

Long-term Studies at Rainbow Bay

Rainbow Bay is an isolated seasonal wetland located within the Rainbow Bay Amphibian Reserve Set-Aside Area, in the center of the Savannah River Site (SRS). This 87.5-acre Set-Aside Area includes Rainbow Bay, a 200-meter forested buffer area, and a wedge-shaped corridor extending to a tributary of Fourmile Creek. This corridor provides a forested connection between the Rainbow Bay wetland, Bullfrog and Pickerel Ponds, and the Fourmile Creek drainage, allowing amphibians to move freely among these wetlands. Prior to the establishment of the SRS, Rainbow Bay was surrounded completely by agricultural fields. In the 1950's, these fields were planted in slash and loblolly pine by the U.S. Forest Service. The 200-meter buffer area surrounding this wetland has not been subjected to clear-cutting or prescribed fire for over twenty years.

SREL Research at Rainbow Bay...

The Savannah River Ecology Laboratory (SREL) began research in Rainbow Bay in 1978, when this wetland was selected as a control site to examine the ecological importance of Sun Bay, a wetland eliminated during construction of the Defense Waste Processing Facility (DWPF). As part of this research project,



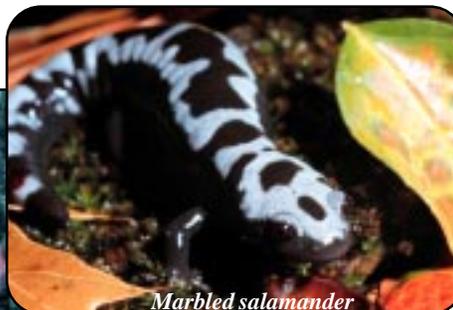
Aerial view of Rainbow Bay.



a drift fence was installed around Rainbow Bay, allowing SREL researchers to census on a **daily** basis the amphibian and reptiles that use the wetland and the surrounding terrestrial habitat. Animals moving into and out of the wetland fall into buckets located at regular intervals along both sides of the drift fence; captured animals are identified, measured, and marked prior to their release. This 20-year study is the longest running project of its kind in the world and is considered to be a model for the type of long-term studies that are required to understand the effects of climatic fluctuations and habitat disturbances on natural amphibian populations. Studies of Rainbow

Bay fauna have resulted in over 60 scientific research articles and countless articles in the popular press. Such long-term intensive studies of a single natural community have revealed that amphibian species can go through major population fluctuations from year to year and that a species dominant in some years may be almost absent in others, and vice versa. This study was the basis for an article in the journal *Science* which concluded that long-term studies are required to separate the effects of natural climate-induced

fluctuations in amphibian populations from human-induced population declines.



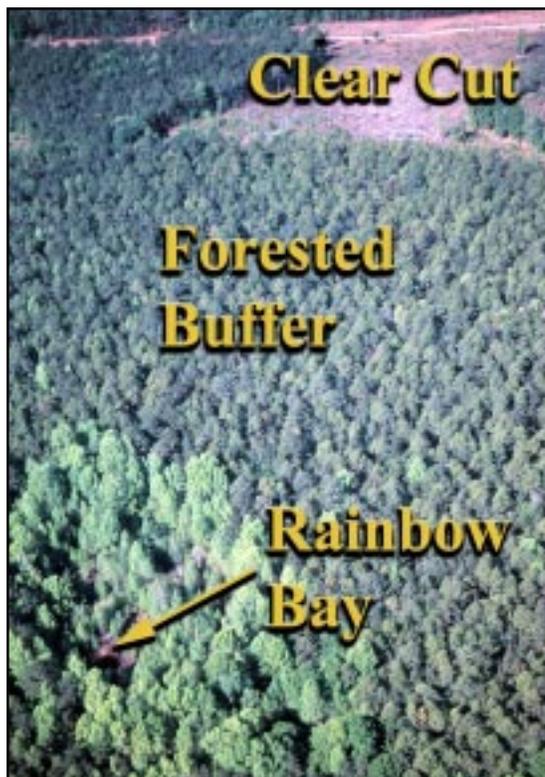
Marbled salamander

Other SREL studies have examined the species composition and population dynamics of zooplankton, bacterial diversity, and the relationship between precipitation and water chemistry in Rainbow Bay. Research has determined that although the aquatic invertebrate community is strongly influenced by the pond's hydroperiod, Rainbow Bay usually holds water for long enough periods to support a diverse array of zooplankton species, which serve as the primary food base for larval salamanders. Surveys of cloned

and sequenced bacterial DNA extracted from Rainbow Bay sediments revealed that, of the 35 clones sequenced, most were novel species. Other studies of the microbial community at Rainbow Bay determined that SRS operations have not had a detectable impact on antibiotic resistance expressed by the bacteria surveyed. A study of the water chemistry in Rainbow Bay revealed that water in this bay is soft and acidic (pH 4.0-5.9), with dissolved organic matter ranging from 4-60 mg/L. Like other bays examined in this study, atmospheric inputs of human-produced acids may influence the water chemistry of Rainbow Bay.

What we've learned at Rainbow Bay...

- Hydroperiod (the number of days in a year that a wetland holds water) is the single most important factor that influences what species are "successful" at Rainbow Bay and how these species interact.
- No direct relationship could be detected between the pH of surface water in Rainbow Bay and acidic rainfall entering the bay, suggesting that the water quality in Carolina bays is influenced not only by precipitation but also by shallow groundwater and potentially important in-bay processes that are as yet poorly understood.



A 200-meter forested buffer separates Rainbow Bay from a recent clear cut.



Drift fence used at Carolina bays to census amphibians and reptiles. Typical captures at Rainbow Bay include ornate chorus frogs, tiger, mole, and marbled salamanders, and narrowmouthed toads.

- Surveys of cloned and sequenced bacterial DNA extracted from Rainbow Bay sediments revealed that most of the 35 clones sequenced represented novel bacterial species.
- The importance of hydroperiod is clearly evident in the amphibian community. If the hydroperiod is too short, no species reproduce successfully; if too long, then only a few species may do well. The number of species successfully reproducing in the pond and the number of young emerging from the pond appear to be highest at intermediate hydroperiods.
- Conditions in the larval environment (the aquatic phase of the life cycle) affect the traits of adults, such as body size, survival, and age at maturity. The density experienced by larval salamanders plays an important role in population regulation.
- Long-term daily censusing of amphibians indicated that any population declines within a species were the result of drought conditions and several years of unsuccessful reproduction. The unexplained declines observed at other locations around the world have not occurred in populations at Rainbow Bay.
- Data from long-term monitoring of Rainbow Bay suggest that it may be difficult to distinguish natural population fluctuations from human-caused declines.
- Statistical analyses show that, due to the extreme levels of natural fluctuations in amphibian numbers, long time periods (greater than 20 years) may be necessary to identify population trends, especially if changes are subtle.



Narrowmouthed toad



Marbled salamanders