EFFECTS OF COPPER ON AMPHIBIANS INHABITING A CONSTRUCTED WETLAND ON THE SAVANNAH RIVER SITE

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Abstract. An artificial wetland system (H-02) was constructed on the Savannah River Site (SRS), South Carolina, to treat process and storm water discharge from an industrial facility. The ability of natural wetlands to improve many aspects of water quality is well known. One aspect of natural wetland function that is capitalized on at the H-02 wetlands is the ability to sequester trace metals such as copper (Cu) and zinc (Zn) from the effluent discharged into this wetland system. Constructed wetlands can provide new habitat for local wildlife, but if poor water quality limits recruitment, these wetlands could become "population sinks." The H-02 wetlands provide permanent water that doesn't have any fish, potentially providing ideal habitat for amphibians. However, amphibians are also highly susceptible to environmental contaminants. Thus, the potential for the constructed wetlands to become population sinks is of concern. We have been monitoring amphibian colonization of the H-02 wetlands and evaluating the effects of elevated levels of trace metals on amphibian success.

Amphibians are ideally suited for studying the effects of contaminants because they are important components of aquatic and terrestrial communities and represent a large proportion of the standing biomass in some systems. In many communities amphibians are the most abundant vertebrates. Because of their high biomass and conversion efficiencies, they are responsible for substantial transfer of energy through food webs, and may also serve as a critical link in trophic transfer of contaminants. Consequently, if environmental contaminants negatively affect amphibian populations then the whole ecosystem can be impacted.

A majority of studies examining the effects of contaminants on amphibians focus on acute toxicity studies of model organisms. Although these studies have contributed to the field of amphibian ecotoxicology they lack applicability to natural settings. Most toxicology studies only expose amphibians for the first 96 hours to two weeks of development. This approach is not biologically representative since most amphibians will be exposed for their entire larval development. In addition, different species develop at substantially different rates such that a two-week time period covers different ontogenetic exposure periods for different species. To truly understand the effects of contaminant exposure on amphibians it is important to expose them for the entire larval period and then assess the effects across multiple life stages.

Amphibian species may differ in their sensitivities to contaminants, so it is also important to examine effects across a range of native species. The model organism typically studied is the African clawed frog, *Xenopus laevis*. *Xenopus* is unlike most amphibians in that it is entirely aquatic and it is also phylogenetically very distinct from most.

Thirteen species of amphibians have colonized the H-02 wetland complex since its construction. Those species differ in their feeding habits and larval duration. To incorporate these species differences we examined the effects of Cu exposure on three species of amphibians: southern leopard frogs (*Rana sphenocephala*), southern toads (*Bufo terrestris*), and eastern narrowmouthed toads (*Gastrophryne carolinensis*). For all three species we used an exposure period that extends from fertilization to metamorphosis. We conducted all studies in both a controlled laboratory setting with precise biologically relevant Cu treatments and in the wetlands where larvae were exposed to a water chemistry gradient under ambient field conditions. The H-02 treatment complex consists of a retention pond, which receives the process water, and two constructed wetland cells. Water in the retention pond has the highest levels of Cu, Zn, and pH, and after a residence time of several days water exiting the wetland cells has lower levels of these variables. For field studies we reared amphibians in the retention pond, and at both the influent and effluent ends of the treatment cells. We observed substantial species-level variation in sensitivity to contaminants at both the egg and larval stages. To accurately assess the impacts of contaminants on pond-breeding amphibians it is necessary to study native species throughout their aquatic life stages.