05 October 2017
Issue 496

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Source: Schuler, M.S., Hintz, W.D., Jones, D.K., Lind, L.A., Mattes, B.M., Stoler, A.B., Sudol, K.A. & Relyea, R.A. (2017). How common road salts and organic additives alter freshwater food webs: in search of safer alternatives. *Journal of Applied Ecology*. DOI: 10.1111/1365–2664.12877.

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1. e.g. Blasius, B.J. & Merritt, R.W. (2002). Field and laboratory investigations on the effects of road salt (NaCl) on stream macroinvertebrate communities. *Environmental Pollution,* 120, 219–231.

2. Mount, D.R., *et al.* (1997). Statistical models to predict the toxicity of major ions to *Ceriodaphnia dubia, Daphnia magna* and *Pimephales promelas* (fathead minnows). *Environmental Toxicology and Chemistry,* 16, 2009–2019.

European Commission

Science for Environment Policy

Additives used in alternative road salts may affect aquatic ecosystems

A new study shows that run-off from de-icing road salts can affect freshwater aquatic ecosystems by increasing certain types of plankton. The study is the first to compare effects of the most popular road salt, sodium chloride, with the effects of alternative salts and additives used to increase de-icing efficiency. Based on their findings, the researchers recommend that magnesium chloride and salt additives are used cautiously near water bodies.

Applying salts to de-ice roads has been widely practised in North America and Europe since the 1960s. The most common salt used is sodium chloride, with 10–20 million tonnes applied to roadways annually in the United States, where the study was conducted. Magnesium chloride is also used. In Europe, the amount of salt used varies per country, but about 2 million tonnes are spread on UK roads each year, for example. A number of organic additives (e.g. vegetable juice) that make the salt more efficient — for example by making it stick to the road better — are sometimes also applied. These additives are attractive from an economic perspective, as they mean that less salt needs to be spread on roads.

Past studies have shown that increased salinity can have a negative impact on individual aquatic species[1], and that magnesium chloride can be more toxic than sodium chloride[2], yet few have looked at the effect of multiple salts on aquatic communities, or at the effects of the run-off organic additives.

In order to study the effects of road salts and additives on aquatic communities, the researchers identified five common de-icing agents used in North America. As well as pure sodium chloride and pure magnesium chloride, these included ClearLane™ (mainly sodium chloride with about 2% magnesium chloride); sodium chloride plus the additive GeoMelt™ (based on vegetable juice); and Magic Salt™ (magnesium chloride with an additive made from a by-product of distillation).

The researchers filled 100-litre ponds with 85 litres of fresh water, to which they added leaf litter and organisms from nearby lakes, for example zooplankton (microscopic organisms), amphipods (shrimp-like crustaceans) and snails. The leaf litter contained communities of microbes, which were allowed to establish for one week before the other organisms were added.

As the chloride concentration in most lakes and ponds in North America is no higher than 200 milligrams per litre (mg/l), the researchers studied salt concentrations of 50, 100 and 200 mg/l (low, medium and high concentration), reflecting real-world scenarios. Salts were added to the ponds as a solution. After one and four weeks, the researchers collected data on organism numbers and species diversity in each experimental pond, compared to a control pond with a salt concentration of 25 mg per litre.

The results showed that adding sodium chloride to the ponds had no effect on the aquatic communities. Adding magnesium chloride, ClearLane™, GeoMelt™ or Magic Salt™, however, had at least one effect on the communities.

Continued on next page.

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Additives used in alternative road salts may affect aquatic ecosystems *(continued)*

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GeoMeltTM at medium and high concentrations, and Magic SaltTM at high concentration, reduced the amount of dissolved oxygen in the water. The researchers concluded this was due to increased microbial activity, as bacteria and fungi worked to break down the organic additives. They note that in a real-world situation, where salts are repeatedly washed into a body of water, this effect may last for a long time and be more noticeable in the spring, as warmth increases microbial activity. Reduced oxygen in water could negatively affect breeding populations of amphibians and insects at this time.

GeoMelt™ and Magic Salt™ also increased the abundance of zooplankton. The researchers attribute this to increased phosphorus in the water, due to microbial interaction with the additives, which increases the growth rate of phytoplankton (photosynthesising microscopic organisms) and periphyton (algae and microbes that live on surfaces underwater). Phytoplankton are the primary food sources for zooplankton and periphyton is the primary food resource for grazers such as snails and amphipods. The results also showed reduced diversity of zooplankton among ponds, in treatments containing magnesium chloride and Magic Salt™, possibly due to an increase in certain types of algae preferred by the relatively abundant types of zooplankton (ostracods and the cladocerans, *Scapholeberis mucronata* and *Chydorus sphaericus*). These changes could significantly alter the ecosystem's food-web dynamics, say the researchers — altering the numbers of fish and other predators of zooplankton.

Although past studies have shown magnesium chloride to be more toxic than sodium chloride, this study found that numbers of amphipods increased in treatments where low concentrations of magnesium chloride were applied. The researchers suggest this could be due to the direct positive effect of magnesium as a nutrient for the amphipods, or, more likely, due to magnesium chloride increasing food resources for amphipods (algae). Amphipods play an important role in aquatic nutrient cycling, so an increase in their numbers could affect the rest of the ecosystem — for example, types of algae that are less popular with amphipods could increase.

As road salts and their additives can have an effect on aquatic ecosystems[3], the researchers argue that they should be used with caution near lakes and ponds. New roads could also be designed to minimise run-off. Further research on the effects of road salts in aquatic ecosystems at higher concentrations would be useful, as it is possible for them to reach higher concentrations than those used in this study. In particular, the researchers suggest that more information is needed on the interaction between microbes and organic additives, and the effect on algae.

3. Hintz, W. D., Mattes, B. M., Schuler, M. S., Jones, D. K., Stoler, A. B., Lind, L., & Relyea, R. A. 2017. Salinization triggers a trophic cascade in experimental freshwater communities with varying food-chain length. *Ecological Applications*. 27:833-844