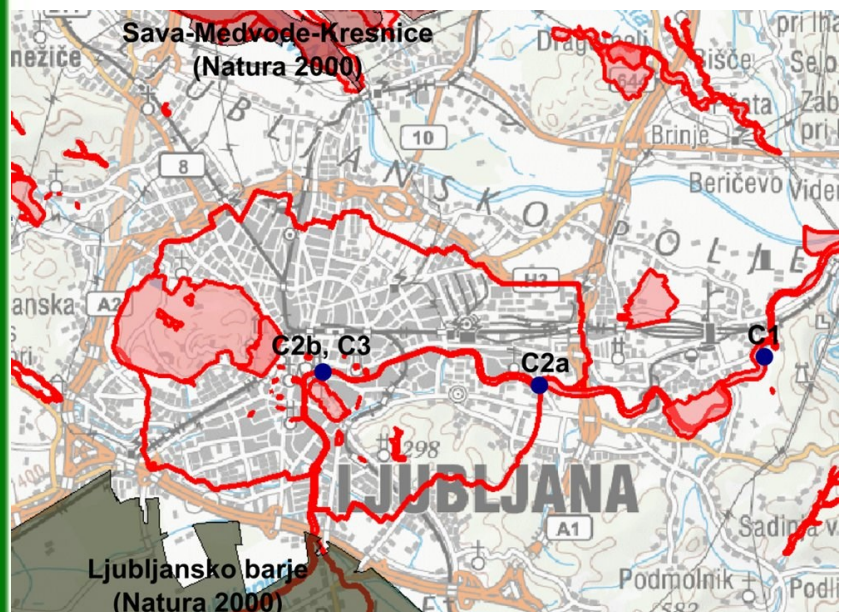
The project relates to the area along the entire Ljubljanica river channel, from Vrhnika to its mouth to the Sava River. There are two Natura 2000 sites in the area: Ljubljansko barje (Ljubljana Marshes) and Sava–Medvode–Kresnice.

In this project we focused on the most degraded section of the river, which flows through the city core of Ljubljana. Here we restored the fish passes at the sluice gate at Ambrožev trg (C2b) and at the weir at Fužinski grad (C2a) as well as the gate lifting system at Ambrožev trg (C3). We also improved the living conditions in the oxbow downstream from the centre of Ljubljana, at Zalog (C1). Along the entire Ljubljanica channel we carried out ichthyological surveys and installed measuring stations to record water level height, temperature, and concentration of dissolved oxygen in water.

CILJI PROJEKTA

Glavni cilj projekta je izboljšanje ekološke funkcije, povezanosti in prehodnosti odseka reke Ljubljanice od mesta Ljubljane dolvodno. Reka Ljubljanica namreč predstavlja pomemben habitat zaščitenih ribjih populacij Natura 2000: sulca (*Hucho hucho*), platnice (*Rutilus pigus*) in blistavca (*Leuciscus souffia*).

Ostali cilji projekta so tudi vzpodbujanje izboljšav ekološkega statusa rek z razmeroma enostavnimi obnovitvenimi ukrepi, izvajanje ekohidroloških raziskav in postavitev hidrološkega modela za izboljšanje poznavanja Ljubljanice ter osveščanje širše javnosti, ki zaradi preteklega upravljanja voda Ljubljanico še vedno dojemajo predvsem kot nevarnost in ne kot bistveni element kakovosti okolja.



PROJEKTNÁ OBMOČJA

Projekt poteka vzdolž celotne struge reke Ljubljanice od Vrhnike do izliva v Savo. Tu sta tudi dve območji Natura 2000: Ljubljansko barje in Sava-Medvode-Kresnice.

V projektu smo se osredotočili na najbolj degradirani odsek reke, ki teče skozi mestno jedro Ljubljane. Tukaj smo obnovili ribji stezi pri zapornici na Ambroževem trgu (C2b) in ob pregradi pri Fužinskem gradu (C2a) ter sistem dvigovanja zapornice na Ambroževem trgu (C3). Izboljšali smo tudi življenjske pogoje v mrtvici dolvodno od centra Ljubljane, pri Zalogu (C1). Vzdolž celotne struge Ljubljanice pa smo izvajali izlove rib in namestili merilne postaje, kjer merimo višino vodne gladine, temperaturo in koncentracijo kisika v vodi.

KAJ SMO DELALI V OKVIRU PROJEKTA?

Predhodna študija habitatnih pogojev

Reka Ljubljanica ima pestro zgodovino s številnimi regulacijami. Prvi korak je bil preveriti trenutno hidrološko in hidravlično stanje na reki ter oceniti stanje ogroženih ribjih populacij.



Priprave na izvedbo obnovitvenih akcij

Projekt je obsegal tudi več konkretnih obnovitvenih akcij, v katere smo vključili različne zaščitene objekte na Ljubljanici. Pred začetkom del je bilo treba pridobiti potrebna soglasja in natančno preveriti stanje na terenu.

Vzpostavitev ekohidrološkega monitoringa

Za stalno spremljanje višine vode v Ljubljanici ter bioloških in kemičnih parametrov smo vzpostavili merilno mrežo, s katero izvajamo ekohidrološke raziskave. Merilno mrežo sestavlja 17 merilnih postaj s senzorji za tlak vode, tlak zraka, temperaturo vode in vsebnost raztopljenega kisika, ki so postavljene vzdolž Ljubljanice. Tri od teh postaj imajo tudi *online* povezavo.

WHAT DID WE DO IN THIS PROJECT?

Preliminary study of habitat conditions

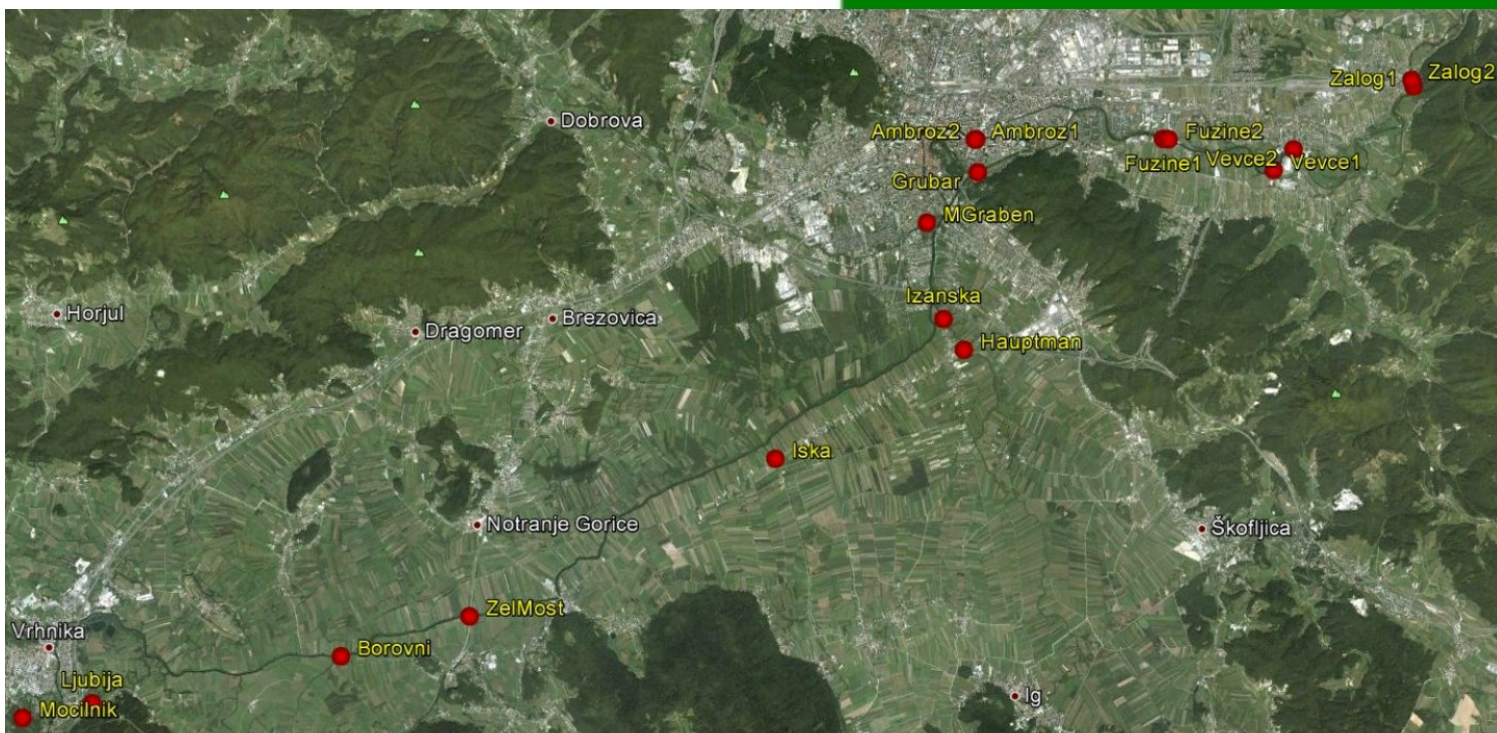
The Ljubljanica River has a diverse history, which included many river engineering works. The first step was to check the current hydrological and hydraulic condition on the river and assess the condition of endangered fish populations.

Preparations for restoration campaigns

The project comprised several restoration campaigns which included the restoration of various protected structures on the Ljubljanica River. Before commencing the works we had to acquire all the necessary consents and check the condition in the field.

Setting-up of ecohydrological monitoring

A measuring networks for ecohydrological investigations was set up for permanent monitoring of water height in the Ljubljanica as well as of biological and chemical parameters. The network is composed of 17 measuring stations installed along the Ljubljanica with sensors for water pressure, air pressure, water temperature, and dissolved oxygen content. Three of these stations have online connection.



The restoration of the weir at Zalog

An oxbow formed from the Ljubljanica River at Zalog. The oxbow with its unique habitat conditions – almost standing, somewhat warmer water – is home to many animals and plants. Next to the Ljubljanica's headwaters, the oxbow is a popular spawning ground for fish.

In the summer, during Ljubljanica's low flows, the inflow of water into the oxbow was repeatedly discontinued, which negatively affected the habitat conditions. For this condition to improve, some time ago a weir was built a few hundred metres downstream from the oxbow; however, the weir suffered various damages and was no longer functional. It was restored, raised, and the bank was secured using dry stonework. So we ensured a higher water level of the Ljubljanica upstream and thus the inflow of water into the oxbow also during low flows.

Improvement of the fish pass at Fužine

At the weir at Fužine Castle, there is a fish pass that was not operational during low to medium flows, due to the incorrect execution prior to the restoration works, while due to the lack of maintenance it was completely overgrown; furthermore, it partially collapsed during high flows.

In cooperation with Papirnica Vevče, the fish pass was restored and its operation improved. It was cleared of moss and overgrowth, while the torn-down wall was replaced by prefabricated elements; at the inflow another element was installed which prevents the deposition of debris to the fish pass.

Improvement of the fish pass at Ambrožev trg

At the square of Ambrožev trg, the fish pass is located behind the crossing across the Plečnik's sluice gates at the right bank, which was also out of function due to incorrect execution and deterioration. At the time when the gates were closed the fish could not pass the barrier. This fish pass was also cleared first, and the



Obnova praga v Zalogu

V Zalogu se na Ljubljanici nahaja mrtvica. Zaradi edinstvenih habitatnih pogojev - skoraj stoječe in nekoliko toplejše vode, v njej najdemo številne živali in rastline. Poleg povirnih delov Ljubljanice je tudi mrtvica priljubljeno okolje za drstenje rib.

Poleti, v času nizkih pretokov Ljubljanice, je bil dotok vode v mrtvico večkrat prekinjen, kar je negativno vplivalo na habitatne pogoje. Za izboljšanje tega stanja je bil nekaj sto metrov dolvodno od mrtvice že pred časom zgrajen prag, ki pa zaradi različnih poškodb svoje naloge ni več opravljal. Prag smo obnovili, ga dvignili ter s kamnito zložbo utrdili brežino. Tako smo zagotovili višji vodostaj Ljubljanice gorvodno in s tem dotok vode v mrtvico tudi v času nizkih pretokov.



Izboljšava ribje steze na Fužinah

V sklopu jezusa pri Fužinskem gradu je ribja steza, ki zaradi nepravilne izvedbe pred obnovo ni delovala v času nizkih do srednjih pretokov, zaradi ne vzdrževanja je bila povsem zaraščena, novembra 2013 pa se je ob visoki vodi še delno porušila.

V sodelovanju s Papirnico Vevče smo ribjo stezo obnovili in izboljšali njeno delovanje. Stezo smo očistili mahu in zarasti, porušeno steno nadomestili z montažnimi elementi, na vtoku pa smo namestili še element, ki preprečuje vnos plavja v ribjo stezo.



Izboljšava ribje steze na Ambroževem trgu

Na Ambroževem trgu se za prehodom preko Plečnikovih zapornic v desnem bregu nahaja ribja steza, ki zaradi napačne izvedbe in dotrajanosti prav tako ni opravljala svoje funkcije. V času, ko so bile zapornice zaprte, ribe niso mogle prehajati preko ovire.

Tudi to stezo smo najprej očistili, porušene stene med posameznimi stopnicami pa nadomestili z novimi. V stezo smo namestili cev, ki na iztoku iz ribje steze



ustvari hitrejši tok, da ribe lažje zaznajo vhod vanjo. Tudi pri tej ribji stezi smo na vtoku postavili zaščitni element, ki preprečuje vnos in zastajanje plavja.

Izboljšava dviznega sistema Plečnikovih zapornic

Zapornična pregrada na Ambroževem trgu skupaj s tisto na Gruberjevem kanalu služi uravnavanju količine vode v Ljubljanici vse do Ljubljanskega barja. Zapornic na Ambroževem trgu do sedaj ni bilo mogoče natančno regulirati, saj pogon zapornice in njena nazivna moč nista bila zasnovana za počasnejše in preciznejše premike. Dvig zapornic je tako lahko povzročil nenadno spremembo v vodnem toku in povečal kalnost vode, kar lahko hipno poslabša ekološke pogoje.

Da bi omogočili bolj fino regulacijo zapornic, smo si zadali cilj, da prenovimo pogonski sistem zapornice na Ambroževem trgu tako, da bi ta dovoljeval hod zapornice do 200 mm nad pragom s fino regulacijo odprtja z najmanjšim korakom 5 mm. Dela na zapornici so obsegala rekonstrukcijo strojne in elektro opreme zapornice. Vgradili smo nov motor, izdelali mehansko kazalo in potrebne dele za vgradnjo merilnih naprav položaja spodnje zapornice. Vsa dela so se izvajala izključno v strojnici ob desnem bregu.

torn-down walls between the stairs were replaced by new ones. A pipe was installed at the fish pass creating a faster current at the outflow from the fish pass, to stimulate the fish to find the entry into the fish pass. Here, too, a protection element was set up at the inlet of this fish pass, which prevents the ingress and the build-up of debris.



Improvement of the gate lifting system at the Plečnik's Sluice Gates

The gated dam at Ambrožev trg, together with that at the Gruber Canal, allows for the regulation of the water volume in the Ljubljanica up to Ljubljansko barje (Ljubljana Marshes). Until now, the gates at Ambrožev trg could not be precisely regulated, because the drive of the gate and its nominal power were not designed for slower, more precise movements. The lifting of the gate could cause a sudden change in the water current and increase turbidity, which could instantaneously deteriorate the ecological conditions downstream.

To allow for a finer regulation of the gates, we set the goal to restore the drive system of the gate at Ambrožev trg so that it would allow the travel of the gate of up to 200 mm above the weir, with a fine regulation of the orifice with a minimum increment of 5 mm. The works on the gate consisted of reconstruction of mechanical appliances and electronic equipment of the gate. We installed a new engine as well as created a



mechanical indicator and the necessary parts for installing the measuring devices of the position of the lower gate. All the works were carried out exclusively in the machinery on the right bank.

Information, education, and project promotion

The project is underway in an environment that is well known to us and where we are daily active. To encourage people to appreciate the natural assets around them we invited them to take part – in various ways. For the general public we organised two roundtables where we focused on the problems tackled by the project; we met with the professional community at a workshop at the beginning of the project and at an international conference during its completion. We attended various professional meetings abroad, where we also presented the project. We were most happy to be working with young people and about their response to the project.

Monitoring fish migration

The fish movements and operation of fish passes are monitored in two ways. At the target section we conducted fish surveys in collaboration with fishermen; before releasing the fish back to the river, the fish were tagged with various colours according to the location of the catch. When the tagged fish is recaptured, we will be able to assess the route of this fish. In the restored fish pass we also installed two cameras to assess the abundance and species diversity of the fish passing through successfully.

Ecohydrological monitoring

The survival of fish populations and other aquatic organisms in the Ljubljanica depends not only on the organisation of the passage structures, allowing for their migration upstream to more favourable grounds for spawning, but also on favourable water conditions. For the fish under the Ljubljanica Connects project, the most significant indicators of favourable conditions are concentration of dissolved oxygen in water, water temperature, and water level. All these parameters are monitored using measurements along the Ljubljanica.

Informiranje, izobraževanje in promocija projekta

Projekt poteka v okolju, ki ga vsi dobro poznamo in v katerem se dnevno gibljemo. Da bi spodbudili ljudi, da se pričnejo zavedati naravnih bogastev okrog sebe, smo jih na različne načine povabili k sodelovanju. Tako smo za širšo javnost organizirali dve okrogli mizi, kjer smo se osredotočili na problematike, ki jih obravnavamo s projektom, s strokovno javnostjo pa smo se srečali na delavnici ob začetku projekta in mednarodni konferenci ob njegovem zaključevanju. Udeležili smo se več strokovnih srečanj v tujini, kjer smo projekt tudi predstavili. Najbolj veseli pa smo bili odziva mladih in sodelovanja z njimi.



Spremljanje migracije rib

Gibanje rib in delovanje obnovljenih ribjih stez spremljamo na dva načina. Na ciljnim odseku smo v sodelovanju z ribiči izlavljal ribe, ki smo jih pred izpustom označili z različnimi barvami glede na lokacijo ulova. Ob ponovnem ulovu označene ribe bomo lahko ocenili, kje se je ta gibala. V obnovljeni ribji stezi pa smo namestili tudi kameri, s katerima lahko ocenimo število in vrsto rib, ki stezo uspešno prečkajo.

Ekohidrološki monitoring

Preživetje ribjih populacij in drugih vodnih organizmov v Ljubljanici ni odvisno samo od ureditve prehodnih objektov, ki jim bodo omogočali selitve gorvodno do ugodnejših mest za drst, temveč tudi od ugodnih razmer vode. Za ribe, na katere se osredotočamo v sklopu projekta Ljubljanica povezuje, so najpomembnejši pokazatelji ugodnih razmer koncentracija raztopljenega kisika v vodi, temperatura vode in vodostaj. Vse te parametre spremljamo z meritvami vzdolž Ljubljanice.

KAKO JE PROJEKT ZAŽIVEL Z MLADIMI

Eden od ciljev projekta je bil tudi obveščanje javnosti in širjenje zavesti o Ljubljanici kot pomembnem in vitalnem elementu okolja v mestu. Pri uresničevanju tega cilja smo se osredotočili na mlade, saj bodo oni tisti, ki bodo gradili našo prihodnost. Zato si želimo, da bi se reševanja problemov lotili z učinkovitimi ukrepi ter pri tem znali opazovati in upoštevati našo okolico, zgodovino območja in naravna bogastva. K sodelovanju smo tako povabili mlade, predvsem osnovnošolce in srednješolce iz Ljubljane, saj je njim Ljubljanica najbližja in najbolj poznana. Zanje smo pripravili kratke dvourne delavnice v njihovih učilnicah, včasih pa smo šolo preselili pod most, kjer smo si v sklopu terenskih vaj zmočili noge, povabili pa smo jih tudi k nam, na Oddelek za okoljsko gradbeništvo UL FGG, kjer smo zanje pripravili celodnevne naravoslovne dni.



Tople in sončne spomladanske dni smo izkoristili za delavnice na terenu. Ob Gradaščici v naši bližini smo skupaj z mladimi zabredli v vodo in izmerili pretok, temperaturo in pH vode ter vsebnost raztopljenega kisika. Vrednosti teh parametrov namreč določajo kakovost življenjskih pogojev v reki, ki so poleg zagotavljanja prehodnosti za ribe prav tako pomembni. Na terenu smo se družili z dijaki Gimnazije Jožeta Plečnika Ljubljana, Srednje lesarske šole, Škofijske klasične gimnazije, Srednje vzgojiteljske šole in gimnazije Ljubljana, Gimnazije Šiška ter z osnovnošolci OŠ Martina Krpana in OŠ Vič.

Včasih pa smo zaradi vremena ali oddaljenosti od reke terensko delo preselili kar v učilnice, kjer smo pripravili interaktivne delavnice. Pri tem smo dogajanje iz narave v zaprte prostore prenesli s pomočjo različnih

GETTING YOUNG PEOPLE INVOLVED

The project objectives included publicity and awareness-raising about the Ljubljanica as an important and vital element in the urban environment. In achieving this objective we focused on the young people who will be the ones to build our future. Therefore, we want to tackle our problems with efficient measures, along with observing and taking into account our environment, local history, and natural assets.

We relied on the help of young people, particularly of primary and secondary school students from Ljubljana, because they are the ones most familiar with the Ljubljanica river. We prepared short two-hour workshops in their classrooms, while the

classroom was occasionally moved under the bridge where we, as part of field work, also wet our feet; we also invited them to visit us at the Department of Environmental Civil Engineering at the Faculty of Civil and Geodetic Engineering of the University of Ljubljana, where we prepared full-day science days.

The warm and sunny spring days were used for field workshops. We waded into the water of the Gradaščica River in our vicinity, and recorded water flow, temperature, pH, and dissolved oxygen content. The values of these parameters determine the quality of the living conditions in the river, which are also significant. In the field we worked with the students of Gimnazija Jožeta Plečnika Ljubljana, Srednja lesarska šola, Škofijska klasična gimnazija, Srednja vzgojiteljska šola in gimnazija



Ljubljana, Gimnazija Šiška and primary school pupils from OŠ Martina Krpana and OŠ Vič.

Depending on the weather and the distance from the river, the field work was occasionally moved inside into the classroom, where we prepared interactive workshops. Nature was brought inside using various models, of which the groundwater model was the most popular one among the young generation. The students from Srednja ekonomska šola Ljubljana and primary school students from OŠ Vrhovci also tested the measuring equipment, listened to the project presentation, and took part in a quiz. After the presentation of the project, the students from Srednja trgovska šola were taken to the Ambrožev trg, one of the project sites. There they could see for themselves everything that was presented previously: the fish pass, all the improvements, and the famous Plečnik Sluice Gate.

We organised short thematic lectures for the students from Vegova Ljubljana and Šolski center Novo mesto.

The response of the pupils, students, and teachers to workshops was very positive. The young people were attracted by the fact that the useful and interesting knowledge was delivered outside the conventional school frameworks, while the teachers were pleased with the topicality of the content and the readiness of the students to take part. Therefore we will continue with these activities after the project's completion.

modelov, med katerimi je bil mladim najljubši model podtalnice. Poleg tega so dijaki Srednje ekonomske šole Ljubljana ter osnovnošolci OŠ Vrhovci preizkusili še merilno opremo, poslušali predstavitev projekta in se pomerili v kvizu. Dijake Srednje trgovske šole pa smo po predstavitvi projekta odpeljali kar do bližnjega Ambroževega trga, eno od lokacij projekta. Tam so si v živo ogledali vse, kar smo jim pred tem predstavili: ribjo stezo, vse izboljšave in znamenite Plečnikove zapornice.

Organizirali pa smo tudi krajša tematska predavanja za dijake z Vegove Ljubljana in s Šolskega centra Novo mesto.



Odziv šolarjev, dijakov in profesorjev na delavnice je bil zelo dober. Mlade je pritegnilo predvsem to, da smo jim uporabno in zanimivo znanje posredovali zunaj okvirjev klasičnega pouka, profesorji pa so bili zadovoljni z aktualnostjo predstavljenih vsebin ter s pripravljenostjo učencev na sodelovanje. Zato bomo s temi aktivnostmi nadaljevali tudi po koncu projekta.



DELOVANJE RIBJIH STEZ SKOZI KAMERO

Pomemben del projekta je ovrednotenje rezultatov in ocena doseženih izboljšav. Eden glavnih ciljev tega projekta je bil izboljšati prehodnost reke Ljubljanice z obnovo dveh dotrajanih ribjih stez. Ker se je metoda z izlovom in označevanjem rib izkazala za neučinkovito in izredno dolgotrajno, smo za spremljanje gibanja rib skozi obnovljene ribje steze razvili lasten monitoring prek nizkocenovnega *online* sistema s kamero, nameščeno v ribji stezi.

Sistem za monitoring rib je sestavljen iz dveh delov. Prvi del je vodoodporna škatla, v kateri je nameščen tablični računalnik. Na računalniku teče programska oprema Yawcam, ki omogoča zajem in shranjevanje slik s spletnih kamer. Program sliko ribe shrani na lokalni disk, zaradi večje varnosti pa se slika shrani tudi v oblak.



V drugi škatli sta nameščeni kamera in dodatna osvetlitev, ki omogoča snemanje rib pri slabših svetlobnih razmerah, tudi ponoči. Z zagotovljenim dostopom do interneta si posnetke in s tem dogajanje v ribji stezi v živo lahko ogledate na spletni strani projekta.

Sistem spremljanja migracije rib se je izkazal za zelo uspešnega, saj smo v ribji stezi na Ambroževem trgu od poletja 2015 do konca decembra 2015 posneli že več kot 100.000 slik.



OPERATION OF THE FISH PASSES THROUGH THE CAMERA LENS

An important part of the project is evaluation of the results and appraisal of the improvements achieved. One of the main goals of this project was to improve the Ljubljanica river passability by restoring two deteriorated fish passes. Because the fish catching and tagging method was found to be inefficient and extremely time-consuming, we developed our own monitoring method of fish migration through the restored fish passes, using a low-cost online system with a camera installed in the fish pass.

The fish monitoring system consists of two parts. The first part is a water-resistant box with a tablet computer. The computer uses Yawcam software that allows for capturing and storage of images from the web cameras. The programme also stores the images of the fish to the local disc and, for security reasons, the images are also stored in a cloud environment.

In the second box, a camera and additional lighting are installed allowing to take images during poorer lighting conditions, also at night. The access to the internet allows for live streaming of the images from the fish pass on the project website.

The system of fish migration monitoring has proven to be highly successful; from the summer of 2015 to the end of December 2015 more than 100,000 images were taken in the fish pass at Ambrožev trg.

GETTING THE PROJECT OUT INTO THE WORLD

The problems of river passability and fish migration are increasingly topical throughout the world. In the pursuit of as sustainable animal-friendly solutions as possible many researchers from various scientific fields come together. Each year several events are devoted to the exchange of views and experience as well as finding solutions among people from around the world. Using an engineering approach to providing for fish migration, the "Ljubljana Connects" project is of interest to many of them.

In autumn 2014 we presented the project at international events River Revitalisation Workshop in Slovakia and at the Riverine LIFE Platform Meeting in Estonia.

In June 2015 an international conference Fish Passage 2015, was held in the Netherlands. 540 experts throughout the world attended the conference and the "Ljubljana Connects" project was among the 236 presentations.

Between 20 and 22 June 2016, we also attended the Fish Passage 2016 at the University of Massachusetts Amherst, USA, where we preserved contacts with the researchers from the previous year and made many new ones.

In April 2016 a few project team members attended the European Geosciences Union (EGU) 2016 in Vienna. They presented the project in general, the cameras in the fish passes, and ecohydrological measurements.

On 21 May 2016 we were involved in the World Fish Migration Day. This is a one-day event to create worldwide awareness of the importance of freshwater migratory fish and free-flowing rivers. On this day, many events are organised by local organisations, supported and coordinated by the World Fish Migration Platform. A total of 450 events took place all over the world; we organised one of these events in collaboration with the City of Ljubljana where we presented the project Ljubljana Connects to the people of Ljubljana.



S PROJEKTOM V SVET

Problematiki prehodnosti rek in migracije rib sta čedalje bolj aktualni po celem svetu. V iskanju čim bolj sonaravnih rešitev, prijaznih živalim, se združujejo številni raziskovalci različnih ved. Izmenjavi mnenj in izkušenj ter iskanju rešitev je tako letno namenjenih več dogodkov, ki se jih udeležijo ljudje s celega sveta. Projekt Ljubljana povezuje je z inženirskim pristopom k omogočanju migracije zanimiv za številne med njimi.

Jeseni 2014 smo projekt predstavili na mednarodnih dogodkih River Revitalisation Workshop na Slovaškem in Riverine LIFE Platform Meeting v Estoniji.



Junija 2015 je na Nizozemskem potekala mednarodna konferenca Fish Passage 2015. Udeležilo se je je 540 strokovnjakov s celega sveta, med 236 predstavitvami pa je bil predstavljen tudi projekt Ljubljana povezuje.

Med 20. in 22. junijem 2016 smo se udeležili tudi konference Fish Passage 2016, ki je potekala na University of Massachusetts Amherst v ZDA, kjer smo ohranili nekatere stike z raziskovalci, pridobljene prejšnje leto, in navezali številne nove.

Aprila 2016 se je več članov projektne ekipe udeležilo EGU 2016 na Dunaju. Predstavili so projekt na splošno, kamere v ribjih stezah in ekohidrološke meritve.

21. maja 2016 smo sodelovali pri Svetovnem dnevu migracije rib. To je enodnevni dogodek, namenjen povečanju svetovne zavesti o pomenu sladkovodnih migratornih rib in prehodnosti rek. Na ta dan se zvrstijo številne prireditve, ki jih pripravijo lokalne organizacije, podpira in usklajuje pa jih World Fish Migration Platform. 450 dogodkom po celem svetu smo se pridružili tudi mi, ko smo projekt Ljubljana povezuje v sodelovanju z Mestno občino Ljubljana predstavili Ljubljancanom.

REZULTATI MONITORINGA S KAMERAMI

Kot smo omenili na eni od prejšnjih strani, smo se vrednotenja izvedenih ukrepov za izboljšanje povezanosti reke Ljubljanice in s tem izboljšanja stanja ogroženih ciljnih vrst rib lotili z inovativnim načinom monitoringa s kamerami. Na posnetkih kamer, ki so zaenkrat še slabše kakovosti, so bile zaznane vse tri ogrožene ciljne vrste rib: sulca (*Hucho hucho*), platnico (*Rutilus pigus*) in blistavca (*Leuciscus souffia*). Zelo pomembno je, da smo poleg ciljnih vrst rib na posnetkih kamer prepoznali tudi 9 drugih vrst rib: Common Barbel (*Barbus barbus*), Common Bleak (*Alburnus alburnus*), Common Nase (*Chondrostoma nasus*), Common Roach (*Rutilus rutilus*), European Chub (*Squalius cephalus*), Mediterranean Barbel or Southern Barbel (*Barbus balcanicus*), Schneider (*Alburnoides bipunctatus*), Brown Trout (*Salmo trutta m. fario*), and Grayling (*Thymallus thymallus*).

Analiza je obsegala podatke enoletnega monitoringa, tj. od septembra 2015 do avgusta 2016. Največ rib je migriralo skozi ribjo stezo v mesecu juniju 2016 (več kot 25. 000 rib). Največ ciljnih vrst smo na kamerah v ribjih stezah zaznali v mesecu maju (8 sulcev, 16 platnic in 3 blistavce). Velja izpostaviti, da smo ciljne vrste našli tako v ribji stezi na Ambroževem trgu kot v ribji stezi v Fužinah. To potrjuje, da so bili ukrepi uspešno izvedeni in ciljnim (ter ostalim) vrstam rib omogočajo prehajanje v gorvodno ležeče dele reke.

RESULTS OF MONITORING WITH CAMERAS

As was mentioned on the one of the previous pages, the evaluation of the implemented concrete actions for improvement of the passability of the Ljubljanica river was carried out by cameras which are installed in the fish passes. On the images all three target fish species were observed: Danube Salmon (*Hucho hucho*), Danube Roach (*Rutilus pigus*), and Striped Chub (*Leuciscus souffia*). Also 9 other fish species were observed.

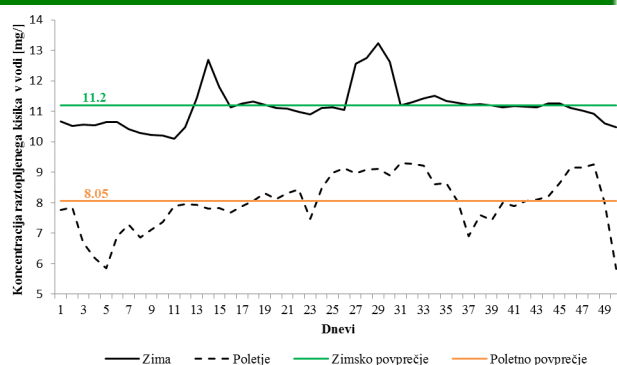
The analysis included data of one year of monitoring, ie. from September 2015 to August 2016. Most of the fish migrated through the fish pass in June 2016 (more than 25 000 fish). Most of the target fish species were observed in the May (8 Danube Salmons, 16 Danube Roaches and 3 Striped Chubs). Target fish species were observed in both fish passes (Ambrožev trg and Fužine). This confirms that the measures have been successfully implemented and the target (and other) fish species can pass into the upstream parts of the river.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Avg	Sep	Oct	Nov	Dec	Total
<i>Hucho hucho</i>				6	8	5	5	1					25
<i>Rutilus pigus</i>				13	16	9	1						39
<i>Leuciscus souffia</i>				5	3	3		1					12
<i>Alburnoides bipunctatus</i>				70	6093	24988	95	21					31267
<i>Squalius cephalus</i>					30	17	4	6		280			337
<i>Chondrostoma nasus</i>			1	3080									3081
<i>Salmo trutta m. fario</i>	1		1	9									11
<i>Barbus barbus</i>					1	1	12	27					41
<i>Thymallus thymallus</i>			1	70									71
<i>Barbus balcanicus</i>							1						1
<i>Rutilus rutilus</i>							4						4
<i>Alburnus alburnus</i>								2					2
Total	1	0	3	3253	6151	25023	122	58	0	280	0	0	34891

RESULTS OF ECO-HYDROLOGICAL MONITORING

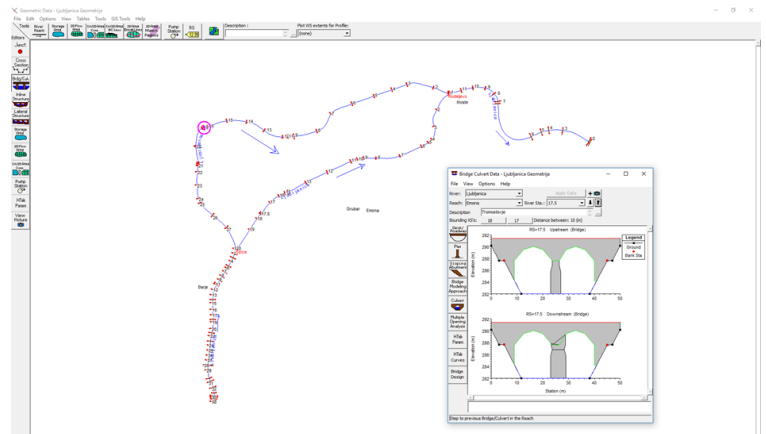
Establishment of the eco-hydrological monitoring allows us to monitor water levels and water temperatures at 17 locations across the Ljubljanica river and its tributaries. At three locations we can measure also the concentration of dissolved oxygen in the water. Data obtained in the eco-hydrological monitoring have served during the project for the construction and/or calibration of hydrological and hydraulic model. Models serve as a basis for further planning of flood scenarios and scenarios in case of low flow.

Temperature of water is the basic indicator of the water quality. At Ambrožev trg (upstream and downstream of the barrier) and upstream from the sill in Zalog we measure also the concentration of dissolved oxygen in the water. Analysis which were made so far show that the water quality in the Ljubljanica river (based on the basic parameters) is suitable for the life of target and other fish species. Detailed results of the eco-hydrological monitoring can be found in the article: *Impact of the river gate on the Ambrož Square on the temperature and oxygen conditions in the Ljubljanica River* in the journal *Acta Hydrotechnica*.

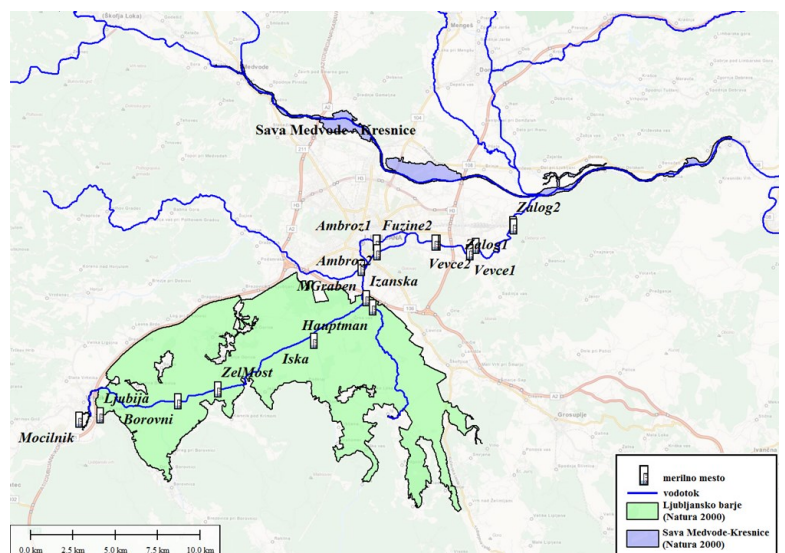


REZULTATI EKOHIKROLOŠKEGA MONITORINGA

Vzpostavitev ekohidrološkega monitoringa v okviru projekta nam omogoča spremljanje vodostajev in temperature vode na 17 lokacijah na reki Ljubljanici in njenih pritokih, na treh od teh lokacij pa lahko spremljamo tudi koncentracijo raztopljenega kisika v vodi. Podatki, pridobljeni s tem monitoringom, so že tekom projekta služili za izgradnjo oziroma kalibracijo hidrološkega in hidravličnega modela, ki sta podlaga za nadaljnjo načrtovanje poplavnih scenarijev in scenarijev za primer nizkih pretokov.



Podatki o temperaturi vode so osnovni pokazatelj kakovosti vode. Na Ambroževem trgu, gorvodno in dolvodno od zapornic, ter v mrtvici gorvodno od praga v Zalogu, pa spremljamo tudi koncentracijo raztopljenega kisika v vodi. Dosedanje analize podatkov kažejo, da je kakovost vode (na podlagi osnovnih parametrov) ustrežna za življenje tako ciljnih kot ostalih vrst rib. Podrobnejše rezultate ekohidrološkega monitoringa najdete v prispevku: *Vpliv rečne zapornice na Ambroževem trgu na temperaturne in kisikove razmere v Ljubljanici* v reviji *Acta Hydrotechnica*.



O PROJEKTU

Vodilni partner:

Univerza v Ljubljani, Fakulteta za gradbeništvo in geodezijo



Univerza v Ljubljani
Fakulteta za *gradbeništvo in geodezijo*

Pridružena partnerja:

Geateh d.o.o.

Purgator d.o.o.



Sofinancerja:

Ministrstvo RS za okolje in prostor



REPUBLIKA SLOVENIJA

MINISTRSTVO ZA OKOLJE IN PROSTOR

LIFE –

finančni instrument Evropske unije



Trajanje:

1. januar 2012–31. avgust 2016

Kontakt:

mag. Andrej Vidmar

UL FGG

Jamova 2

1000 Ljubljana

Slovenija

andrej.vidmar@fgg.uni-lj.si

Spletna stran projekta:

ABOUT THE PROJECT

Beneficiary:

University of Ljubljana, Faculty of Civil and Geodetic Engineering

Associated partners:

Geateh d.o.o.

Purgator d.o.o.

Co-financed by:

Ministry of the Republic of Slovenia for the Environment and Spatial Planning

European Commission under LIFE+ Nature & Biodiversity 2010

Duration:

1 January 2012–31 August 2016

Contact:

mag. Andrej Vidmar

UL FGG

Jamova 2

SI-1000 Ljubljana

Slovenia

andrej.vidmar@fgg.uni-lj.si

Project website:



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Ljubljana, 2016



