**Review of Research**

Hintz, W.D, and R. A. Relyea. 2019. A review of the species, community and ecosystem impacts of road salt salinization in fresh waters. Freshwater Biology. 64: 1081-1097. <https://doi.org/10.1111/fwb.13286>

Hintz and Relyea give a thorough contemporary review of the literature pertaining to increasing salinization of global freshwaters. Published in 2019, it is the most current synthesis of the available studies on the salinization of freshwater caused solely by road salt contamination that I could find. Broadly they conclude that road salts are having a direct and significant impact to aquatic organisms across the globe, and more work needs to be done to better understand these impacts.

The authors emphasize that the use of road salt is a substantial source of salinization, and that the use of road salts is increasing, especially in colder regions where the use of salt for deicing is commonplace. They also point out that calcium chloride (CaCl₂) and magnesium chloride (MgCl₂) are commonly used in warmer months for dust binding on dirt and gravel roads. Typical natural chloride (Cl¯) concentrations for streams and rivers is 1-20 mg Cl¯/L. In studies reviewed by the authors they found that road salt contamination levels ranged from 10 – 7,730 mg Cl¯/L.

The authors review studies on the effects of salinization at different trophic levels. They show that many bodies of water that are being impacted by road salt salinization, are also being impacted by eutrophication. Some phytoplankton communities are deleteriously affected by elevated salt concentrations and others seem to benefit. High diatom species turnover rates have been linked to increased salinity. These changes to community structure occurred at concentrations at ≥35 mg Cl¯/L which is relatively low since streams are regularly observed to have been contaminated with salt concentrations exceeding 5000 mg Cl¯/L. Freshwater insects seem fairly tolerant to acute exposure to road salt, but exhibit increased drifting behavior at concentrations above 1000 mg Cl¯/L. Unionid mussels show a decrease in the viability of glochidia attachment at acute exposures of more than 113 mg Cl¯/L. Increased salt concentrations have also induced increased mussel siphoning behavior, suggesting the need to flush road salt from the body. In amphibians, wood frogs and spotted salamanders are rarely found in ponds/wetlands with more than 200 mg Cl¯/L, whereas spring peepers and bullfrog are unaffected up to concentrations of 1000 mg Cl¯/L. Fish show varying responses to salt concentrations. Bridle shiners showed an increase in biomass at concentrations up to 1000 mg Cl¯/L. Rainbow trout fry showed reductions in growth at 3000 mg Cl¯/L for the first 25 days of life but showed no effect when exposed to 4000 mg Cl¯/L at a later life stage.

The authors reviewed studies that documented the effects of road salt contamination at the community level. Lakes can be expected to have dramatic shifts in diversity and food web dynamics, leading to phytoplankton blooms, which triggers further trophic cascade. There are few studies on the effects of road salt on streams at the community level, but the studies that have been done show decreases in diversity across most trophic levels can be expected. Wetland communities can also be expected to suffer from phytoplankton blooms at increased salinity, as well as increased mosquito host availability for diseases West Nile Virus and Zika Virus.

The authors provide the following summary graphic: 

**Maryland Report**

https://mde.maryland.gov/programs/Marylander/Documents/2013\_Stranko\_Road\_Salt\_(final)\_TMF\_edits.pdf

In 2013, a group led Scott Stranko prepared a report outlining the ecological effects of road salt application for Maryland waters. The major findings of this report closely align with the findings of Hintz and Relyea (2019). Most waterways tend to exhibit lowered species richness across all taxa with increased chloride concentrations. Stranko presents indices from benthic macroinvertebrates, brook trout, stream salamanders, and freshwater mussels. These were plotted against chloride levels for their respective streams. It was noted that Mayflies are the most sensitive benthic macroinvertebrate group with no mayflies in streams above chloride concentrations above 500 mg/L. Brook Trout are not found in streams with a chloride level greater than 280 mg/L. Stream salamanders were not collected in streams with concentrations above 400 mg Cl¯/L. Freshwater mussels were not found in streams with chloride concentrations over 85 mg/L. All of these concentrations are well below concentrations measured in Hintz and Relyea (2019) and Jackson and Funk (2019) which showed stream reaching chloride concentrations well over 7,000 and 10,000 mg/L respectively.

**Research in Pennsylvania**

Jackson JK, Funk DH. 2019. Temperature affects acute mayfly responses to elevated salinity: implications for toxicity of road de-icing salts. Phil. Trans. R. Soc. B 374: 20180081. <http://dx.doi.org/10.1098/rstb.2018.0081>

John Jackson and David Funk are research scientists at the Stroud Water Research Center located on White Clay Creek in Avondale, PA. This study was the only one I could find investigating the effects of salinization on aquatic life in Pennsylvania specifically. The goal of the study was to investigate the toxicity of sodium chloride (NaCl) to several mayfly larvae species at a range of 5-7 different temperatures. The study found that sensitivity to salinization was reduced as temperature decreased. Although mayflies exhibit a reduced toxic response at lower temperatures, the authors show in the figure below that Rocky Run (an urban stream just over the border of PA in New Castle County, Delaware) reaches salinities above this threshold. These data from Rocky Run were collected to provide context for the laboratory results.

The increased salinities begin in late December and taper out some time in April which coincide with the snowy season in the Northeast, which would coincide with increases in the application of road salt. It can also be seen that Rocky Run regularly reaches salinities of greater than 1000 mg/L and peaks at a salinity of over 11,000 mg/L. It can be assumed that streams near urban areas of Pennsylvania follow a similar trend.

**In Summary**

The effects of road salt to aquatic life is a topic that is gaining more awareness both by researchers and management agencies. In my review of the literature, and in reaching out to PennDOT and other agencies, it is apparent that something must be done to gain a better understanding of the effects of salinization of our freshwaters. To date there has not been an ecosystem wide study of the effects of road salt in Pennsylvania.