L J U B L J A N I C A C O N N E C T S

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PROTOCOLS AND GUIDES FOR SURVEY OF THE ECOLOGICAL STATUS, HYDROLOGICAL AND HYDRAULIC CONDITIONS OF THE LJUBLJANICA RIVER CORRIDOR

Action: A1

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PROTOCOLS AND GUIDES FOR SURVEY OF THE ECOLOGICAL STATUS OF THE LJUBLJANICA RIVER

Methodologies for sampling and evaluation of ecological status are determined separately for each type of surface water body, the water quality and the individual elements. For our work we will use officially accepted protocols that our data will be comparable with official monitoring. Methodologies were accepted by Ministry for Environment and Physical planning in year 2009. The documents are available on the web page: http://www.arhiv.mop.gov.si/si/delovna_podrocja/voda/ekolosko_stanje_povrsinskih_voda/ .

One part of our field work will include catching the fish on fish pass, which is not described in the methodology. We will catch the fish using wicker fish trap – a net strained on metal frame in the shape of a box, which will be set on upstream inflow part of fish pass. One will be put in the fish pass at the Fužine weir and one at Ambrožev trg barrier, approximately in the middle of the fish pass. Each caught fish will be measured from the point of the nose till the end of the dorsal fin and weighed. We will also determine the species of the caught fish, mark them with a tag and after that return them into the river according to the official methodology.

Methodology for fish sampling

The procedure of sampling and fish treatment is based on standardized methods, allowing comparability of results with other Member States of the European Community. Professional basis for the methodology of fish sampling with electrofishing are:

- SIST EN 14011:2003 Water quality – Fish sampling with electricity.
- SIST EN 14962:2006 Water quality - Guidance for use and selecting methods for fish sampling.
- Austrian estimation method (Fish Index Austria) and
- European Fish Index (EFI).

With fish monitoring we will try to obtain the best possible information as we can about present situation in fish population on the examined section of Ljubljanica River. Its important that we choose the right sampling site, which must include all the representative habitats. We will consider to use the best catching instruments, to catch with an optimal method and with the help of an expert electrofishing team.

With corresponding monitoring we will get information about the population density in the nature. We will be able to estimate the abundance of fish population, species diversity and population diversity (about size or age). The abundance of fish population is estimated whether relatively (number of caught fish by one electrocatch on a known water surface) or absolutely (calculated number of fish by multiple electrocatches on a known water surface by comparison with the catch of fish by one electrocatch).

According to the official methodology the monitoring will be performed repeatedly in a long term. Each time we will perform the sampling on the same place, in the same season, at similar stream conditions, with the same catch effort, with the same equipment and in the same way. We will determine the sampling places with GPS coordinates and document them with the camera.

To ensure the efficiency of electrofishing we will perform it at the end of the fish growing period. Juveniles at that time are large enough that we can catch a proper number of them. In rivers with water conductivity below 100 µS/cm it is used starting voltage ≥ 600 volts, while in rivers with higher water conductivity the starting voltage represents ≥ 350 volts.
In all cases the sample will be of proper size, so that it will include all the typical habitats of the river (pools, rapids) with what we will ensure the representativity of fish population sample.

Electrofishing is not performed:
• when water temperature is below 5°C (decreased fish activity and sampling efficiency),
• during heavy rain,
• when water is in a very muddy state,
• when people are endangered,
• during night.

Passable regions with lot (>2) of autochthon species of fish

On passable regions of Ljubljanica River we will perform electrofishing by foot. In this case the length of the examinated segment is at least 10 time the medium width of the river (but not less than 100 metres) and its not divided into sectors.

Table 1: Minimal length of the examinated segment

Length of the passable river	Minimal length of the examinated segment
small brook, width <5 m	>=100 m, whole river width
small river, width 5-15 m	>100-150 m, whole river width
medium-sized river, width more than 15 m	>150 m, whole river width, at least 2250 m2

Unpassable regions

In parts of Ljubljanica River where width and depth of the riverbed are too big we will not perform electrofishing by foot. There where the depth isn't more than 3 metres we will use »Strip« method. Sampling according to this method is performed stratified in all representative mezohabitats in deep and shallow parts, along bank and in river current, on a longer river segment. Electrofishing will be carried out in stripes along the river, alternately on the left, middle and right part of the riverbed.

Selected length of the monitored segment isn't prescribed. Each present mezohabitat should be monitored at least 3 times. Length of the stripes is chosen regarding the structure of the riverbed, generally they are supposed to be 50 – 100 metres long in the riparian areas and 100 – 300 metres long in the river current. The width of the stripe is limited by the width of the electrofishing equipment.

Fishing procedures

Passable regions

We will perform the electrofishing along whole width of the river with 1,3 kW backpack electrofisher. Electrofishing team will be made up of 4 members. Electrofisher will manage the anode, first assistant will scoop the fish with the fishing net, second assistant will carry the electroaggregate on his back, while third assistant will collect the caught fish in a plastic bucket.

Fish will be caught towards the current so that the troubled state wouldn't affect fishing efficiency. The team will be moving slowly. Electrofisher will attract the fish from nearby surroundings and hideouts with systematical short pulls with the anode through water,

stupefied fish will be caught by the first assistant and handed to the third assistant. In fast flowing conditions the assistant will follow with the fishing net close under the anode.

Before electrofishing we will transversally restrain the upper part of the riverbed with a net to prevent the fish from running away in the upstream direction (if possible we could use natural barriers instead of the net). In this limited area we will repeat the fishing two times with the same catch effort. If the probability of catching the leading species in the first of two catches will be less than 50%, we will have to perform third catch.

In particular cases the electroaggregate will be placed on the river bank with the use of long electric cables for anode or the electroaggregate will be placed in a small boat and draged behind the team.

Unpassable regions

The electrofishing will be performed with stunboat. In the front side of the boat is transversally installed a carrier from non-conductive material which carries several hanging anodes. In the back of the boat there is an electroaggregate more powerful than in backpack electrofisher (7,5 kW, 9,0 or 13 kW), while on the side or in the back of the boat a cathode is hanging in the water.

The boat team (4 members) will be moving according to the speed of the current and catching fish in stripes along the river, alternately on the left, middle and right part of the riverbed. The conductor will orientate the boat with the engine and turn on and off the electric current with a foot switch. At the front side of the boat there will stay two members of the team, scooping stupefied fish with the fishing net and handing them to the third member, who will collect them in a plastic tub.

Each stripe will be monitored only once, so it will be necessary to estimate the probability of the catch in the best possible way. This represents the ratio of fish caught with the fishing net according to the number of all the noticed fish, which cannot be caught because of the abundance and/or current speed. Estimation of the probability of the catch will be made for each fish species, its size and habitat. To check this estimation, particularly in the case of small and juvenile fish, it is recommended to occasionally do for the catch in the riparian areas also a second one.

Electrofishing will be in deeper parts of Ljubljanica River difficult and only partly successful. We will be able to carry out a monitoring with an acceptable stage of efficiency only near banks, while will be unable to catch fish in the deeper water. Boat team will be moving slowly along the bank of the river and electrofisher will systematically explore water environment with draging the long anode through the water column. He will perform this action especially in places where the river bottom will be covered with macrophytes or where will be present any potential hiding places for fish. Work and organization of the team will be the same as for electrofishing with "Strip" method. If the configuration of the river will be appropriate, we will restrain the pre-determined area on the sampling site with a net, allowing to obtain a quantitative assessment.

Fish species determination and measurements

In passable regions samples will be treated contemporary with electrofishing, in unpassable regions after finished fishing in a single strain. Each fish will be determined by species, measured, weighed and, if necessary, scale sample will be taken to determine the age.

The caught fish will be handled very carefully, so that the damage caused by gripping and processing will be reduced to the minimum. In cases where we will catch numerous fish, will the fish waiting for treatment, be supplied with oxygen or airing of water in the storage tank.

Caught fish will be determined till species after external morphological signs. In cases when they will not be clear (hybrids, species in close relationship or juvenile specimens) or we won’t be able to determine specimens on the field (little-known and new species), they will be taken to the laboratory for further examination.

Before the measurements we will anaesthetize the fish. Various narcotics are used for this, very suitable is Ethylene glycol monophenyl ether.

Length of the fish will be written down in millimeters. We will measure the entire length and length till the tail notch ("fork" length).

Weight will be written down in grams.

Scales for age determination will be taken with tweezers.

After treatment, we will move the anaesthetized fish in the tub with fresh water. There they will wake up from narcosis and start to swim, then we will release them in a quiet area close to the river bank. All fish, except those removed for further investigation, will be released back into the river at the site of the catch. In the case, when part of the specimens will die during the treatment, this will be written down as a percentage of sampling mortality (%).

If necessary, we will disinfect all the used equipment after work, especially if risk of transfer of parasites, diseases or other unwanted unknown species or pathogens will exist.

Data analysis

Data analysis depends on the used sampling method, type of monitored habitat and on the proportion of sampled surface of the river.

For passable regions we will give the list of fish caught on an individual sampling site and for unpassable regions ("Strip" method) a list of fish captured separately for each type of habitat and for the whole monitored area.

For passable regions we will give the number of individuals and weight of each caught fish species for an individual catch and sampling site and for unpassable regions the number of individuals and weight of each caught fish species for an individual catch and type of habitat (average of more stripes of the same type of habitat) as for the species on the sampling site. We will state also the probability of the catch.

For passable regions we will calculate abundance and biomass after DeLury (1947) and for unpassable regions after Schmutz et al. (2001). Number of individuals and fish biomass will be both expressed as their quantity per hectare. The width of the hydrated part of the riverbed will be considered as a basis for the surface while calculating.

The age structure for each fish species will be determined by the length-frequency distribution. Exceptionally we can determine the fish age regarding scales and otoliths. For age structure of each species we will give the average length by age group, the standard deviation and the number of fish in the sample. Based on the data of length-frequency distribution for the dominant species there will be given the abundance (number, frequency) of age groups 0+, 1+ and individuals older as 1+ to display the possible impairment of species transition from one age group to another.

Methodology for laboratory fish treatment

Laboratory fish treatment will provide the determination of individuals with unclear morphological signs, poorly known specimens and new species, which we won't be able to determine exactly on the field.

For help we will use:

- literature for the determination, where typical signs of individual fish species are stated,
- personal communications with experts for each fish group,
- morphological examinations under the magnifying glass,
- preparation and review of microscopic slides and
- genetic analysis.

Occasionally it is necessary to check the age structure of fish, which we obtain by length – frequency distribution, due to unclear boundaries of age classes (poor living conditions, investment fish from breeding). In these cases, the age of the fish is determined according to scales or otoliths. On field taken scales are examined in the laboratory under the magnifying glass with transmitted light at magnifications 10-80x. When the scale is taken on the right side of fish, we have nicely expressed concentric circles, by which you can determine the age of fish. In the middle of the scale it is clearly visible focus, from which centre go to the edge of the scale rayed lines or radii. Focus are followed by bands of separated and compressed concentric circles, which are usually exchanging. Separated bands of concentric circles represent a period of the year, when the growth of fish was fast. There was enough food for its growth and development and living conditions were favourable. In Slovenia is this period usually in summer, when the water temperature is higher. Denser bands of concentric circles represent a period of the year, when the fish grew slowly. In Slovenia is this usually in winter, when less food is available and the water temperature is lower and consequently the growth slower. Within one year of fish life one band of separated and compressed concentric circles (year or anulus) emerge. Sampling and laboratory sample treatment have to be in accordance with the SIST EN 14996:2006 standard.

Safety precautions

- During field work we will have to hold on to general safety precautions:

- All parts of the body of the electrofisher, who may come in contact with the electric field, will have to be secured with appropriate waterproof and non-conductive clothing.
- If necessary, a suitable protection against climatic conditions (warm clothes in cold water, sun protection) and noise due to the operation of electroaggregate (ear protective device) will be used.
- Handle of the fishing net will have to be from non-conductive material. Mesh on the fishing net will have to be without knots for the sake of minor injuries.
- When electrofishing by foot in water exceeding your knees and when sampling from a boat, a life jacket will be worn.
- We will use tanks of adequate size for the storage of caught fish. Where necessary we will supply the oxygen into tanks. Tanks, which may come into contact with electrical field, will be made of non-conducting material.
- Proper first-aid and communication equipment (mobile phones) will be at hand.

PROTOCOLS AND GUIDES FOR SURVEY OF THE HYDROLOGICAL AND HYDRAULIC CONDITIONS

Hydrological measurement, data collection and transformation will be developed according to WMO Guide to hydrological practice, 1994.

Construction of 17 water stations, 3 of these water stations with online connection. The water stations continuously and precisely monitor water levels along the Ljubljanica River and its tributaries. Position of the stations is on the map.

Data water level, temperature and velocity will be sampled with time step 5 minutes or 1 hour. During manipulation by weir the sampling time will be shorter. All data will be tested and collected in relational data base for further use.

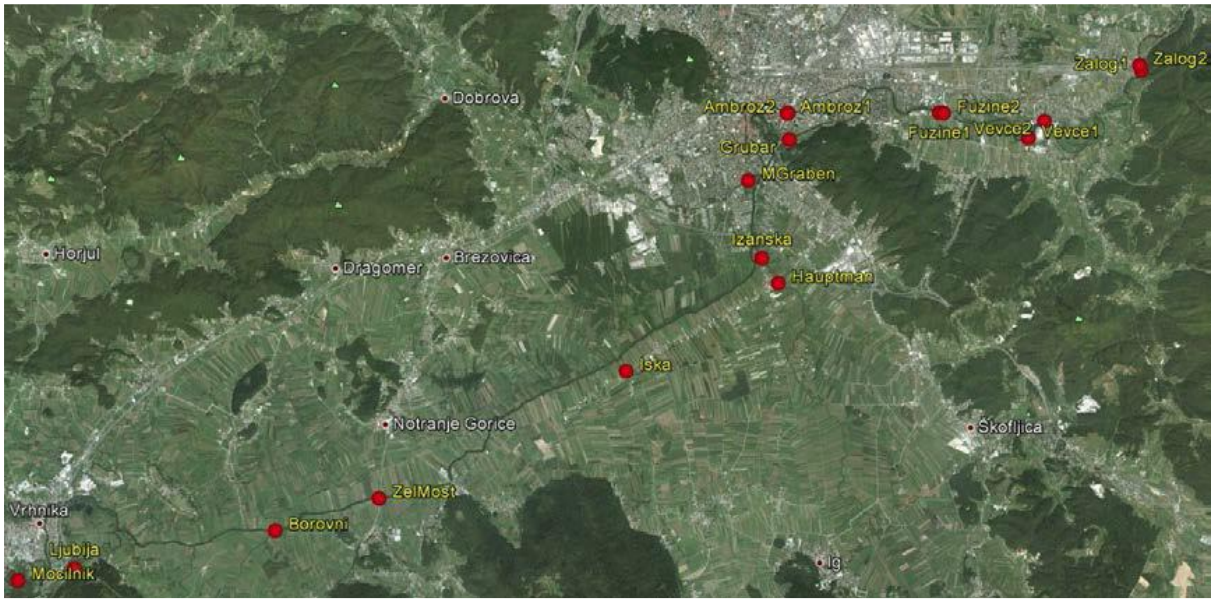


Figure 1: Water stations on the Ljubljanica Connect project

Data will be collected with guides: Instructions for collecting and reading hydrographic data from the ONSET U20 absolute pressure sensors.

Data of Ljubljanica River bed are collected in 3D form, figure 02. Cross section on each 50 meters will be derived from data and used for hydraulics model.

Discharge measurements will be making by 3D Doppler velocity meter. Measurements of velocity and discharges will be done on cross sections 6 times per year.

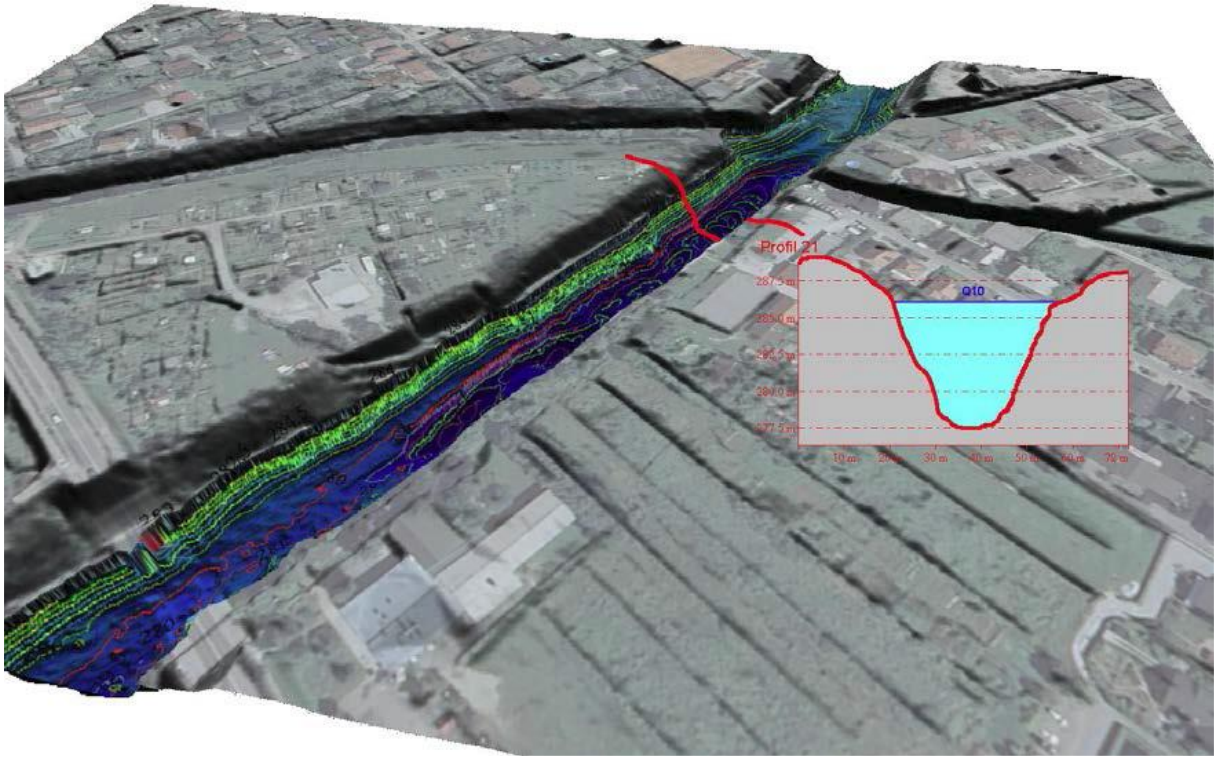


Figure 2: 3D model of Ljubljanica river bed.

GUIDES FOR COLLECTING AND READING HYDROGRAPHIC DATA FROM THE ONSET U20 ABSOLUTE PRESSURE SENSORS

Summary of the manual for the collection and reading hydrographic data from the onset U20 absolute pressure sensors

At the beginning it should be noted that the quality of the measured data depends on the maintenance of the instrument.

How to prepare the portable card reader HOBO Waterproof data Shuttle:

1) Before data collection is required to check the battery status and clock on the reader. Our experience shows that the clock on the reader misses/is ahead for about 20 seconds.
2) B Before reading you save previous data, if any. Memory must be compulsorily deleted.
3) The clock in the reader must be set by program HoboWare.

Note: The computer, on which the program HoboWare is running, must be synchronized with the atomic clock. In Windows XP, this is set to 2x click on the clock on the taskbar right, then open the "Date and Time Properties". Then select "Internet Time" and "Update". Another way is to do with the program Atomic Clock Sync, which is more transparent and easier www.worldtimeserver.com. System automatic synchronization of clocks in XP does not always work best or are some problems with synchronization, so beware: A manual verification and control is needed!

Reading the data from the reader HOBO Waterproof Shuttle:

1) Above gauge zero on the stage gauge open strip cylinder lock, pull out bearing aluminum strip with a pressure sensor and unscrew the black cap.
2) Sensor with a carved side of the thread joint with an interface card reader and press the rod magnetic switch. Then the yellow light starts flashing. When the green starts to flashing it is finished. The sensor has set the clock and the data are deleted. The sensor is prepared for a new recording.
3) Sensor return to the measuring point.

Maintenance of pressure sensors:

1) HOBO U20 sensors generally do not need much maintenance. It is necessary to ensure that the sensor does not shake too hard, that is not hitted, or that it does not fall on the hard ground, because it is a fairly sensitive device.
2) If you observe that in the holes the sediments are accumulated the sensor must be flushed. Drawn the sensor across the surface of water to wash it carefully. Leeches and larvae are removed with the straw, branch or something similar. Then, gently blow and wash it.
3) Algae are wiped with a cloth.
4) When collecting data unscrew the protective cap (black), taking care that the cap is not dirty because it will be difficult to unscrew it by the next collecting of data.
5) Every so often it is necessary to lubricate "O-ring" seal and the threads with silicone grease. Threading should not be screwed too tightly, and don not use any force when threading, because there is no need. Screw cap, and then slightly unscrewe, thereby avoiding over-wrap protective caps, but the "O-ring" seal is still tight.

Reading from stage gauge:

1) From the stage gauge must be read as accurately (+/- 0,5 cm) as defined default precision sensor. That water fluctuations can be seen by at least 10 seconds oobservations. At a higher water level water level can vary greatly.
2) Record the nearest average 5-minute interval. So the clock is rounded off to 5 minutes.
3) Read from the stage gauge before the collection of data from the sensor.
4) Read from the gauge also after the collection of data from the sensor.
5) Take a picture of stage gauge as much as possible perpendicular to the junction point of water.
6) Before taking a picture, check if the date and time in the camera are set properly. Take a picture of the clock on the screen and check if the clock on the photo matches.
7) Photographed image of clock on the screen check with Shooting Information in the EXIF. Deviation should not be greater than +/- 10 seconds.
8) Battery on the camera should be filled. It is good to have on hand a spare battery.
9) Write the time in which the clock is; Summer CEST (Central EU Summer Time), or. winter CET (Central Time the EU).
10) CEST=GMT+2 in CET=GMT+1
11) At a higher water level it is good to record at least 15-30 second movie (WAV), that captures mean fluctuations.

12) All the information are required to be written in the format: (Name, Date (clock); water level).
13) The table below is suitable to enter in the notebook as book of records of reading the data from the stage gauge. Many times it happens that the various sheets are misplaced and lost.

Table 2: Example of the attributes.

VP	Ime	Datum	Čas	Vodostaj	Režim	Odčital	Ocena	Opomba	Link
3	AmbrozD	19.09.2012 06:50	GMT+2	1098,5	Upada	AV	+-3	na lati	
3	ZalogB	16.11.2012 13:15	GMT+1	111	Raste	AV	+-1	lata+fotografija	XXX
3	ZalogM	12.12.2012 18:30	GMT+1	92,5	Miruje	AV	+-0,5	na lati	

HOBO® Waterproof Shuttle (U-DTW-1) Manual

The HOBO Waterproof Shuttle performs several major functions:

- Reads out all logger information (serial number, deployment number, data, etc.) from loggers in the field for transfer to host computer, and stores each logger's data in a "bank"
- Nonvolatile memory preserves data, even if batteries are depleted
- Relaunches the logger, resetting the logger's time to the shuttle's time and synchronizing the logging interval on relaunch
- Can be used as an optic-to-USB base station
- Can be used to read out and relaunch loggers underwater

Although the HOBO Waterproof Shuttle is easy to use, Onset strongly recommends that you spend a few minutes reading this manual and trying out the procedures described here before taking the shuttle into the field.

HOBO Waterproof Shuttle

U-DTW-1

Included Items:

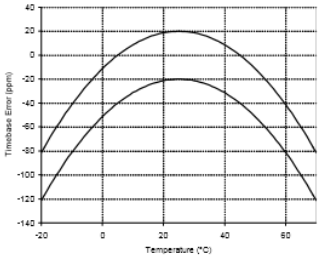
- USB cable
- Set of couplers;
  - For UA Pendant (COUPLER2-A)
  - For U20 Water Level (COUPLER2-B)
  - For U20L Water Level, U22 Water Temp Pro v2, U24 Conductivity, and U26 DO (COUPLER2-C)
  - For UTBI TidbiT v2 (COUPLER2-D)
  - For U23 HOBO Pro v2 (COUPLER2-E)

Required Items:

- HOBOware Pro 2.2 or later
- Compatible logger and matching coupler

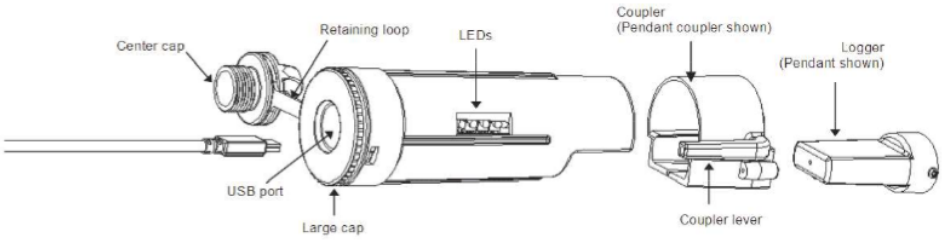
Specifications

Compatibility	All HOBO U-Series loggers with optic USB. Not compatible with the HOBO U-Shuttle (U-DT-1).
Data Capacity	63 logger readouts of up to 64K each
Operating Temperature	0° to 50°C (32° to 122°F)
Storage Temperature	-20° to 50°C (-4° to 122°F)
Wetted Materials	Polycarbonate case, EPDM o-rings and retaining loop
Waterproof	To 20 m (66 feet)
Time Accuracy	±1 minute per month at 25°C (77°F); see Plot A
Logger-to-Shuttle Transfer Speed	Reads out one full 64K logger in about 30 seconds
Shuttle-to-Host Transfer Speed	Full shuttle offload (4 MB) to host computer in 10 to 20 minutes, depending on computer
Batteries	2 AA alkaline batteries required for remote operation
Battery Life	One year or at least 50 complete memory fills, typical use
Weight	150 g (4 oz)
Dimensions	15.2 x 4.8 cm (6.0 x 1.9 inches)
CE	The CE Marking identifies this product as complying with all relevant directives in the European Union (EU). To maintain CE compliance, this product must be used with the supplied USB cable or equivalent (less than 3 m long).



Plot A

HOBO Waterproof Shuttle Features



Preparing to Go on Location

Before using the shuttle for the first time, you must launch it with HOBOware 2.2 or greater. You must also launch any compatible loggers that were last launched with an earlier version of HOBOware, or have never been launched at all.

1. Use HOBOware 2.2 or greater to launch each logger you wish to read out and relaunch with the shuttle later. (Read "Using the shuttle as a base station" for instructions if you do not have another base station for the loggers.) The shuttle cannot relaunch loggers that were last launched with an earlier version of HOBOware. (You only have to do this once for each logger.)
2. Plug the large end of a USB interface cable into a USB port on the computer. (Avoid using a USB hub, if possible.)
3. Unscrew the center cap on the shuttle. If the cap is too tight to loosen by hand, insert a screwdriver through the lanyard hole and rotate counterclockwise until the cap is loosened.
4. Plug the small end of the USB interface cable into the USB port in the shuttle. (If the shuttle has never been connected to the computer before, it may take a few seconds for the new hardware to be detected.)
5. Follow the instructions in the *HOBOware User's Guide* to access the **Manage Shuttle** dialog. Make sure the battery level is good, and change the batteries now if they are weak.

Important: If you change the batteries in the field, the shuttle's clock will stop, and the shuttle will not read out loggers again until you relaunch it in HOBOware.

6. If you are using the shuttle for the first time, launch the shuttle as described in the *HOBOware User's Guide*. Launching synchronizes the shuttle's clock to the host computer and initializes the shuttle's header.

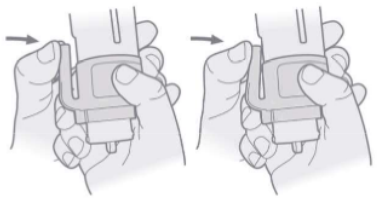
Important: The shuttle's clock is used to set the logger's clock at relaunch. For most accurate results, make sure the host computer's clock is correct before launching the shuttle. If you need to adjust the computer's clock, quit HOBOware, set the computer's clock, then reopen HOBOware and launch the shuttle.

7. If you have used the shuttle before, make sure there are enough banks available to accommodate the loggers you plan to read out.
8. Disconnect the USB cable from the shuttle and replace the center cap securely.

Reading Out and Relaunching Loggers in the Field

After you have ensured that the shuttle's batteries are good, there is sufficient memory available, and the shuttle's clock is synchronized, follow these steps to read out and relaunch a logger in the field:

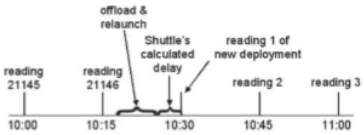
1. Make sure the shuttle's large cap and center cap are closed securely. Tighten the center cap until it is just flush with the large cap, or until the O-ring is no longer visible.
2. Make sure the communication end of the shuttle is clean. Attach the correct coupler for the logger, and ensure that it is seated properly.
3. Insert the logger into the coupler, following the instructions that came with the coupler.
4. Momentarily press the coupler lever (pressing hard enough so the lever bends).



Readout should begin immediately. The amber LED blinks continuously while readout and relaunch are in progress. Do not remove the logger when the amber LED is blinking.

5. After reading out the logger, the shuttle synchronizes the logger's clock to the shuttle's internal clock and relaunches the logger, using the description, channels to log, logging interval, and other settings that are already in the logger. (If the logger was launched with multiple logging intervals, the final defined logging interval will be used.) The logger is

launched with a slight delay that causes its readings to be synchronized with those of the previous deployment, as shown in the following diagram.



Important: If the logger was launched with multiple logging intervals, there will be no synchronizing delay. The logger will start immediately with the last defined logging interval.

6. When the relaunch has completed, the green LED blinks for 15 minutes, or until you momentarily press the coupler lever to stop it (press hard enough so the lever bends). If the red LED blinks instead, there was an error, and the logger may have stopped. Refer to "Troubleshooting" in this manual for details.
7. Remove the logger from the coupler.

Checking Shuttle Status in the Field

The shuttle's memory has 63 "banks." One logger readout can be stored in each bank. To check the shuttle's memory and batteries in the field, remove the logger and press the coupler's lever for at least three seconds (pressing hard enough so the lever bends). When you release the lever, the green LED blinks once for each unoccupied bank in the shuttle's memory. (Press the lever momentarily to stop the blinking, pressing hard enough so the lever bends.)

If the shuttle's batteries are running low, all of the shuttle banks are full, or the clock has not been set, the red LED blinks. (Press the lever momentarily to stop the blinking, pressing hard enough so the lever bends) Use HOBOware to check the shuttle's battery level, available memory, and clock. You may need to change the batteries, or offload the datafiles to the host computer and delete them from the shuttle to free up memory before you can continue reading out loggers.

Offloading Data to the Host Computer

You can offload the data stored in the shuttle even when the batteries are depleted. Take the following steps:

1. Connect the shuttle to a host computer running HOBOware.
2. Follow the instructions in the *HOBOware User's Guide* to offload the new datafiles or access the **Manage Shuttle** dialog. The **Manage Shuttle** dialog shows you how many banks are occupied, and whether they have already been offloaded and saved to the host computer.
3. Offload and save data from the banks of your choice. Refer to the *HOBOware User's Guide* for details on saving datafiles offloaded from the shuttle.
4. Review the list of banks and delete any that are no longer needed. Make sure the battery level is good, and change the batteries now if they are weak. (If you change the batteries in the field, the shuttle's clock will stop, and the shuttle will not read out loggers.) Update the shuttle's clock, if necessary.
5. When finished, disconnect the shuttle from the computer and close the center cap securely.

Using the Shuttle as a Base Station

You can use the shuttle as a base station for any U-Series logger with an optic USB interface. (This function is available even when the batteries are depleted.) To use the shuttle as a base station:

1. Connect the shuttle to the host computer running HOBOware.
2. Attach a compatible logger and coupler.
3. Momentarily press the coupler's lever (pressing hard enough so the lever bends).
4. The amber LED blinks momentarily, then the green LED should glow steadily to indicate that the logger is ready to communicate with HOBOware. (If the red LED blinks instead, the logger was not found. Make sure the logger and coupler are aligned and seated properly, and that there is no dirt or strong sunlight interfering with communications.)
5. When finished, remove the logger from the coupler. The green LED stops glowing when you disconnect the logger or the USB cable.

Important: The Waterproof Shuttle cannot be used *as a base station* with Pendant logger models UA-001 and UA-003 (including rain gauges RG3 and RG3-M) with serial numbers less than 988278. These loggers require a BASE-U-1 for communication with the host computer.

Indicator Lights

Green "OK" LED
The green "OK" LED blinks when HOBOware recognizes it as a base station; when it finishes reading out and relaunching a logger; and when you press the coupler lever to check the shuttle's status (see "Checking shuttle status in the field" for details). Momentarily press the coupler lever to stop the blinking (pressing hard enough so the lever bends).

The green LED glows steadily when the shuttle is being used as a base station.

Amber "Transfer" LED
The amber "Transfer" LED blinks when the shuttle is reading out a logger and relaunching it. Do not remove the logger when the Transfer light is lit.

Red "Fail" LED
The red "Fail" LED blinks whenever the shuttle encounters an error condition. Refer to "Troubleshooting" for details.

All LEDs
All LEDs blink in unison when the shuttle has just been powered up, either by installing fresh batteries or (if batteries are not installed) by connecting to the computer's USB port.

Troubleshooting

This section describes problems you may encounter while using the shuttle.

Shuttle is not recognized by host computer
If HOBOware does not recognize the shuttle when you connect it to the computer, simply disconnect and reconnect the shuttle.

Red "Fail" LED blinks
The red "Fail" LED blinks (for 15 minutes, or until you press the coupler lever, pressing hard enough so the lever bends) whenever the shuttle encounters an error. There are several conditions that might cause an error:

- **Shuttle is full:** If the red LED blinks when you try to read out a logger, check whether all of the banks are full, as described in "Checking shuttle status in the field." Or, use HOBOware to check the shuttle's memory.
- **Shuttle batteries are low:** If you cannot read out any loggers at all, check the logger's status, as described in "Checking shuttle status in the field," or use HOBOware to check the shuttle's batteries. The batteries may simply need to be replaced.
- **Compatibility:** The shuttle cannot read out or relaunch loggers that were last launched from HOBOware prior to version 2.2. You will need to read out these loggers on the host computer and relaunch them in HOBOware 2.2 or greater before you can use them with the shuttle.
- **Shuttle clock is not set:** The shuttle has experienced a power failure that caused the clock to reset. You must use HOBOware to offload the files that are already on the shuttle, then relaunch the shuttle before you can read out another logger.
- **Can't communicate with logger:** Remove the logger and coupler. Inspect them and the shuttle to ensure that all are free of dirt that could block the optic communication sensor. Carefully reassemble the shuttle, coupler, and logger, and make sure they are all seated properly. Shield the shuttle from strong sunlight, if applicable, which can interfere with optic communications.
- **Other logger problems:** If you can read out some loggers but not others, or if you cannot read out any loggers even with fresh batteries in the shuttle, check the loggers in HOBOware. Make sure their batteries are at acceptable levels and that there is no "corrupted header" message.

Amber "Transfer" LED stays on without blinking
The amber light is magnetically activated when you press the coupler lever. If it glows steadily at any other time, the magnet in the lever may be too close to the magnetic switch in the shuttle, or another strong magnet may be present. Try bending the lever away from the coupler to reduce the magnet's effect.

LEDs do not function
If the LEDs are not functioning at all, the batteries may be completely exhausted. To test this, attach the shuttle to the host computer and check the battery level. The shuttle should be able to communicate with the host computer, blink its LEDs normally, and perform as a base station even when the batteries are missing or depleted.

Replacing the Shuttle's Batteries

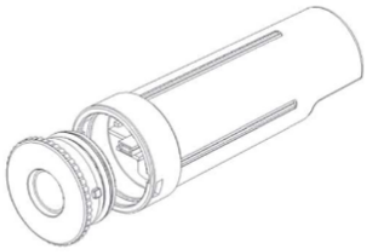
The shuttle's batteries should last about one year or at least 50 complete memory fills in typical conditions. When the shuttle's batteries run low (2.2 V or less), any logger data that is already in the shuttle will remain safe, but the shuttle will not read out another logger until its batteries are replaced.

To avoid battery problems, always check the shuttle's batteries in HOBOware before going into the field, and replace them if needed. If you cannot replace the bad batteries right away, you should remove them as soon as possible to ensure that they do not leak and damage the shuttle.

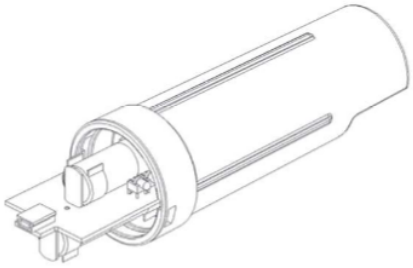
To change the shuttle's batteries:

1. Work over a clean surface to provide a safe platform for the disassembly.
2. Unscrew the center cap on the shuttle. If the cap is too tight to loosen by hand, insert a screwdriver through the lanyard hole and rotate counterclockwise until the cap is loosened.
3. Use the center cap to help you carefully pull the rubber loop free of the large cap. The large cap cannot be removed while the rubber loop is in place.

4. Turn the large cap counter-clockwise slightly, then pull it off.



5. Turn the shuttle over and tap it gently. The circuit board should slide into your hand.



6. Remove the old batteries and install two new ones in the correct orientation. Both batteries should be turned the same way, with their positive ends facing the USB port on the board. (When the second battery makes contact, all of the shuttle's LEDs will blink in unison.)
7. Put the board back into the case, taking care not to bend the communication LEDs. Align the circuit board with the runners in the case. The USB port should face the open end of the shuttle, and the LEDs should show through the window on the label.
8. Close the shuttle's case. Line up the tabs on the large cap with the slots on the case, press gently, and turn slightly clockwise until the large cap is closed securely.
9. Replace the rubber loop and center cap. Tighten the center cap until it is just flush with the large cap, or until the O-ring is no longer visible.
10. Using HOBOware, offload any datafiles that are on the shuttle and launch the shuttle before going into the field again. The shuttle will not read out and relaunch loggers until the clock has been synchronized.

⚠ **WARNING:** Do not install batteries backwards, recharge, put in fire, expose to extreme heat, or mix with other battery types, as the batteries may explode or leak. Contents of an open or leaking battery can cause chemical burn injuries. **Replace all used batteries at the same time.** Recycle or dispose of batteries according to applicable federal, state, and local regulations.

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