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South Carolina Department of Health and Environmental Control

Memorandum

Aquatic Biology Section

To: Tom Knight, P.G. Manager
AST, Petroleum Restoration and Site Environmental Investigations

From: James Glover, Ph.D., Manager
Aquatic Biology Section

Subject: An Aquatic Macroinvertebrate Bioassessment of the Pacolet River between Lake Blalock and Interstate I-85 (Spartanbutg County, SC) Technical Report 8A19-11.

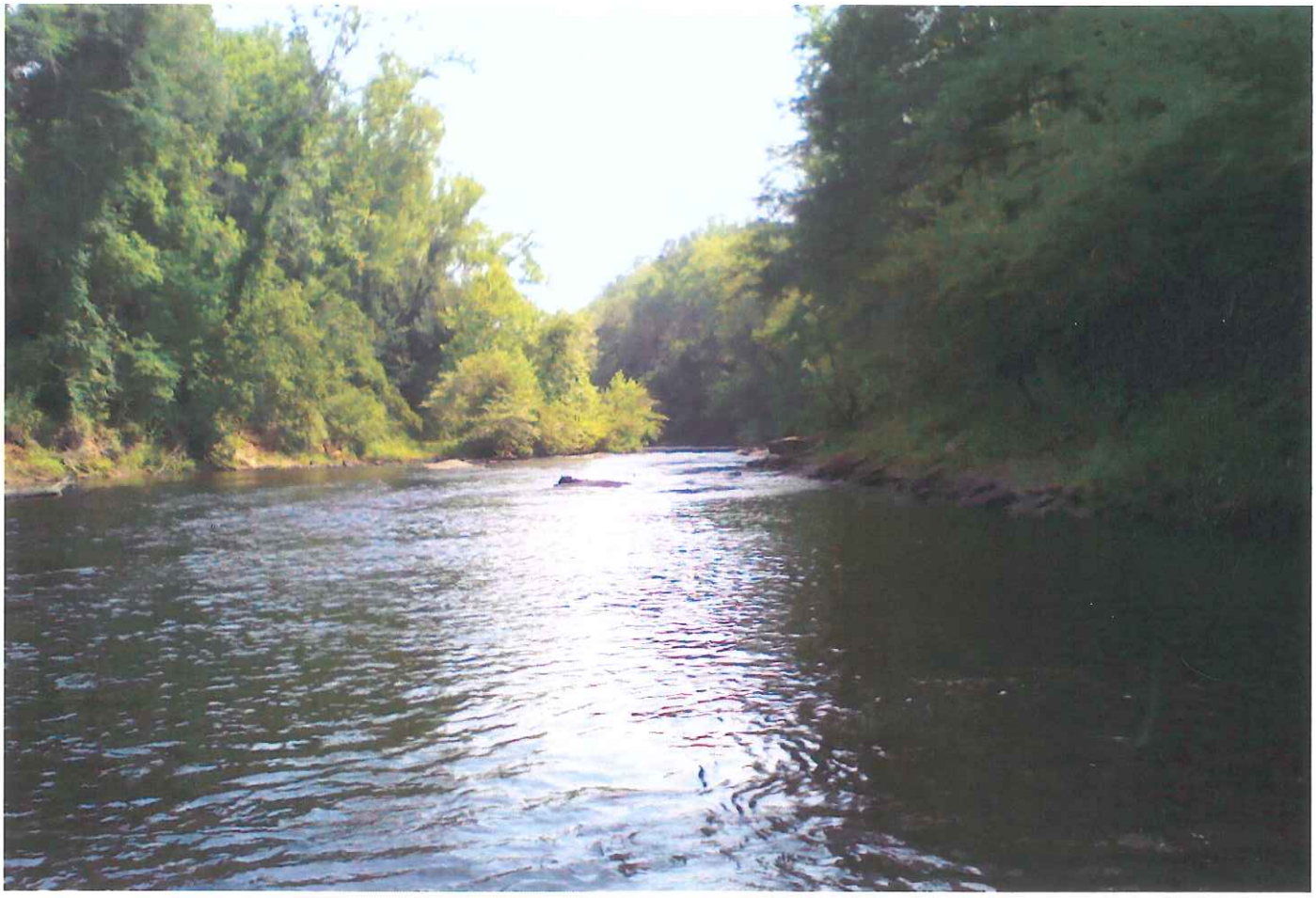
Date: 02 Sept. 2011

The above referenced document has been finalized and is enclosed. Currently, the report is in PDF format and in my custody. The enclosed hard copy was printed from this PDF file. I have not requested multiple copies to be produced by our print shop but can do so if needed. I realize there are many staff that have participated in one way or another on issues related to this facility, but I will leave it up to you or those on the CC to distribute appropriately. In addition to those on this memo a copy will be sent to our FOI office, who received a request for the report shortly after our samples were collected.

Please let me know if you have questions or comments.

CC: Chuck Gorman P.G., Director, Water Monitoring, Assessment and Protection Division
David Baize, Assistant Chief, Bureau of Water
John Litton P.E., Assistant Chief, Bureau of Water
David Wilson P.E., Chief, Bureau of Water
Ken Taylor P.G., Director, Site Assessment Remediation and Revitalization Division
Don Siron P.G., Assistant Chief, Bureau of Land and Waste Management
Fran W. Marshall, J.D., M.S.P.H., State Toxicologist
Susan Turner, Director, EQC Region 2

An Aquatic Macroinvertebrate Bioassessment of the Pacolet River between Lake Blalock and Interstate I-85 (Spartanburg County, SC)



By James B Glover, Ph.D.

Bureau of Water
Aquatic Biology Section

August 2011

2600 Bull Street
Columbia SC 29201

Technical Report Number 8A19-11

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Suggested Citation

Glover, J.B. 2011. *An aquatic macroinvertebrate bioassessment of the Pacolet River between Lake Blalock and Interstate I-85 (Spartanburg County, SC).* The South Carolina Department of Health and Environmental Control. Bureau of Water. Columbia, South Carolina. S.C. DHEC Technical Report Number- 8A19-11

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Summary

On 11 July 2011, the SCDHEC initiated an aquatic macroinvertebrate bioassessment to determine, in part, the ecological condition of the Pacolet River in the vicinity of the former Hoechst AG facility in Spartanburg County, South Carolina. Three collection sites on the Pacolet River were established: one being above the confluence with Cherokee Creek (B-838), one in the river adjacent to the plant but upriver from Auriga Polymers, Inc. National Pollution Discharge Elimination System (NPDES) discharge point (B-839), and one below interstate 85 (B-840). Station B-838 was above all current and former NPDES effluent points to the river and served as a control to which B-839 and B-840 could be compared.

The SCDHEC uses a Bioclassification System to evaluate the condition of aquatic communities in flowing water. Based on the composition of the organisms collected at a particular location a Bioclassification Score can be calculated as follows: 5 (Excellent), 4(Good), 3 (Good/Fair), 2 (Fair) and 1 (Poor). Data from the 2011 Pacolet River study reported here shows:

1. The Bioclassification and Bioclassification Scores at B-839 (Good/Fair 3.0) and B-840 (Good/Fair 2.5) were comparable to the upriver control site of B-838 (Good/Fair; 2.5), suggesting no obvious impact to the rivers macroinvertebrate community from the former Hoechst AG facility or the current Aurega Polymers NPDES discharge.
2. The Bioclassification of Good/Fair was comparable to historic data from the Pacolet River near the Broad River confluence (B-752, Good/Fair, 2.8); the Enoree River at secondary road 75 (BE-018, Good/Fair, 2.73 mean); the Enoree River at SC Hwy 418 (BE-019, Good/Fair, 2.55 mean); and the Reedy River at secondary road 68 (S-778, Good/Fair, 3.0 mean) but lower than the Tyger River at SC Highway 56 (B-318, Good, 3.6 mean) and the South Tyger River at secondary road 86 (B-332, Good, 4.3 mean).
3. While conducting the 2011 investigation an extremely strong, unfamiliar chemical odor was detected in the sediment in a backwater area of the Pacolet River at the confluence of Cherokee Creek. Subsequent analysis at this site indicated the sediment is contaminated with various organic chemical compounds.
4. While not reflected in the bioclassification scores there was a notable near absence of caddisflies in the family Hydropschidae from the site adjacent to the facility (B-839), and these were abundant at the upriver control site (B-838) and present at the site below I-85 (B-840). There are published

reports showing that some organic chemical contaminants and certain metals can produce chronic toxicological effects to Hydropsychid larvae. In the presence of certain compounds the larvae are unable to properly construct their silk filter nets required for their survival.

The results suggest that there are currently no overt acute toxic effects on the aquatic macroinvertebrate community in the Pacolet River from activities on the former Hoechst AG facility. However, based on the findings presented here it is my opinion that further investigations are warranted to determine if aquatic life in the river near the facility has been harmed. Recommendations for additional research are provided at the conclusion of this report.

Introduction

On 11 July 2011 an assessment of the Pacolet River was conducted by staff of the Aquatic Biology Section (ABS) of the South Carolina Department of Health and Environmental Control (SCDHEC) to determine the condition of aquatic life in the section of the river adjacent to property formally owned and operated by Hoechst AG in Spartanburg County, South Carolina.

A macronvertebrate bioassessment was conducted by Mr. Rick Renfrow and myself, SCDHEC ABS, at three locations on the Pacolet River. From a reconnaissance visit on 08 July 2011, we determined that the safest and most practical entry point to the river was from the property now owned by Auriga Polymers, Inc. We met with Mr. Ken Brown, Environmental Engineer, Auriga Polymers, who escorted us to the river from the facilities property. Mr. Renfrow and I determined that three sampling sites should provide insight to the condition of the river above, adjacent to, and below the property formerly occupied by Hoechst AG. The study was conducted at these three stations to determine the overall condition of the aquatic life in the river and to determine if activities, past and/or present, have contributed to any deleterious effects to the aquatic biota of the river.

Aquatic Bioassessments

Aquatic biological assessments, or bioassessments, broadly defined are studies that utilize biological methods for the assessment of water quality (Cairns and Dickson 1973). One example are studies conducted in the laboratory, such as bioassays, that evaluate the toxicity of an effluent or surface water on a test organism. Another bioassessment is one that examines the aquatic life within the waterbody itself, which can help determine the ecological condition of an aquatic ecosystem. By sampling a body of water for fish, algae, zooplankton, plants, bacteria, or aquatic invertebrates insight can be gained about the condition of the water and in certain cases suggest the cause of the impairment. The biological community structure and diversity is often used to assess the ecological health of surface water. Also the abundance of select organisms, such as fecal coliform bacteria, or the levels of certain chemicals in the flesh of organisms, can also provide clues to past perturbations of an aquatic system.

Bioassessments provide many advantages over chemical analysis of surface water some of which are outlined in Barbour et al (1999). Possibly one of the most important advantages is that aquatic organisms are continuously exposed

to surface water and their presence or absence from a river or stream can aid in the assessment of the overall ecological health of the water. In addition some organisms can bioaccumulate certain pollutants that can be concentrated in their flesh and measured by traditional laboratory procedures. Thus aquatic plants and animals serve as valuable sentinels that can provide the researcher information regarding environmental degradation that may have occurred in the past.

For the bioassessment conducted in the Pacolet River on 11 July 2011, aquatic macroinvertebrate communities were examined at three different locations on the river. Aquatic macroinvertebrates are animals without a backbone living on or beneath the surface of water for at least a portion of their lives (SCDHEC 1998). These include crayfish, certain snails, mussels, aquatic worms, and aquatic insects such as mayflies. Some of these animals are very sensitive to physical or chemical harm within a river and will not be found in areas with elevated contaminants or severe hydrologic modification. Alternatively, some species are well equipped to live in rivers that are polluted or where the hydrology is impaired. By taking samples of these animals and comparing their community to reference, or non-impaired, sites an evaluation of the river can be made. Also if there is a suspected point of entry of a contaminant samples can be collected below this point and compared with a river section above the point to determine if any change has occurred.

Watershed Description and Historical Monitoring

The Pacolet River and its tributaries are located in northwestern South Carolina with portions of the watershed occurring in North Carolina (Figure 1). The headwaters originate in the Blue Ridge Mountains and form the North Pacolet and South Pacolet Rivers. These two main stems converge north of the city of Spartanburg, below which the river is referred to as the Pacolet. On its way to the Atlantic Ocean the water of the Pacolet flows in a southeastern direction through the Piedmont of South Carolina until it confluences with the Broad River.

Landuse of this watershed is dominated by forest in the headwaters (Figure 2). As the tributaries course eastward from the mountains to the Piedmont the forests give way to open fields, agriculture, and some urbanization. Towns in the watershed include Tryon in NC and Landrum, Campobella, Chesnee, and Mayo in SC, upriver of I-85. The North Pacolet remains relatively intact. The South Pacolet was impounded in 1925 to form reservoir number 1, again in 1963

to form the Bowen Reservoir, and the Pacolet itself was dammed in 1983 with the poolside portion of the river named Lake Blalock (Figure 3). These reservoirs serve as drinking water supply for the city of Spartanburg and surrounding areas (Spartanburg Water 2011).

The property formerly owned and occupied by Hoechst AG lies on the west shore of the river in Spartanburg County north of the interstate 85 crossing (Figure 4). Two tributaries enter the Pacolet in the vicinity of the plant; Island Creek on the east side of the river and Cherokee Creek on the west bank. For the purposes of this report the Pacolet River Watershed is defined as the drainage area above the I-85 river crossing (Figures 1-5).

The SCDHEC ABS has conducted surface water bioassessments statewide for many decades (Glover et al 2008). Over these years many waterbodies across the state have been assessed using various biological methods along with physical/chemical parameters. For the Pacolet watershed above I-85, macroinvertebrate bioassessments have been conducted at 9 different locations, fish tissue have been analyzed at 2 locations (in Lakes Bowen and Blalock), while surface water chemistry and physical measures have been monitored at 11 different sites (Figure 4). The North Carolina Department of Environment and Natural Resources (NCDENR) has also conducted macroinvertebrate bioassessments at three locations on the portion of the North Pacolet in their state (NCDENR 2011).

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 devises 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 coble 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 evaluation 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, that 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.

For the Pacolet River study described here 3 locations on the river in the vicinity of the former Hoechst AG facility were selected for sampling (Figure 4 and Figures 6 - 8). Station B-838 was located above the confluence of Cherokee Creek and the Pacolet River and served as a control. Station B-839 was located below Cherokee Creek but above the current discharge point of Auriga Polymers NPDES discharge. The river here was directly adjacent to the facility property. Station B-840 was located below the I-85 bridge and was downriver of the former

Hoechst AG property and all current NPDES discharge points. Below is a description of each site at the time of sampling:

Station: B-838 (Figure 6)

Latitiude: 35.0399387
Longitude: –81.8482868
Name: Pacolet River approximately 100 meters above the confluence with Cherokee Creek. Spartanburg County SC, USA.
Description: Aesthetically the river at this location is more reminiscent of a remote waterway than one so near the urban center of Spartanburg. Graffiti on the boulders and the occasional piece of trash however indicated the river is in close proximity to development. And the highly eroded banks extending upwards in places for many meters betrayed the deforestation and agricultural activities that occurred in the piedmont of centuries past. This also served as a reminder of the oft-quoted passage of H.B.N. Hynes (1975) that "in every aspect, the valley rules the stream." Nevertheless the description by Simms (1844) over 150 years ago could still be applied today, at least to this section of the river: "Several beautiful cascades occur in these rivers. Those of the Pacolet are particularly so." Upriver toward the Blalock dam it appears from aerial photos that several of these cascades are present, interrupted by long stretches of runs containing occasional deep pools along the river margin.

Station: B-839 (Figure 7)

Latitude: 35.035138297
Longitude: –81.849517606
Name: Pacolet River approximately 50 to 100 meters upstream of Auriga Polymers NPDES Discharge number 2. Spartanburg County SC, USA.
Description: The Pacolet River at this location consisted of a long run with water rolling over the numerous boulders and cobble. The cascades, near B-838, were absent at B-839 and the large pools at B-838 were not as abundant at B-839. Other aspects however, including the eroded yet heavily vegetated banks, were similar to the control site. The water was clear and had no unusual foam or smells at the time of sampling.

Station: B-840 (Figure 8)

Latitude: 35.032344984
Longitude: –81.849872811
Name: Pacolet River immediately downriver of Interstate 85 bridge crossing, Spartanburg County, SC, USA.
Description: The gradient of the Pacolet River was less here than the other two locations but the river was similar in many other aspects as the two locations upriver. The banks were more highly eroded and extremely large sandbars were

present along the east shore. But still, riparian vegetation was heavy on both shores except where the interstate crossed the river.

Results and Discussion

Historical Data

Historical data indicates that the North Pacolet and South Pacolet rivers and their tributaries are healthy streams with a balanced and diverse community of aquatic organisms. Most of the streams in the SC portion of the watershed received bioclassifications of good or excellent when sampled. Similarly the portion of the North Pacolet in North Carolina was generally classified as having a good or excellent bioclassification by NCDENR (2008). The portion of the watershed above I-85 remains relatively undeveloped, lacking large urban centers such as Spartanburg or Greenville. While some agriculture and deforestation has occurred most of the open lands are fields rather than row crops. Above Lake Bowen most of the waterways remain free flowing without major hydrological modifications. A single bioassessment sampling event occurred in the 1990s on the Pacolet River near where it empties into the Broad River (Figure 5). The assessment was Good/Fair (score= 2.8). The watershed above this site is much more urbanized, receiving water from the city of Spartanburg and surrounding areas. In addition to the Pacolet other large tributaries of the Broad River are the Tyger and the Enoree. Historic Bioassessment results are shown in Figure 9 along with those of the Reedy River as points of comparison. In general, similar stressors exist for these moderately-sized Piedmont rivers, which are reflected in the bioclassification of Good/Fair. The Tyger and South Tyger are an exception, both receiving bioclassifcations of Good.

Results of fish tissue analysis for Lake Bowen and Lake Blalok revealed fish without significant levels of contaminants in their flesh and currently SCDHEC has no consumption advisories for these lentic systems. For the contaminant mercury this is thought to be related to piedmont rivers lacking the methylation efficiency of the low-country, black water streams, which scientists now understand fairly well (Glover et al. 2010, Glover and Altman 2010). The data set is limited to Lake Bowen for organic compounds. Most organic compounds from fish tissue analyzed from this reservoir from 1995 to 1999 were below the analytical detection limits or below any human health screening value.

The macroinvertebrate bioassessment results are presented in Figure 9 and Appendix A. The aquatic macroinvertebrate communities at B-839 and B-840 were similar to B-838, the upriver control, with a bioclassification of Good/Fair at all three sites. This suggests that the former Hoechst AG property or the current Auriga Polymers Inc NPDES discharge are having little to no obvious impact on the macroinvertebrate community of the Pacolet River. Station B-839 had a slightly lower EPT Index than the upriver control and the overall abundance of organisms were noticeably depressed but this could have been due to natural variability. That the Pacolet River received a Good/Fair rating rather than a Good or Excellent that was found in the upper watershed was not unexpected, because of the two large dams that occur in the rivers. Scientist have known for some time that the damming of rivers can have deleterious effects on aquatic communities downriver of the reservoir (see Poff et al. 1997) and that appears to be the case here.

While it is not reflected in the bioclassification scores one aspect of the results that warrants further investigation is the near absence of caddiflies in the family Hydropsyidae at B-839. Hydropsychids were abundant at the control site but only a single small specimen was recovered from B-839. Species within this family are common and their near absence from B-839 was a peculiarity that we noted even while on site. A preliminary literature review indicated that various organic contaminants may result in the inability of hydropsychids to properly construct their capture nets, which are essential for these filter feeders survival (Tessier et al. 2000a, Tessier et al. 2000b, Tessier et al. 2000c).

Another observation we made was the detection of an extremely pungent odor at the mouth of Cherokee Creek in the sediments. Locating the river and the intended sampling site required us to park our vehicles on a dirt road on Auriga Polymers property and navigate through a wooded area until the river was located. This point was near the confluence of Island Creek, which was on the opposite shore of the Pacolet River. We walked upriver along the bank where we noticed the confluence of Cherokee Creek near a small island in the Pacolet River. We waded upriver along the west shore of the river to get around the island and above the confluence of Cherokee Creek. This portion of the river was a backwater area on the west side of the Island with slack water and deep sediment. It was here that, when the sediment was disturbed by our wading, the odor was detected. After sampling B-838, and as we returned to the vehicle, we investigated further and entered Cherokee Creek. Cherokee Creek at this point

widened where it joins the Pacolet. A cursory sample for macroinvertebrates was taken from the undercut banks and as we further disturbed the sediment the unfamiliar odor became extremely pungent. These findings were reported to other DHEC staff and sediment samples were collected in this area of the river and other parts of Cherokee Creek on 15 July 2011. These data will be reported in a separate document but initial results show the detection of various organic chemicals known to have been used by the Hoechst AG facility.

Conclusions and Recommendations

The results of the 11 July 2011 bioassessment indicated that the Pacolet River in the vicinity of the former Hoechst AG property and I-85 crossing contains a Good/Fair aquatic macroinvertebrate community. This is comparable to other similar sized Piedmont rivers. The bioclassification scores at the river adjacent to the plant and downriver of I-85 were comparable to the upriver control, suggesting no acute toxic effect from activities near the facilities property. However, the near complete absence of Hydropsychid caddisflies from the river adjacent to the plant, combined with the discovery of contaminated sediment in the river suggests that further studies are needed. Below are potential investigations that should be considered:

1. Additional macroinvertebrate community bioassessments

Further bioassessments should be conducted to determine if the paucity of the hydropsychids at B-839 was a result of natural or anthropogenic causes. Additional sample locations should be established including one between Cherokee Creek and Island Creek. Quantitative collections of hydropsychid larvae along a transect should also be considered.

2. Investigation of hydropsychid capture nets above and below the confluence of Cherokee Creek.

The work of Tessier et al. (2000a, 2000b, 2000c) suggests that chronic toxicological effects can be detected by studying hydropsychid capture nets. They conducted their work in a laboratory but *in-situ* studies could theoretically detect anomalies if any exist. Their work could be replicated *in-vetro* using Pacolet hydropsychids returned to the laboratory and/or *in-situ* by collecting river organisms and examining their capture nets. Protocols would need to be established if this work were to occur.

3. Tissue analysis of *Corbicula fluminea.*

The Asiatic Clam, *Corbicula fluminea* is abundant in the Pacolet River. Because these organisms are in constant contact with the water and sediment, are filter feeders, and relatively sessile they can serve as an excellent indicator of bioaccumulation (Sherman et al. 2009). Samples taken above and below the confluence of Cherokee Creek as well as in Cherokee Creek should help determine if and what kinds of contaminants are bioacumulating in aquatic biota.

4. Fish Tissue Analysis

Tissue analysis of fish above and below the confluence with Cherokee Creek should be considered. This should provide insight into the bioaccumulation of contaminants to organisms in higher trophic guilds. Because humans consume fish this assemblage would be relevant to both ecological and human health concerns.

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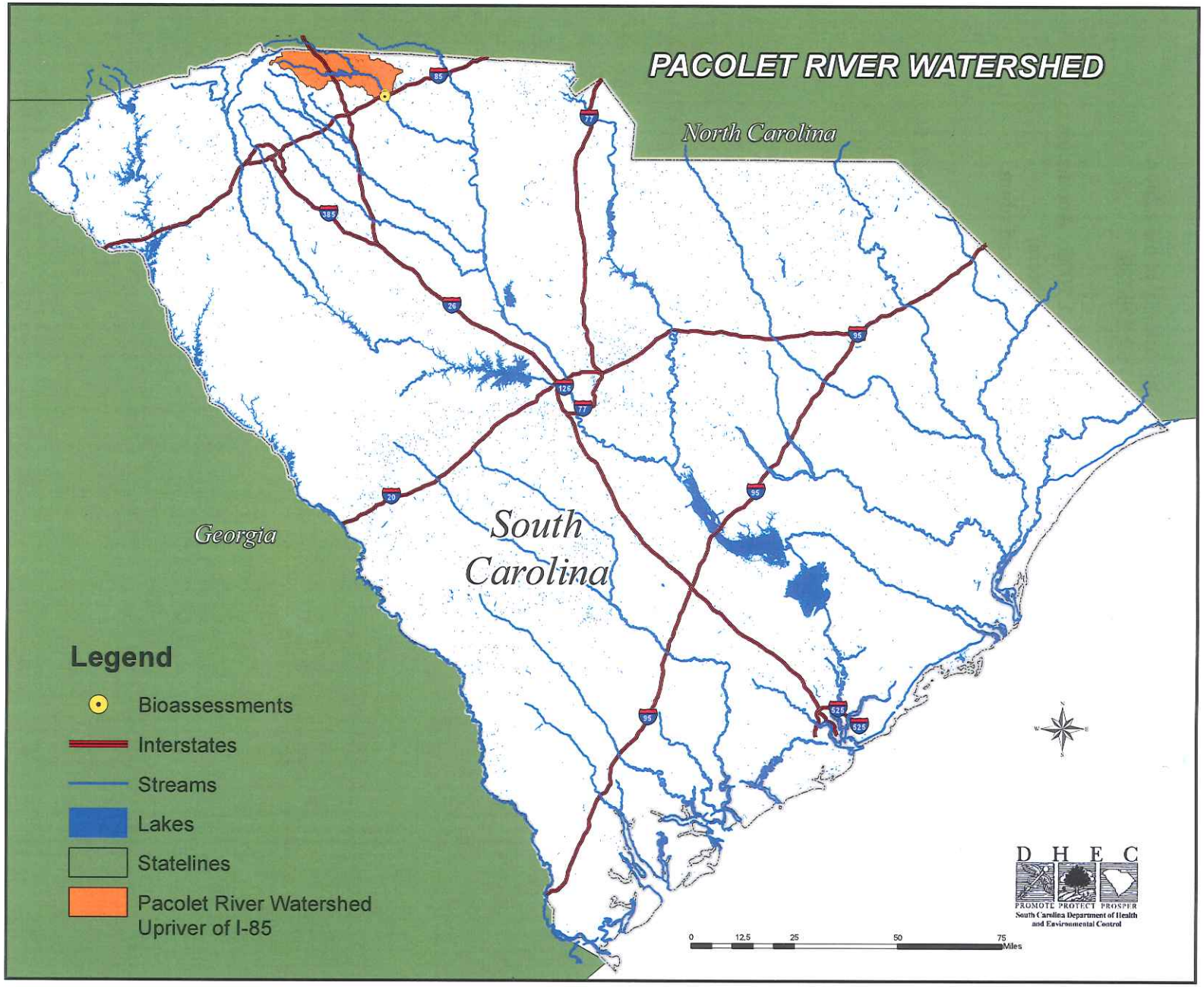


Figure 1. The Pacolet River Watershed above I-85 in South Carolina and North Carolina.

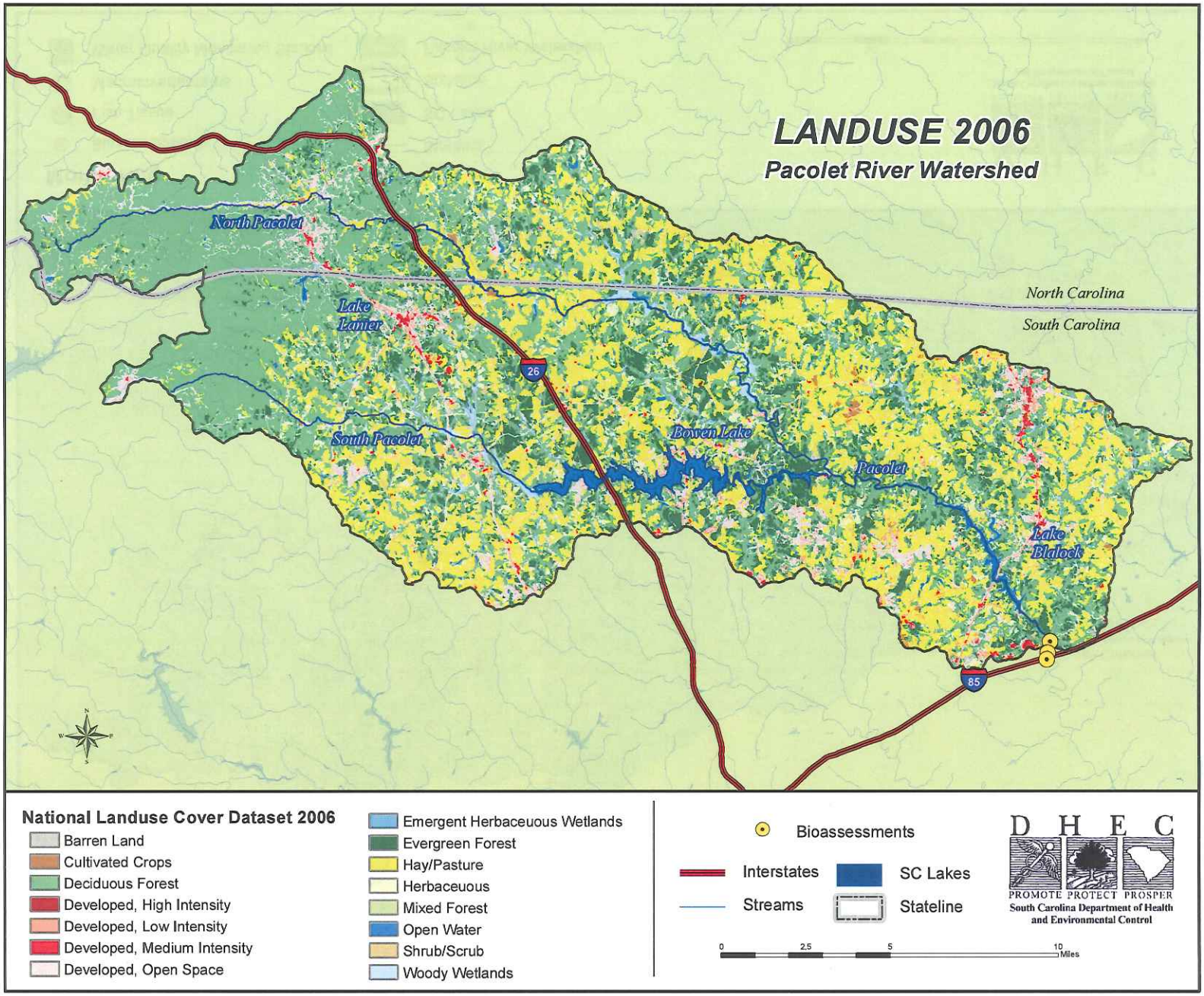


Figure 2. Landuse in the Pacolet River Watershed above I-85 in South Carolina and North Carolina.

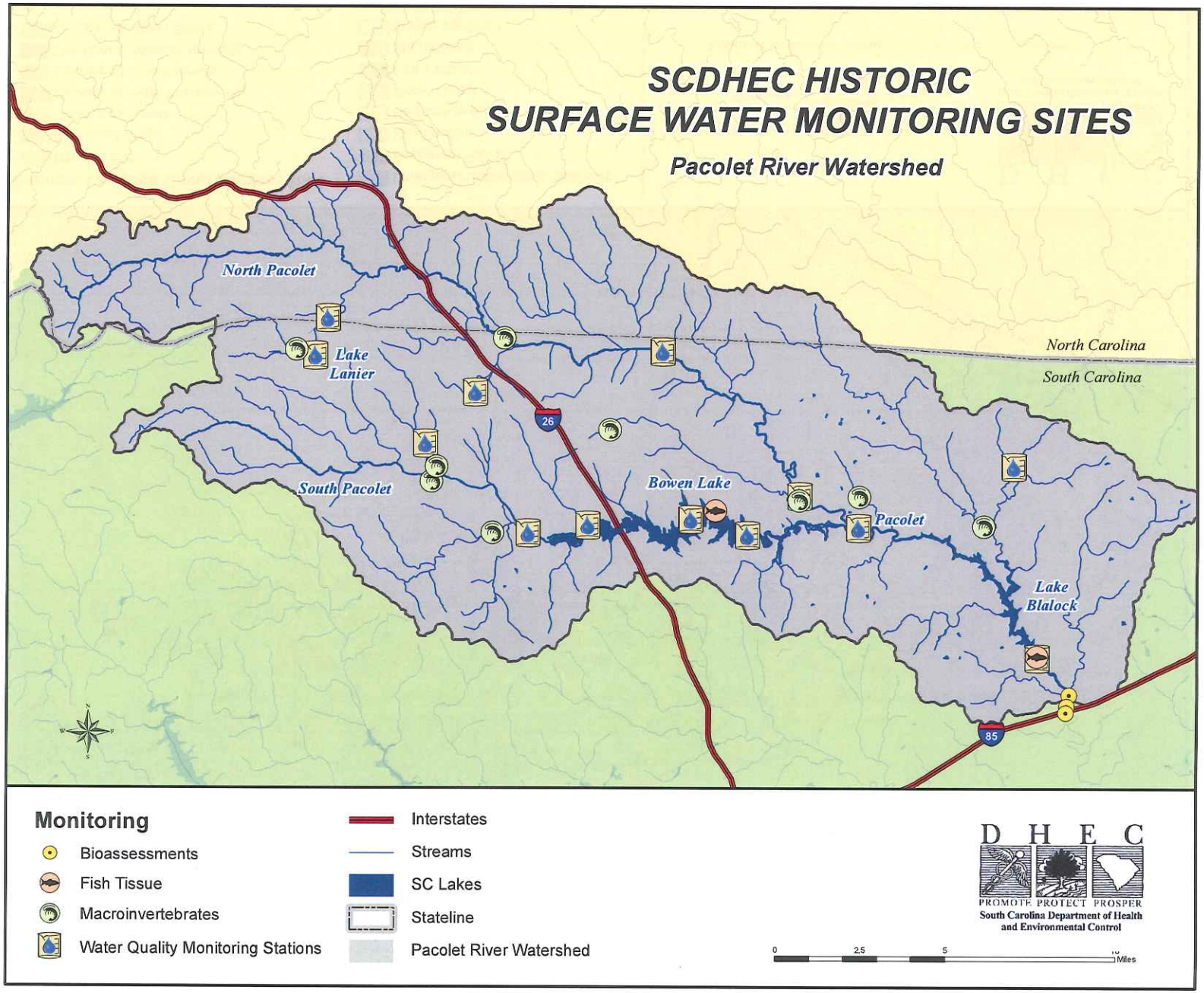


Figure 3. SCDHEC historic monitoring locations in the Pacolet River watershed above I-85.

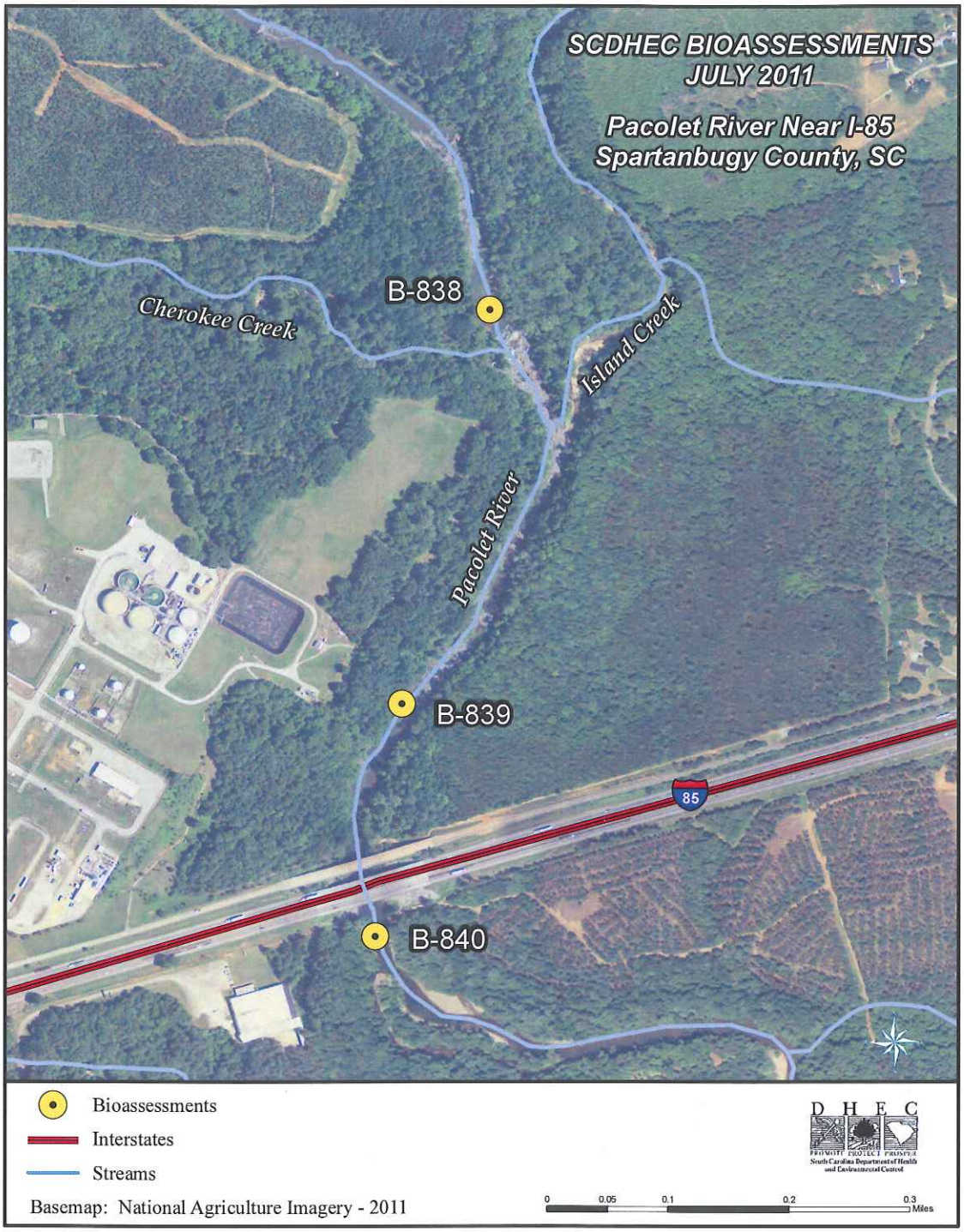


Figure 4. Pacolet River showing July 2011 SCDHEC Bioassessment locations.

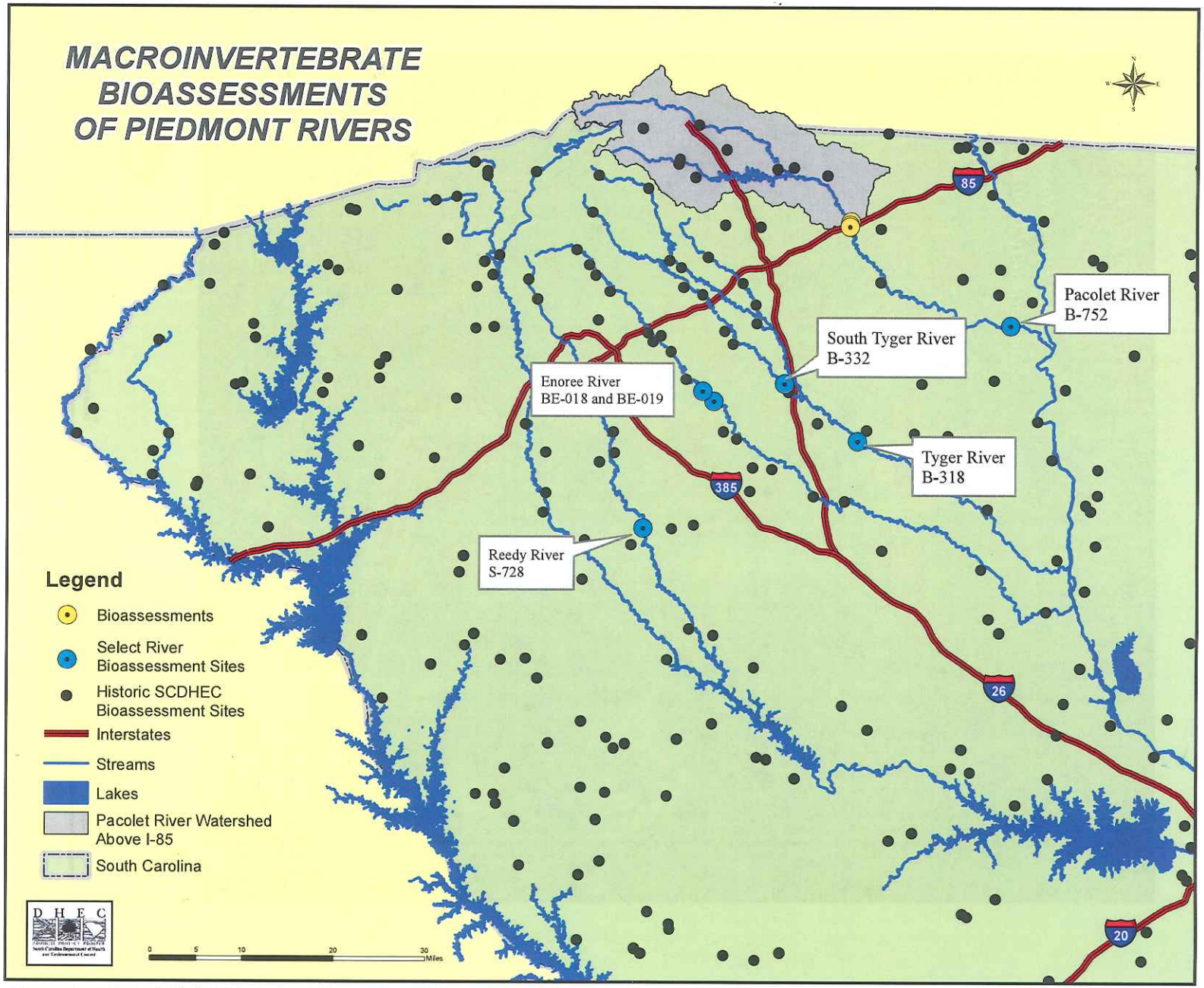


Figure 5. Historic SCDHEC macroinvertebrete bioassessment locations in South Carolina.

A

B

C

D

Figure 6. Pacolet River near station B-838; A. Looking at shoals while standing at mouth of Cherokee Creek, B. Mouth of Cherokee Creek at the confluence with the Pacolet where pungent sediment odor was detected, C. B-838 in the Pacolet looking upriver, D. B-838 in the Pacolet looking down river

A

B

C

D

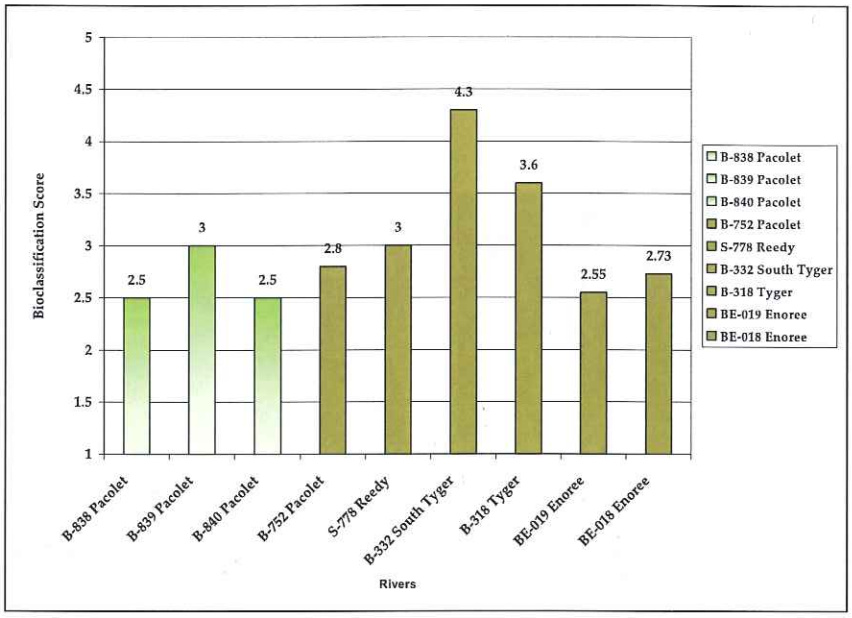
Figure 7. Pacolet River at B-839. A. Rock and coble substrate in river; B Banks of river showing erosion; C. Banks eroded but heavily vegetated; D. Looking downriver.

A

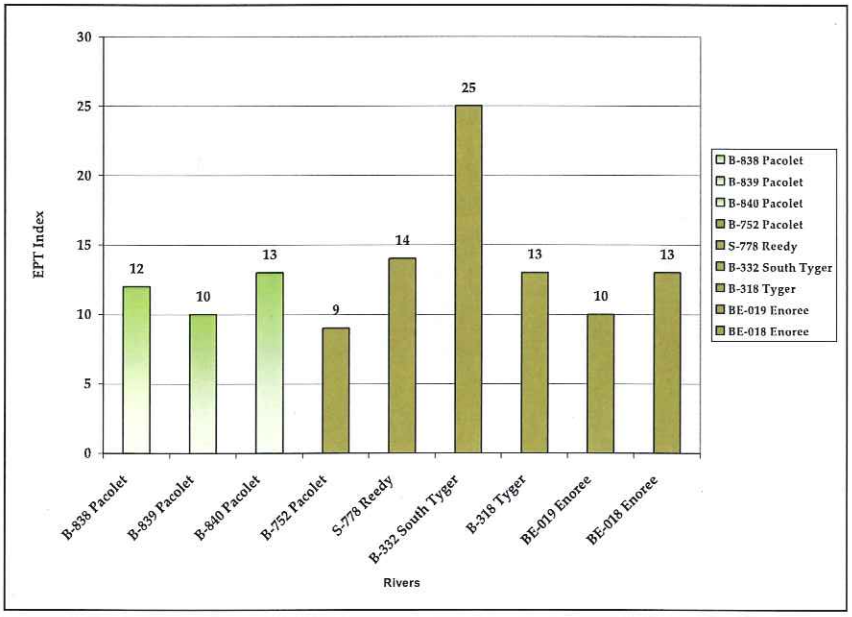
B

C

Figure 8. Pacolet River at B-840. A. Looking downriver showing high, eroded banks; B. Looking upriver toward I-85 crossing; C. Another downriver photo showing large sediment bar on opposite shore.



A



B

Figure 9. Bar charts comparing 2011 Pacolet River results with historic data from other piedmont rivers. A. Bioassessment Scores; B. EPT Index.

Appendix A. Aquatic macroinvertebrates collected on 11 July 2011 from the Pacolet River near I-85. TV= Tolerance Values.

PHYLUM	CLASS	ORDER	FAMILY	TAXA	TV	B-838	B-839	B-840
Annelida	Hirudinea	Rhynchobdellida	Hirudinidae	Hirudinidae	5			1
	Oligochaeta	NA	NA	Oligochaeta	0	2	12	3
Arthropoda	Crustacea	Decapoda	Cambaridae	Cambaridae	7.5			4
	Hexapoda	Coleoptera	Elmidae	*Dubiraphia sp.*	5.93	5		
				Macronychus glabratus	4.58		1	
				Stenelmis sp.	5.1			1
			Gyrinidae	*Dineutus sp.*	5.54		2	7
				Gyrinus sp.	6.17			1
			Haliplidae	*Peltodytes sexmaculatus*	0			1
			Hydrophilidae	Hydrophilidae	0			1
		Diptera	Chironomidae	*Ablabesmyia sp.*	7.2			1
				Cladopelma sp.	4.09	1		
				Cricotopus bicinctus	8.5	2	1	3
				Cricotopus/Orthocladius	0		2	3
				Dicrotendipes sp.	8.1	6	1	1
				Orthocladiinae	0		2	
				Procladius sp.	9.1		1	1
				Rheotanytarsus sp.	5.89	1	7	1
				Stenochironomus sp.	6.45			1
				Tanytarsus sp.	6.76	1		
			Culicidae	*Anopheles sp.*	8.58			1
			Empididae	Empididae	7.57			1
			Simuliidae	*Simulium sp.*	0	2	4	4
			Tipulidae	*Tipula sp.*	7.33		1	
		Ephemeroptera	Baetidae	Baetidae	0	1	2	
				Baetis intercalaris	4.99	2	3	6
				Baetis pluto	4.28	1	5	3
				Heterocloeon sp.	3.48	6	11	1
				Plauditus sp.	5.4	8	13	5
				Pseudocloeon propinquum	5.8		3	11
			Ephemeridae	*Hexagenia sp.*	4.9		1	

Appendix A. Aquatic macroinvertebrates collected on 11 July 2011 from the Pacolet River near I-85. TV= Tolerance Values.

PHYLUM	CLASS	ORDER	FAMILY	TAXA	TV	B-838	B-839	B-840
			Heptageniidae	*Maccaffertium modestum*	5.5			3
				Maccaffertium sp.	0			1
			Isonychiadea	*Isonychia sp.*	3.45	2		6
		Megaloptera	Corydalidae	*Corydalus cornutus*	5.16	2	3	1
			Sialidae	*Sialis sp.*	7.17			1
		Odonata	Aeshnidae	*Basiaeschna janata*	7.35	1	1	6
			Coenagrionidae	*Argia sp.*	8.17	4	5	7
				Ischnura/Anomalagrion	0			1
			Corduliidae	*Tetragoneuria sp.*	8.57	2		
			Gomphidae	*Arigomphus sp.*	5.8			2
				Hagenius brevistylus	3.99			3
			Macromiidae	*Macromia sp.*	6.16	1	1	5
		Trichoptera	Hydropsychidae	*Cheumatopsyche sp.*	6.22	10		8
				Hydropsyche betteni	7.78	25		21
				Hydropsyche sp.	0		1	4
				Hydropsyche venularis	4.96	4		10
			Hydroptilidae	*Hydroptila sp.*	6.22	2	4	1
				Hydroptilidae	0	1	6	
			Leptoceridae	*Oecetis sp.*	4.7	1		
				Triaenodes ignitus	4.58	11	2	5
				Triaenodes sp.	4.46	8	1	7
			Philopotamidae	*Chimarra aterrima* group	2.76			1
			Polycentropodidae	*Polycentropus/Cernotina*	3.53	1	1	
Mollusca	Gastropoda	Basommatophora	Ancylidae	*Ferrissia sp.*	6.55			1
			Physidae	*Physella sp.*	8.84	3	2	22
			Planorbidae	Planorbidae	0			1
	Pelecypoda	Heterodonta	Corbiculidae	*Corbicula fluminea*	6.12	10	17	3
			Sphaeriidae	Sphaeriidae	0	4		3