

**AN AQUATIC MACROINVERTEBRATE BIOASSESSMENT OF THE
NORTH FORK OF THE EDISTO RIVER AFTER A CYANIDE RELEASE
(ORANGEBURG COUNTY, SC)**



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Summary

On 11/27/2012 staff in the Aquatic Biology Section of the South Carolina Department of Health and Environmental Control (SCDHEC) conducted a macroinvertebrate bioassessment of the North Fork of the Edisto River in Orangeburg County, SC. The study was conducted in response to a self reported cyanide release into the river by Albermarle Corporation that occurred over a 31 hour period beginning on 11/12/2012 (ICAR 2012). An estimated 80 lbs of cyanide was released to the river during this period. The release occurred because of a false negative laboratory reading at the facility and was discovered after aberrant readings began to occur in the facilities waste water treatment plant prompting a shutdown of the effluent discharge to the river.

To determine if the biological integrity of the North Fork of the Edisto River was impaired by the cyanide release sampling locations were established upriver and downriver of the effluent release. We frequently refer to these sorts of projects as upstream-downstream studies with the upstream station serving as the scientific control. Because of the robust ambient monitoring program the SCDHEC once had, historic data is often also available on most waterbodies and can serve as a pre-spill control. Data were available at E-008 on the North Fork of the Edisto and E-012 of the South Fork of the Edisto and these data were also used for pre-spill controls.

Results of this study indicated that the North Fork of the Edisto River in Orangeburg County contained a balanced and indigenous population of invertebrate fauna at the location upriver of the cyanide release and at the site below the discharge point. The bioclassification score was 4.0 (Good) upriver and 4.0 (Good) downriver of the release indicating there was no impact to the river by the release. These scores are in close agreement with results of ambient bioassessments at SCDHEC monitoring station E-008 (4.5 in 1997, 4.2 in 2001), which is located approximately 8.5 miles below the facility's discharge point. It is also very similar to results obtained from the South Fork of the Edisto. While a fish community assessment was not conducted we did observe small fishes of various kinds in the river at the time of our visit.

In conclusion, the results of this study suggest that the Abermarle Corporation NPDES discharge is having no measurable negative adverse effect on the North Fork of the Edisto River. Further the aberrant cyanide release does not appear to have resulted in a measurable toxic effect to the aquatic organisms of the river.

Introduction

The congressional declaration of the goals and policy of the Federal Water Pollution Control Act of 1972 is to restore and maintain the physical, chemical, and biological integrity of the waters of the Nation (Clean Water Act CWA, 1972). Various regulatory and non-regulatory provisions are provided in the CWA as tools for State Agencies, in partnership with the US Environmental Protection Agency (USEPA), to achieve these objectives. A robust surface water monitoring and reporting program is required to determine the effectiveness of these tools. Some of the more effective monitoring activities are biological assessments, or bioassessments, that in various forms have been utilized for nearly a century (Hynes 1994).

The SC Water Pollution Control Authority began conducting bioassessments of surface water in the mid 1950's. Community assessments utilizing algal communities, aquatic invertebrate communities, and fish communities in the 1970's under the auspices of the SCDHEC (SCDHEC 1974) have been used for at least 40 years by the State to assess the effects of water pollution. These assemblages of aquatic organisms respond in a predictable way to various pollutants owing to their distinct tolerance to physical and chemical alterations to the waters of the Nation (Barbour et al. 1999). Aquatic macroinvertebrates are particularly useful in this regard for various reasons outlined in Barbour et al, (1999).

On 11/27/2012 staff in the Aquatic Biology Section of the SCDHEC conducted an aquatic macroinvertebrate study on the North Fork of the Edisto River in Orangeburg County, SC. This study was conducted to assess the condition of the aquatic life of the river after approximately 80 pounds of cyanide was released from the Abermarle Corporation NPDES discharge. Hydrogen cyanide (HCN) is a highly toxic compound that is readily absorbed by aquatic organisms, resulting in adverse health effects including death (Dzombak et al. 2006). While the release in quantities that result in severe environmental degradation is rare, in 1990 an earthen dam owned by The Brewer Gold Mine collapsed releasing large quantities of cyanide into the Little Fork Creek in Chesterfield County SC (Griffin 1991). Aquatic organisms were nearly completely eliminated from Little Fork Creek and Fork Creek, while effects were noted miles downstream in the Lynches River.

Methods

Detailed methods for conducting macroinvertebrate bioassessments can be found in SCDHEC (1998). The SCDHEC uses a timed, qualitative, multihabitat, sampling protocol to sample rivers and streams for macroinvertebrates. This involves 2 to 3 biologists sampling all available substrate of a waterbody to characterize the biotic community. Using various sampling devices, biologists enter the river and spend 3 person-hours sampling. Thus, 2 biologists spend 1.5 hours of actual sampling time per site. Substrate includes rocks and cobble in the river channel, trailing roots from riparian vegetation, organic matter such as leaves, sand and gravel, and aquatic vegetation. The many species of aquatic invertebrates are adapted to life in different portions of the river. Therefore some may be found in very swift current under logs or rocks while others can only live along the shore in slack water. Macroinvertebrates are large enough to be seen without the aid of a microscope and are collected in the field and preserved in 80% ethanol. While large enough to collect, species identification requires the use of a microscope to see diagnostic body parts.

Once identified, the numbers and kinds of organisms are recorded in a computer database, which allows for the calculation of metrics that are used to characterize the site. SCDHEC and NCDENR use the Bioclassification System to evaluate data (Lenat 1993). Two important components of the Bioclassification are the EPT Index and the Biotic Index. The letters EPT stand for the ordinal names of mayflies, stoneflies, and caddisflies, respectively. In general these orders are intolerant to pollution and will be found in low numbers in highly contaminated rivers or streams. The Biotic Index is also used to evaluate the health of a stream. Various tolerance values have been assigned to the many species of aquatic invertebrates found in the freshwaters of the Carolinas (Lenat 1993). This value, ranging from 0-10, is used to quantify the level of tolerance different species have to water pollution. These tolerance values are part of the mathematical equation that produces the Biotic Index for a given location in a river or stream. Using these metrics a Bioclassification Score can be calculated as follows: 1 (poor), 2 (fair), 3 (good-fair), 4 (good), 5 (excellent). These values can be calculated to the nearest tenth (e.g. 2.2) but a nominal designation (e.g. Fair) is generated from rounding to the nearest whole number.

The Bioclassification System helps scientists to understand the general health of a river. However, it does not necessarily diagnose the cause of the condition, nor does it necessarily relate to the potential for the water to cause illness to humans,

pets, or livestock that may come in contact with the water. In most streams or rivers there are numerous stressors in the watershed, such as deforestation or urbanization, which can result in a poor aquatic life condition. However, if there is a suspected polluter, studies can be conducted that examines the river above and below the point of entry and by comparing the sites an evaluation can be made. We often refer to these as upstream-downstream studies, with the upstream site serving as the control for which to compare the downstream location.

Description of Study Area

The Edisto River is one of the largest free flowing blackwater rivers in the United States (SCDHEC 2004). The phrase “blackwater” refers to the dark color of the water that is a result of tannins leaching from the decaying organic material in these low gradient waterbodies. The Edisto River originates in the Sandhills Ecoregion of South Carolina with two main tributaries, The South Fork of the Edisto, and the North Fork of the Edisto, joining to form the main stem of the Edisto, which empties into the Atlantic (Figure 1). The watershed is rural and dominated by forested and forested-wetland landuses (SCDHEC 2004). The Edisto River is uniquely South Carolina with its 3100 square mile watershed contained completely within the borders of the state and shared with no other.

Ambient surface water monitoring activities in South Carolina began in 1955 under the SC Water Pollution Control Authority. Ambient monitoring stations on the North Fork of the Edisto in Orangeburg County include stations E-007, E-008, and E-006. Large volumes of data have been accumulated since then and are stored in the USEPA’s STORET data management system (EPA 2013). Similarly a tremendous literature exists for the river, both published and in technical reports, produced by government and academic institutions through the years.

Albemarle Corporation is located near the city of Orangeburg and discharges treated wastewater into the North Edisto River as specified by NPDES industrial permit number SC-0001180 (Figure 2). On 11/12/2012 cyanide was released into the North Fork of the Edisto through the company’s effluent discharge. An estimated 80 pounds escaped before being detected and self reported by the facility. An overview of the steps taken by the Orangeburg Albemarle facility can be found in ICAR (2012).

Staff of the Aquatic Biology Section of the SCDHEC conducted a macroinvertebrate bioassessment on the North Fork of the Edisto River to

determine if the cyanide release resulted in adverse impact to the fauna of the river. On 11/27/2012 biologists with SCDHEC met with Albemarle staff, who were escorts while we were on the facility property. A sampling location was selected at the south end of the property where there was adequate river access (Figure 2). The site that was chosen for the control location (E-007) was upriver of the effluent discharge and is an SCDHEC historic sampling location. Below are descriptions of these monitoring stations:

E-007: SC, Orangeburg County; North Fork Edisto River @ Orangeburg boat landing; Lat. 33.483366 Long. -80.87417. Access was obtained by walking upriver on a boardwalk and entering the water on the east shore. The macroinvertebrate habitat was good with a diversity of instream substrate for invertebrate colonization. Despite human activity in the form of the nature trail the riparian area was well vegetated with large mature trees on either bank. Physical and chemical parameters were unremarkable and were within state standards.

E-607: SC, Orangeburg County; North Fork of Edisto River approximately 0.6 miles downriver from the Albemarle NPDES effluent discharge; Lat. 33.46389 Long. -80.87703. In the 1950's numerous monitoring stations were established in this section of the river. We established the new station E-607, despite this site being only 192 meters above the historic E-007a, to reflect the precise location for this current special study. The river here was similar in many respects to most of the North Fork of the Edisto. Its riparian zone was heavily vegetated with mature native trees and the instream habitat was typical of an unimpaired blackwater river. Good instream habitat was similar to that of the control site. Physical and chemical parameters were all within state standards.

Historic Ambient Monitoring Locations:

E-008: SC, Orangeburg County; North Fork of the Edisto River at S-38-39; Lat. 33.355, Long. -80.887. Using current protocols macroinvertebrate bioassessments were conducted here in 1997, and 2001. Other macroinvertebrate assessments were conducted in the 1970s and 1980s but are not comparable because of the change in methods. This station is located approximately 8.5 miles below Albemarle's NPDES discharge.

E-012: SC, Orangeburg County; South Fork of the Edisto River at S-38-39; Lat. 33.314, Long. -80.965. While not within the same watershed as the Albemarle facility the South Fork of the Edisto is very similar to the North Fork of the Edisto

and historic results can be informative. Bioassessments were conducted in 1997, and 2001 for the South Fork of the Edisto using current procedures.

Results and Discussion

Results of this assessment are shown in Figures 1-3 and Table 1. The assessment of the North Fork of the Edisto River suggests that the cyanide release from the Albemarle facility had no adverse impact on the aquatic macroinvertebrate community. The bioassessment score at station E-607, downriver of the effluent discharge, was 4.0, which was identical to the score obtained at the upriver control site. The aquatic fauna was diverse and abundant with numerous pollution sensitive EPT species present at both locations. The EPT index at E-607 was identical to that at the upstream control (both scores were 18). These scores are also very similar to the scores of the ambient monitoring site E-008 (4.2 in 1997, 4.5 in 2001) and at E-012 on the South Fork of the Edisto (4.2 in 1997, 4.2 in 2001). While the primary objective was to determine if the cyanide release resulted in environmental degradation, our results also suggest that the effluent discharge in general is not causing harm to aquatic invertebrates below the facility's discharge point.

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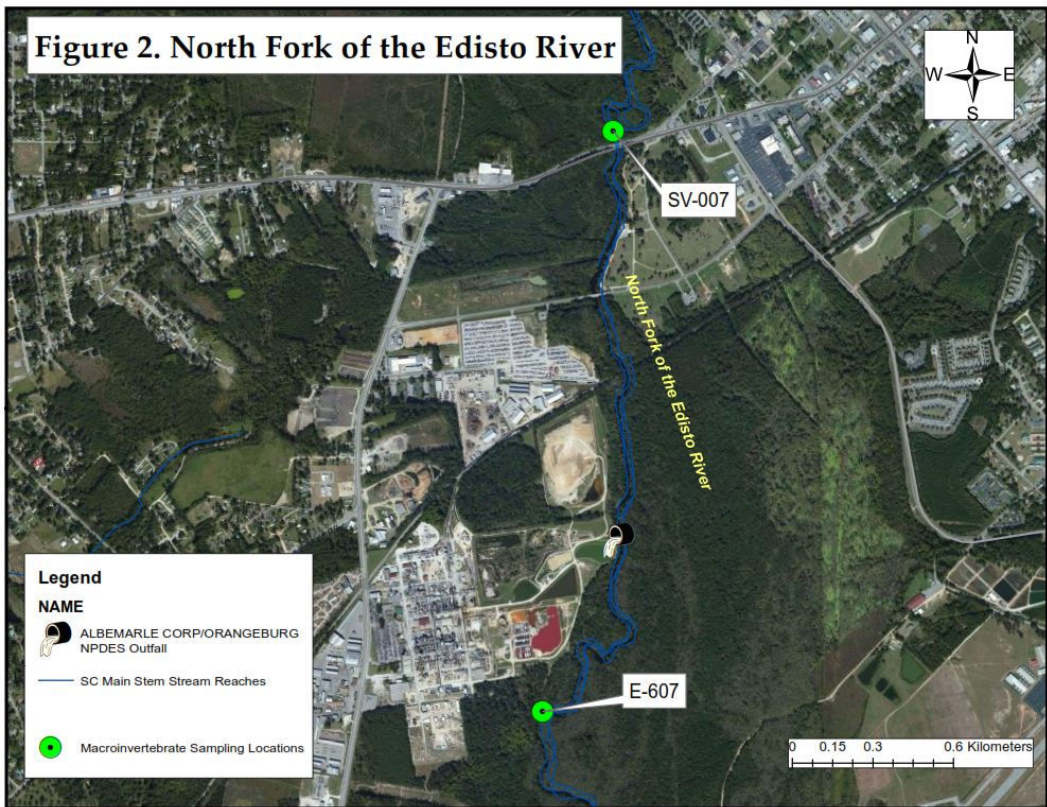
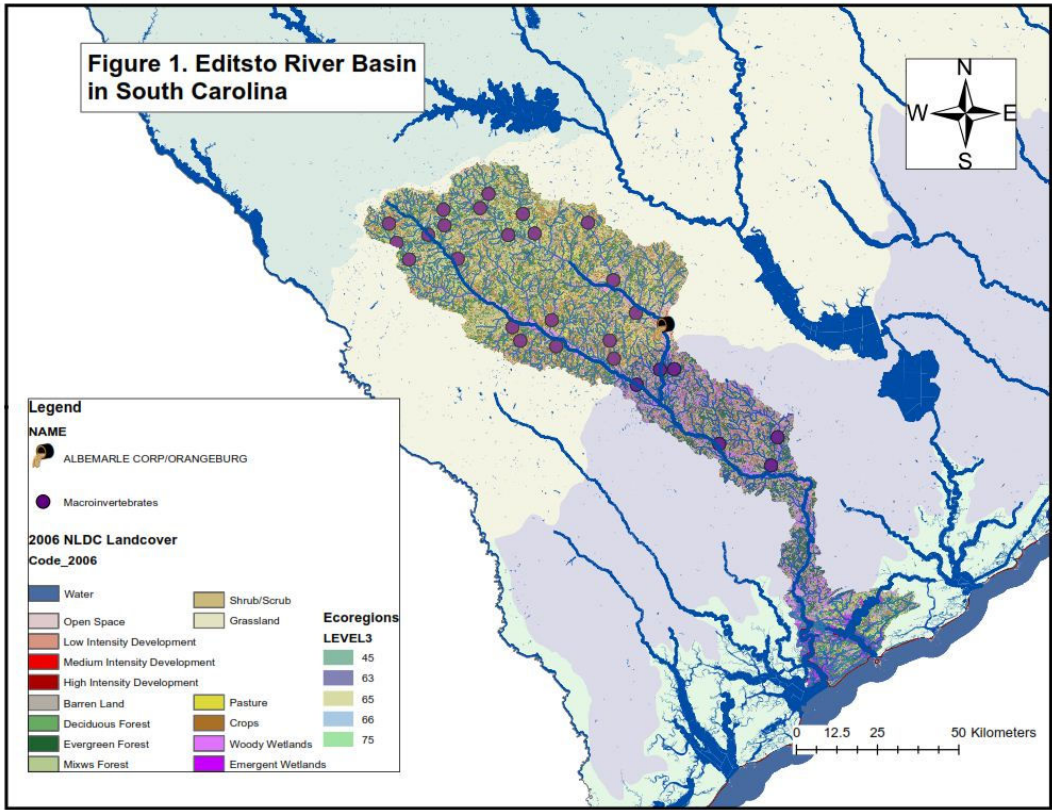


Figure 3. Bioclassification Scores for the North Fork of the Edisto River and the South Fork of the Edisto River showing Good to Excellent Biological Condition.

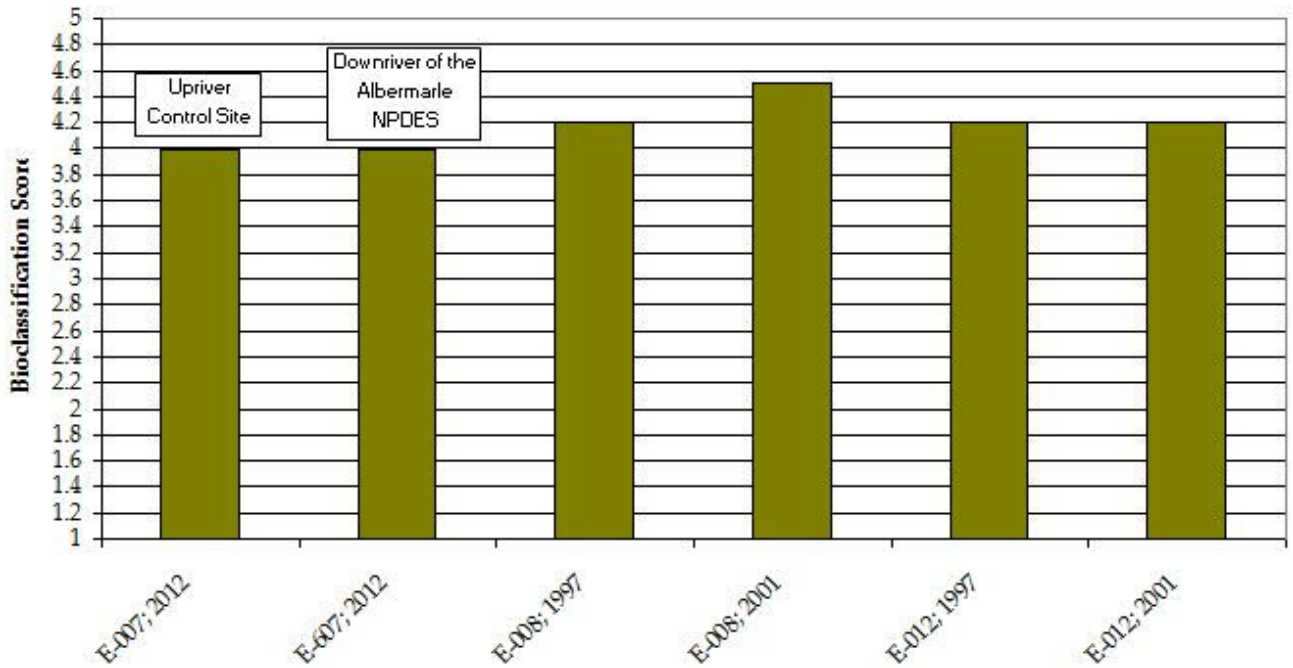


Table 1. Results from bioassessment of the North Fork of the Edisto River and the South Fork of the Edisto River

STATION	DATE	STREAM	Count	Taxa Richness	EPT Index	Biotic Index	EPT Score	Biotic Index Score
E-007; 2012	11/27/2012	North Fork Edisto River @ Orangeburg boat landing 33.483366 80.87417	207	54	18	5.05	3	5.0
E-607; 2012	11/27/2012	North Fork Edisto downstream of Albermarle, 192 m upstream of E-007a, 33.46389 80.87703	145	46	18	5.40	3	5.0
E-008; 1997	9/2/1997	North Fork Edisto R. @ SR 39	432	51	20	4.89	3.4	5.0
E-008; 2001	8/29/2001	North Fork Edisto R. @ SR 39	403	66	26	5.00	4	5.0
E-012; 1997	9/2/1997	South Fork Edisto R. @ SR 39	434	54	20	5.34	3.4	5.0
E-012; 2001	9/4/2001	South Fork Edisto R. @ SR 39	386	60	20	4.80	3.4	5.0