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Applying new methods of substrate mapping and reproduction to enhance passability of fish counters for bottom oriented fish using

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Based on the requirements of the European Water Framework, the fish continuum has to be restored. Thus, a series of new fishways are have been constructed, and more are currently under construction and in planning. State and local environmental authorities often request monitoring data about the efficacy of the fishways, especially considering their cost-benefit. The current state-of-the-art method is to physically count the number of passing fish via fish traps or fish countering devices, which typically use a smooth, flat bottom without structure. Many smaller fish species swim close to the bottom, and often the low velocities provided near the bed offer hydraulic refuge for larger fish as well. At some installations it has been observed using fish counter data, that the lack of passing bottom oriented individuals was observed, although these installations had a good connection to the bottom of the fishpass. These observations raised the question, as to weather the lack of these individuals might be due to the smooth surface and subsequently a lack of hydraulic shelter. In this work, we sought a remedy to this situation by installing hydraulic shelters made of an artificial river substrate. Shelter requirements requiring consideration are the material properties and its stability against glacial silts and floating debris, as well as the surface reconstruction, especially for installations in nature-like fishways. The goal is to measure and reproduce river substrate from locations close to the installation. For this reason methods already known from physical hydraulic models are applied and tested on their feasibility, costs and stability under natural conditions.

This work shows the construction of a cast taken from riverbed-like substrate layer with the addition of larger stones to create shelter for small, bottom-orientated species. The casts are easily reproducible and can be easily installed in fish traps or counting devices and adapted to the local river morphology. A reference substrate is taken from the real riverbed or flume, but it can also be created manually by placing cobbles manually in a given configuration in modeling clay. In the next step, a negative cast is created and cleaned of all chemical residues. This negative is then poured with a two-component liquid epoxy to create the final substrate. This artificial version can be colored individually and cut to fit the needs of the specific installation.

The artificial substrate has been installed in two fish counters in the river Inn (Austria), which also features high amounts of glacial silts, which might prove challenging for a plastic surface under permanent exposure. After half a year of running the installation, first results are promising, i.e. glacial silt caused no measurable abrasion on the artificial substrate, and it was shown that passages of bottom oriented Lota lota took place. The glacial silt had no measurable abrasion to the artificial substrate.

As the cost and time effort for the construction of artificial substrate inserts are quite high, another method for high accuracy measuring and reproducing artificial substrate is tested. A series of digital images are taken from an artificial river substrate and a 3D model is created using the Structure from Motion technique. As 3D printers are becoming progressively more affordable, and the quality of the prints is rapidly increasing, a 3D model can be easily printed out. Comparing both materials under dry conditions and considering time needed for production, the Structure from Motion method in combination with 3D print seems quite promising.

Further research is required on the 3D printed material for its durability over time at additional installations, including a long-term comparison between the unit with and without substrate is needed to prove the correlation between the artificial substrate and the presence and passage of the individuals.