J.W. Snodgrass, D.R. Ownby, R.E. Casey. Influence of Surface Water Sodium Chloride Pollution on Trace Element Bioaccumulation and Transfer.

Salinization as a result of road de-icing chemicals, primarily NaCl, is affecting streams, wetlands, lakes, and human-made water bodies in Northern latitudes throughout North America (Rosenberry 1999, Marsalek 2003, Kaushal et al. 2005, Sanzo and Hecnar 2006). Furthermore, the large amounts of impervious surface (e.g., roof tops, roads and parking lots) typical of urban and suburban areas collect and/or release a wide range of pollutants including metals, polyaromatic hydrocarbons, and polychlorinated biphenyls (Pitt et al. 1995, Davis et al. 2001, Environment Canada and Health Canada 2001, Van Metre and Mahler 2003, Councell et al. 2004). Ultimately, all of these pollutants enter surface or ground waters where they may interact and influence storage, transport, bioaccumulation, and toxicity of pollutants. In the case of NaCl and metals, Cl^- ions may increase the mobility and decrease the bioavailability of metals through formation of soluble chloride complexes (Amrhein et al. 1992). Additionally, Na^+ may compete with metals for biotic binding sites, further reducing toxicity (Di Toro et al. 2001).

Modern stormwater management practices are resulting in the creation of large numbers of stormwater management ponds in urban and suburban areas. While it is known that these artificial habitats support fish and wildlife, particularly amphibians and birds (Campbell 1994, Helfield and Diamond 1997, Bishop et al. 2000, Massal et al. 2007), little is known of pollutant storage, cycling and transport in these systems. We proposed to investigate the influences of NaCl on one path of Zn transport through stormwater pond systems. Zinc entering stormwater ponds can accumulate in invertebrates and amphibian larvae (Casey et al. 2005, 2007; Simon 2007), both of which are consumed by wading and diving birds; thus ponds may serve to concentrate and introduce pollutants into terrestrial foods webs. Therefore, our specific objectives are (1) to assess the influence of NaCl on Zn bioaccumulation by larval amphibians using laboratory microcosms, and (2) assess rates of consumption of aquatic prey by wading birds under field condition in an effort to estimate transfer of Zn to higher trophic levels.

To investigate the influence of NaCl on Zn accumulation by amphibians we will use American toads (*Bufo americanus*) housed in microcosms modified from Snodgrass et al. (2004, 2005). We will model Zn accumulation and potential mortality based on steady-state kinetic models (Landrum et al., 1992) and develop a biotic ligand model (BLM) (Heijerick et al. 2002, de Schamphelaere and Janssen 2002). Briefly, amplexed pairs of toads are collected from clean wetlands, transported to the laboratory, and allowed to oviposite. The following day eggs are randomly assigned to microcosms. Water in microcosms will mimic ion concentrations found in stormwater ponds in the Baltimore metropolitan region with the exception of Zn and NaCl. Every four days all microcosms will have ½ of the water replaced and tadpoles will be fed boiled spinach disks during larval development. In experiments designed to estimate model parameters, tadpoles will be allowed to complete metamorphosis before they are sacrificed for determination of Zn body burdens.

To investigate the potential transfer of Zn from aquatic prey to wading birds we will use field surveys of wading bird feeding rates and Zn levels in prey items. Using standard methods for estimating the consumption rate of wading birds (Cezilly and

Wallace 1988), students will determine general diet categories at several ponds with a range of Zn levels; selection of ponds will be based on existing data on sediment Zn concentrations. Dip nets and seines will be used to collect prey items from the different diet categories for determination of Zn body burdens.

Chemical analyses will be performed according to standard methods. Cations and anions for which ion selective electrodes are commercially available (Na^+, Ca^+, K^+, H^+ and Cl^-) will be measured at test initiation and monitored throughout the course of each experiment. Alkalinity (as mg/L $CaCO_3$) and hardness (Ca^+, Mg^{2+}) titrations will be performed to confirm that water quality between stormwater ponds matches that in synthetic waters. Zinc will be quantified as both total and dissolved (0.45 μm filtered) using flame atomic absorption spectrophotometry. Dissolved organic carbon will be quantified using a carbon-nitrogen analyzer. Total toad body burdens of Zn will be analyzed using a nitric acid digestion, followed by H_2O_2 and then quantified with either ICP-MS or graphite furnace AA.

The study will be conducted in three stages aligned with the three summers of REU funding. During the first summer, students and faculty will: 1) conduct laboratory microcosm studies to determine the ranges of NaCl and Zn condition over which American toad embryos and larvae can complete development; 2) survey regional water quality (concentrating on ion content) to determine water ion concentrations for microcosm experiments; 3) survey wading bird communities at a range of ponds to identify ponds for more intensive feeding studies. During summer two, students and faculty will conduct microcosm studies to develop model parameters for predicting bioaccumulation of Zn as a function of NaCl and Zn concentrations in the water column; 2) begin collection of field data on wading bird diets and prey Zn concentrations; 3) fit the bioaccumulation model to data from the microcosm experiments. Finally, during summer three, students and faculty will gather data from field sites to validate the model of Zn bioaccumulation developed the previous summer; 2) complete field and laboratory analyses of wading bird feeding rates and prey Zn concentrations.

During each summer two students will work on the project; one associated primarily with field work and bioassays and one associated primarily with chemical analysis and modeling. However, both students will participate in all aspects of the project. We chose American toads to work with because they are available at the beginning of the summer and complete development before the end of the summer. Therefore, students will have time to complete microcosm studies and process samples from these studies before the end of the summer.