



Designing Fish-Friendly Culverts (and bridges)

THINGS TO THINK ABOUT AS YOU DESIGN YOUR CULVERT

(Note: Optional information to share with students)

- A. **length of the culvert:** If it's too long, water velocity could increase or water could pool upstream of the culvert which can cause flooding.
- B. **water depth within the culvert:** Will the culvert hold water all year round? Depth affects whether the fish can find shelter and places to rest. They get tired too, especially if they are swimming against strong currents. Depth also affects how water flows and distributes sediments in the culvert; too much sediment could build up if the depths are too shallow.
- C. **slope of the culvert:** This can have a great affect on whether they can make it into the culvert. If it's too high, some fish can't leap up into the culvert to continue upstream. Additionally, if it's too steep, water velocity through the culvert can increase greatly making it hard for fish to swim against the current as they try to move upstream. High water velocities could scour out the substrate inside the culvert, leaving no place to rest and hide when swimming through the culvert.
- D. **entrance and exit conditions:** If the entrance (upstream end of the culvert) is too small, the force of the river through the culvert will increase (like a fire-hose) creating velocities too great for fish to swim against. Flooding upstream also will occur if the river is too big to flow through an undersized culvert. And if the exit (downstream end) is too small, it will be hard for fish to leap into the culvert. Jumping pools below a culvert can help fish pick up speed and momentum for swimming upstream and leaping into a culvert, but pools can also be places where fish are easily preyed on by fish-eating animals. To avoid predation, fish avoid swimming into brightly lighted areas or into areas with drastic changes in lighting. Shading from trees upstream and downstream of the culvert can help protect fish from predators, and prevent them from staying and hiding inside the culvert (which is dark) during their upstream migration.
- E. **water velocity** (through the culvert, compared to water velocity outside the influence of the culvert): If velocities are too high, fish may not be able to swim against the current to reach the other side of the culvert. Or if flows are too low, there may not be enough water for fish to swim through the culvert to the area of the river it wants to reach.
- F. **substrate within the culvert** (compared to the stream outside of the culvert): Substrate is the type of natural material at the bottom of a river or lake; clay, silt, sand, gravel, cobbles, boulders and bedrock. For some aquatic organisms that are food (prey) items for fish, habitat can be a small rock or the space between pebbles. It will be important that both fish and their prey find substrates where they can live, rest and feed. It's unlikely a culvert would be used for spawning, but we can't be certain. Fish will create a spawning nest (a place to lay their eggs) only in substrates that are suitable to their species.
- G. **riparian habitat:** Plants, shrubs and trees located along the side of a river help stabilize the river banks, especially during high water flows. Sometimes vegetation plantings are needed after construction of culverts and bridges.
- H. **size and species of fish:** Some fish are faster and stronger than others, and can swim for longer periods without resting. Some fish can't swim fast (i.e. they can't swim against strong currents), nor can they leap up into culverts perched too high, and they need places to rest.
- I. **fish swimming ability** (varies among species): Most scientists use three categories to describe swimming ability (Beamish 1978). These include (1) burst speed (relatively high speeds that can be maintained for only a few seconds), (2) prolonged swimming speed (including the range of speeds between burst and sustained), and (3) sustained speed (speeds that can be maintained for long periods without fatigue).
- a. **Burst speed:** is most important when fish need to leap over physical barriers, or swim through short sections of fast water.

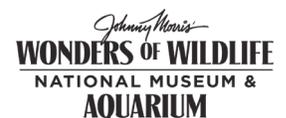
b. **Prolonged speed:** is important for crossing longer sections of fast water.

c. Long-distance movements and the ability to maintain position in the stream channel for long periods of time depend on the **sustained speed** of fish.

J. **sexual maturation of fish:** This can affect a fish's swimming speed and performance. Biologists and engineers will want to make sure that sexually mature, migrating fish are able to reach their spawning habitat.

LITERATURE CITED:

Beamish, F. W. H., 1978. Swimming capacity of fish. pp. 101-187. In Hoar W. S. & Randall D. J. (eds.), Fish physiology. Vol. 7. Academic Press, Inc. ., New York, N .Y. <http://bit.ly/2xtVSAQ>



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