Culverts effects on Brook/Brown trout population and distribution.

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Background/Motivation:

Rivers are one of the most vital sources of freshwater on earth and are key in shaping and maintaining the land and forests that surround them. When investigating the health of rivers and the ecosystems that surround them, a useful tactic is to understand the state of health of indicator species within. In the case of fresh, cold water one of the best indicator species found within are trout, which range both in native and non native species across North America and much of the world. Due to their extreme sensitivity to water pollution (Adams, James, Speas, 2008) trout serve as a perfect indicator species to test the impact of human caused pollution in our waterways.

Humans impact the cleanliness of rivers in a multitude of ways, but one of the most impactful of pollution sources is waste brought into directly through sidewalk and paved area runoff and adjacent roads and through the construction of culverts to pass under them. Where roads, sidewalks and other paved areas intersect with waterways a popular method is to control the path of the water using culverts meaning contained channels through which the water can flow without risking erosion for the nearby structures. These artificial pathways while keeping maintenance costs low, serve as direct access points for pollution to enter the waterways from runoff and constrain the stream or rivers flow leading to an increase in water velocity and subsequent increased turbidity due to the concentrated flow of water (Olson, Marcarelli, Timm, Eggert, Kolka, 2016) . They therefore serve as good markers of increased pollution and possible disturbance of indicator species as we assess water quality moving down a watershed. A correlation between amounts of sediment and other pollutants in the water and the effects that they have on the ecosystem can be determined through the indicator species of trout since population and size both indicate viability for the species in a section of water. Both large size of brook and brown trout and dense populations indicate healthy spawning populations (FWS, 2020), and through segmenting waterways based on locations of culverts an important correlation can be drawn between the two investigating the effects culverts have on the surrounding ecosystem.

Hypothesis:

We hypothesize that Brook and Brown trout populations will be seriously harmed due to increased sediment flow caused by culverts.

This is due to the fact that, starting with installation, you are rapidly changing the river's shape, sediment input, and disturbing its continuity. However, for our hypothesis we will look more into sediment flow rather than continuity as it is more difficult to gather continuous data on a streams continuity. Along with this, when it comes to trout, especially native brook trout, even a small amount of sediment can reduce the number of successful eggs that hatch each year and without a future population, continuity wouldn't matter to trout.

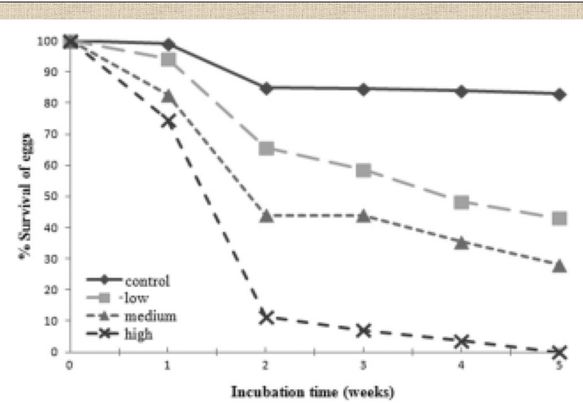
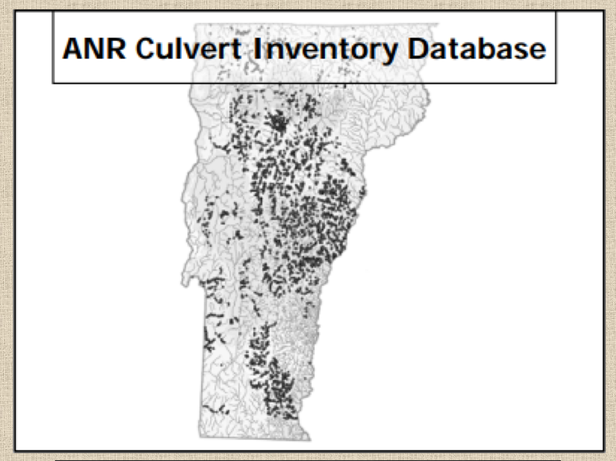


Fig. 3. Average percentage surivival of eggs incubating under the various sediment treatment levels (0–40% fines).

This figure shows egg survival rates in 4 different levels of stream sediment. The fish is water with high sediment had a 0% survival rate, though some eggs did make it to the eye stage. Even in the low sediment stream the success rate was below

Materials and Methods:

By working from order I streams (also known as headwater streams) downwards through a watershed and using both basic water quality testi kits to determine oxygen and bacteria levels, nitrates, dissolved solids, and PH levels as well as using electroshocking to observe population density and size of fish we can correlate presence of culverts and possible changes in pollution levels and health of brook and brown trout populations. Data on the size and number of fish in an area is easily collected using electroshocking which will stun brook or brown trout in t local pools and make them easily collected for length to be measured as well as the number of fish counted (Reynolds, Holliman). When collecting fish we can also note the presence or absence of eggs in females as this could help us to anticipate what the population might look like the following season because egg success is directly linked to dissolved solids in the water. These datapoints will be compared to see if there is a trend that will form as we move down the watershed that might point to the impacts of the presence of culverts in a watershed. Usi these methods the health of Vermont streams can be compared and assessed along their length and also against each other using brook and brown trout as indicators for the impact of culverts on rivers and their ecosystems.



This image shows how many culverts the state of Vermont has , these culverts range from totally impassible by fish (a completely impassible culvert would have a free fall greater than 1 foot, rendering it impassible by juvenile and adult trout) to full passage (no inlet obstructions and stream substrate throughout.

Predictions/Possible implications:

Our prediction is that the populations of trout, both above and below culverts, will be negatively impacted by the presence of a culvert. The downstream populations will suffer more of an impact from increased sediment flow whereas the above stream populations will most likely suffer from a lack of stream continuity. Being that trout are an indicator species in streams (especially brook trout) these results would be showing us that the stream as a whole is degrading. Culverts would not just be affecting the trout, but all other organisms in the stream ecosystem as well.

Intended Analysis:

Given the fact that in our experiment the response variable, presence/absence of trout (both species), is continuous and the independent variable is above or below the culvert (categorical) we will conduct a T-test. This is because we have two groups, trout above and trout below culverts, and a t-test lets you compare the average of two different groups. Doing the t-test will allow us to see any differences between populations.

Citations:

Letizia Cocchiglia, Sarah Curran, Edel Hannigan, Patrick J. Purcell & Mary Kelly-Quinn (2012) Evaluation of the effects of fine sediment inputs from stream culverts on brown trout egg survival through field and laboratory assessments, Inland Waters, 2:1, 47-58, https://doi.org/10.5268/IW-2.1.495

Jean-Baptiste Torterotot, Charles Perrier, Normand E. Bergeron & Louis Bernatchez (2014) Influence of Forest Road Culverts and Waterfalls on the Fine-Scale Distribution of Brook Trout Genetic Diversity in a Boreal Watershed, Transactions of the American Fisheries Society, 143:6, 1577-1591, DOI: 10.1080/00028487.2014.952449, https://doi.org/10.1080/00028487.2014.952449

Mahlum, S., Cote, D., Wiersma, Y., Kehler, D., & Clarke, K. (2014, January 2). Evaluating the Barrier Assessment Technique Derived from FishXing Software and the Upstream Movement of Brook Trout through Road Culverts. Transactions of the American Fisheries Society. https://doi.org/10.1080/00028487.2013.825641

Brook trout. (n.d.). Retrieved November 29, 2020, from https://www.fws.gov/southeast/wildlife/fishes/brook-trout/

Adams, P., James, C., & Speas, C. (2009, December 9). Brown trout (Salmo trutta) Species and Conservation Assessment. Retrieved November 28, 2020, from

Reynolds, J., & Holliman, F. (n.d.). Guidelines for Assessment and Reduction of Electrofishing-Induced Injuries in Trout and Salmon. Retrieved November 28, 2020, from https://nctc.fws.gov/courses/CSP/CSP2C01/resources/8-Electrofishing-Effects/2_Guidelines%20for%20Assessment%20and%20Reduction%20of%20EF%20Injury.pdf