Gulf Coast Watersheds and Water Education: Outreach Alignment and Best Practices

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Previous research (Fulford, Brzuszek, & Roberts, 2008) assessed the impact of ordinances, outreach, and enforcement on the resiliency of the northern Gulf Coastal watersheds. Four watersheds in Louisiana, Mississippi, Alabama, and Florida were selected, and 22 non-governmental organizations (NGOs) in the target watersheds were surveyed with regards to water quality monitoring, environmental education, and watershed management. Detrended Correspondence Analysis (DCA) revealed that the most relevant programs for each watershed varied. Whereas Tchefuncte/Bogue Falaya's NGOs (LA) tended towards a management plan, the Biloxi River Watershed (MS) focused upon conservation easements and managing land restoration. The Fish River Watershed (AL) exhibited more centralized efforts with a tendency toward conservation, partnerships, and policy. The New River Watershed (FL) was strongest toward development review and education. Our current research extended the results of this initial study to investigate how the focus of each watershed reflected or paralleled its state's educational goals, benchmarks, and grade level expectations. The educational programs were also analyzed for correspondence to the National Science Education Standards. We included those educational outreach programs aimed toward K-12 students, and analyzed the NGOs' educational products for alignment with state curricula and national science standards. Additional investigation of other watersheds' educational programs (e.g., Chesapeake Bay) provided benchmarks against which the northern Gulf Coast watershed programs were compared. Our research resulted in the identification and development of best practices for the implementation of effective Water Education programs that include ecology, water management, and water quality focus.

Key words: Conservation, Ecology, Education, Water Quality

Introduction

Water education is important for all citizens, including school-age children who will undoubtedly interact with surface water, groundwater, pollution, and water conservation within their lifetimes. For citizens of Mississippi, water education topics also intertwine with the agriculture, aquaculture, and industry of the state. How well is water education represented in our state, in our neighboring Gulf Coast states, and across our nation? Are our 5th-grade students, 7th-grade students, or even 11th-grade students well informed so that, upon reaching adulthood, they can actively participate within their communities and make sustainable decisions with respect to pollution, storm water run-off, and groundwater extraction?

This research began as a collaborative effort between a landscape architect and a geoscience educator, who sought to determine the quality of water education in the Gulf Coast states of Mississippi, Louisiana, Alabama, and Florida. Our investigation probed the curricula in public schools that directly addressed water education, and the alignment of water education curricula with the National

Science Education Standards. Gulf Coast states' curricula and water education programs were compared also with benchmark programs in other states, including the Chesapeake Bay Foundation. A resultant model for best practices and effective water education within the public school system was developed.

NGOs and Gulf Coast Watersheds: Relevant Programs

Previous research on effective water quality programs underscores the role of non-governmental organizations (NGOs) in successful regional watershed programs (Wiley & Canty, 2003; Koehler, 2001). Beyond the US, NGOs also assume a role toward sustainable development and environmental education (Tilbury et al, 2003), and are viewed by some researchers as the organizations that may best counter the destructive features of modern society (Haigh, 2006). NGOs have been cited as "highly significant factors" in regional resolution of environmental problems (Hirono, 2007), and have become increasingly important within developing countries (Nomura et al, 2003).

Brzuszek et al (2009) investigated the role of NGOs within Gulf Coast watersheds. In Mississippi, Louisiana, Alabama, and Florida, four watersheds were identified (Figure 1), and 22 non-profit groups were surveyed. Five groups were surveyed in each state except Mississippi, which contributed seven NGO groups to the survey. Detrended Correspondence Analysis of the survey participants' responses, using CANOCO 4.55 software, revealed that NGOs' efforts varied across the Gulf Coast region.

Although the sample was not large enough to be conclusive, the researchers noted that relevant associations emerged for each watershed. While the New River Watershed (FL) focused on development review and education, the Fish River Watershed (AL) was more centered, with a tendency toward conservation, partnerships, and policy (Brzuszek et al, 2009). The Florida watershed included Apalachicola National Forest and Tates Hell State Forest, while the Alabama watershed includes a large national estuarine preserve. However, the Mississippi and Louisiana watersheds are primarily in private ownership. Therefore, differences emerged in the areas of concentration of the NGOs of these states. Biloxi River Watershed (MS) NGOs focused on managing land, restoration, and conservation easements, while the Tchfuncte/Bogue Falaya watershed (LA) efforts tended towards a management plan. Although the work of the NGOs is important in public education and sustainable development, several recommendations made by the Center for Watershed Protection (2006) in the Smart Watershed Benchmarking Tool were not employed or implemented by the Gulf Coast watershed NGOs. Importantly, one recommendation went unfulfilled: NGOs did not partner with schools to build watershed education into the curriculum.

Science Reform and the National Science Education Standards

How important is a science curriculum when educating our future citizens about the importance of water conservation and preservation? The American Association for the Advancement of Science (AAAS) initiated Project 2061 in 1985, when Halley's Comet last passed near Earth. The AAAS (1989) identified a core set of knowledge for science, mathematics, and technology that our next generation will need for scientific literacy upon Halley's return. The resultant Benchmarks for Science Literacy (AAAS, 1993) identified the science curriculum needed for all future Americans at the conclusion of grades 2, 5, 8, and 12.

The National Science Education Standards (NSES) grew from the AAAS' Science for All Americans and the Benchmarks for Science Literacy (National Committee on Science Education Standards and Assessment, 1996). Based on the learning theory of constructivism, the science education standards promote building scientific literacy on pre-existing knowledge, and rally against teaching isolated, memorized facts. Eight categories of science content standards were identified and developed, and include 1) Unifying concepts and processes in science, 2) Science as inquiry, 3) Physical science, 4) Life science, 5) Earth and space science, 6) Science and technology, 7) Science in personal and social perspectives, and 8) History and nature of science. These National Science Education Standards guide the science education for all students enrolled in US public schools. Whether water education enters the classroom in US schools is partially determined by how well any water education program aligns with these standards. Shepardson et al (2007) successfully illustrated how watershed study can be aligned with the NSES.

An examination of the content categories of the NSES revealed that there were several portals through which water education can be incorporated in US public schools. At all grade levels (categories K-4, 5-8, and 9-12), the Unifying Concepts and Processes category addresses systems, order, and organization into which the hydrologic cycle and subsequent study can be implemented. The Science as Inquiry category, by promoting "skills necessary for our students to become independent inquirers about the natural world" can also be a portal for teachers to incorporate water education in their classrooms. Both biological and geological sciences (Life and Earth and Space science categories) address some form of water education at various grade levels. In Life Science, early grades (K-4) study organisms and the environment, middle grades (5-8) investigate populations and ecosystems, while high school students (9-12) focus upon matter, energy, and organization in living systems. In the Earth and Space Science category, the youngest students (K-4) learn about the properties of earth materials, while the oldest students (9-12) focus upon geochemical cycles.

Not surprisingly, the best-fit category for water education within the NSES appears to be Science in Personal and Social Perspectives. Within this category, water education is a natural fit in the science curriculum at *all* grade levels: K-4 classrooms study types of resources and changes in environments; 5-8th graders study populations, resources, and environments, and 9-12th graders investigate natural resources and environmental quality.

State Educational Competencies and Learning Expectations

Although the NSES provides the overriding science education content standards for the US public school system, the No Child Left Behind (NCLB) Act of 2001 required each US state to develop content standards. NCLB addresses accountability, teacher quality, and public reporting, with the directive that each state develop and establish a state-wide accountability system. While Reading/Language Arts and Mathematics were the first disciplines identified with NCLB, a newer law mandated "challenging science content standards by 2005-06." While the National Science Education Standards still provided the overriding guidelines, each US state developed individual science content standards, and was accountable for each student achieving at the proficiency level.

Therefore, we researched and examined each Gulf Coast state's curriculum, searching for classroom opportunities through which water education could be addressed in Louisiana, Mississippi, Alabama, and Florida. Were the efforts of the 22 NGOs surveyed in the original Gulf Coast watershed research (Brzuszek et al, 2009) finding a statewide classroom portal for dissemination of water education? The state curricula were retrieved online, and searched for any reference to water education. Through initial research, we discovered grades K-4 addressed only basic water concepts, and therefore we focused primarily on grades 5-8 and 9-12. Our search terms included aquatic organisms, aquifers, coastal loss, flooding, groundwater, infiltration, pollution, quality of water, run-off, soil erosion, Surf Your Watershed (EPA, 2009), urban development, total maximum daily loads (TMDLs), and any state-specific water feature we thought—and hoped—might be addressed in the public school classroom.

Louisiana Grade Level Expectations

Of the four Gulf Coast states reviewed in this research, Louisiana rated an "adequate" science curriculum approach to water education. Several topics were addressed at the middle and high school levels, including aquifers, coastal loss, flooding, groundwater, pollution, water quality, and soil erosion (Table 1). Aquifers, groundwater, pollution, and soil erosion were covered in grades 5, 6, 7, and 8 for a reinforced curriculum on these topics, in the spirit of the constructivist learning theory which suggests building upon existing knowledge. Groundwater was also addressed in the biology core curriculum as well. Although Louisiana's benchmarks in grades 9-12 cover most of the water education information, there is also a disclaimer: "Warning: Benchmarks 9-12 need to be addressed if Earth Science is not offered at the high school level" (Louisiana Department of Education, 2008). Earth Science is not a required science in Louisiana schools.

Alabama Science Standards

Alabama's science curriculum standards focus upon only four of the water education topics we searched, although a few state-specific topics peripherally addressed water (Alabama Department of Education, 2006). In particular, Alabama content standards included coastal loss, flooding, groundwater, and water quality (Table 2). A curriculum search failed to reveal that any topics were covered at more than one grade level, so it appears that topics are introduced, but not re-addressed. Alabama incorporated the hydrosphere as part of the science curriculum in grade 6, included in Alabama's Content 5. Another Alabama-specific topic was "weather phenomena", addressed in grade 3 as part of Content Standard 12.

Florida Sunshine State Standards

Florida science content standards incorporate water education in the public schools using at least six content topics, including flooding, groundwater, pollution, water quality, soil erosion, and aquatic organisms (Table 3). Additionally, the topics of water quality and soil erosion are introduced and reinforced in more than one grade level. However, there is a 3-grade gap between the soil erosion content that is addressed in grades 4 and 7, and a 2-grade level gap between water quality content that is implemented in grades 7 and 9. Florida, like Alabama, also includes state-specific content on the water cycle at grade 5, and again at grade 6 (Florida Department of Education, 2005).

Mississippi Science Competencies and Suggested Teaching Objectives

How does Mississippi fare with water education in the school science curriculum? At first perusal, there appear to be nine topics that are introduced in Mississippi public schools from grade 4 through grade 12 (Table 4).

Additionally, state-specific topics in Mississippi include using maps to identify local watersheds and run-off patterns in grade 4 (Competency 5b, Mississippi Department of Education, 2001). Also in grade 4, conservation of water resources is included in the science curriculum (Competency 7b). Another Mississippi-specific topic is included in Aquatic Science: Competency 7c relates the contribution of aquatic technology to industry and government. Although Mississippi does not have a reinforced water education curriculum—topics that are addressed within one grade level are not reinforced in another grade level—the inclusion of many water education topics is encouraging at first appearance.

Unfortunately, Aquatic Science, Environmental Science, and Spatial Information Science are courses that are not required for students. Additionally, these courses are not offered in every public school district in the state of Mississippi. Although some water education topics are addressed with suggested objectives, the objectives are not required to be taught in Mississippi public schools. While competencies are required, objectives are only alternatives available to a teacher if 1) s/he has time within the curriculum to implement them, and 2) s/he is interested in implementing these specific objectives.

Therefore, in order to gain a more realistic view of water education in the state of Mississippi, we omit those topics that are not required as part of a competency, or topics that are only included as competencies in non-required science elective courses that are not taught in every school district in the state. Table 5 is the disappointing result.

The Gulf Coast and Benchmark Water Education Programs

Our review of the Gulf Coast states' science curricula revealed that, in the required science standards addressing water education content, Louisiana's curriculum is better than most. Not only are several water education topics addressed (7, when compared with 4 topics in Alabama, 5 in Florida, and only 1 topic required in Mississippi's science curriculum), but Louisiana's design has overlapping content in three topic areas for reinforcement of science content at different grade levels. However, even in Louisiana, several topics in water education are not addressed, and not all water content is reinforced through the grade levels.

We can conclude that the work of NGOs to promote healthy watersheds and environmental awareness is not affecting statewide changes in these Gulf Coast states. Although NGOs may make an impact locally with educational programs, this impact is in isolated areas, and is not being translated into a required state curriculum. Only with required grade level expectations, competencies, or state standards can we ensure that water education is being implemented in our public school systems. The requirements of No Child Left Behind leave public school teachers with few opportunities for scheduling alternative curriculum content and activities.

An idealized model for water education feedback (Figure 2) would involve the local watershed, communication of best practices and environmental awareness by the NGOs, implementation of water education into the public school classrooms, and educated students—our future citizens—who are aware of best water practices for their communities. What appears to be occurring, however, is lack of communication between the NGOs and the state educational systems, or a lack of translation between the effects of the NGOs and implementation of water education into required science content standards. We turned our investigation to the other states' curricula, and water education programs with national recognition.

Chesapeake Bay Foundation

The Chesapeake Bay Foundation is recognized as one of the premier partnerships with water education as a goal. Established in 1998, the foundation includes formalized educational partnerships between Maryland, Pennsylvania, Virginia, Delaware, New York, West Virginia, Washington, D.C., and the US Environmental Protection Agency (EPA). An increase in K-12 watershed education programs that support watershed restoration protection efforts in each state is one of the foundation's main goals. Other goals include the creation of interagency education groups within each jurisdiction and a biennial education summit for non-profit and higher education institutions to share and develop formal assessment standards. The Chesapeake Bay Program partners, the National Park Service (NPS) and the National Oceanic and Atmospheric Administration (NOAA) develop strategies for both formal and informal education across the Chesapeake Bay watershed.

For K-12 students, the Chesapeake Bay Program partners provide curriculum-based environmental education programs throughout the watershed for traditional and field excursions (Chesapeake Bay Program, 2009). This is a three-pronged effort that 1) provides technical and financial assistance; 2) ensures that schools utilize the available expertise and resources for Meaningful Watershed Education Experiences (MWEEs); and 3) improves MWEEs through technological advances and Chesapeake Bay education summits. The MWEE is based on active-learning strategies, and seeks to provide experimental or investigative experiences for students that result in enhanced critical thinking. The Chesapeake Bay watershed and associated issues are incorporated in the participating state partners' curricula. Maryland's curriculum, for example, includes the evaluation of the interrelationships between humans, watersheds, and water quality (Table 6).

Illinois Learning Standards Performance Descriptors

During the investigation of the state standards for water education, the Illinois' model revealed some excellent features that should inform the development of water education standards in the Gulf Coast states. The Illinois learning standards in science content addressed 5 topics in water education, including groundwater, pollution, soil erosion, Surf Your Watershed, and TMDLs (Table 7). Although only 5 topics are addressed, there is extensive overlapping of topic coverage in the various grade levels through which students matriculate.

Therefore, the Illinois Performance Descriptors (Illinois State Board of Education, 2001) are not notable for the total amount of water education content they address, but in the manner in which science content is covered in the classroom. The Illinois Performance Descriptors define stages, or performance levels, for the science standards that teachers have to address in their classroom. From Stages A through J, the performance levels increase in content rank from early elementary to late high school. Stages E, F, and G are covered in grade 6, while grade 7 includes stages F, G, H. Grade 8 reviews stage G, and implements stages H and I. Grades 9 and 10 cover stages H, I, and J, while grades 11 and 12 implement stages I and J. If the science curriculum is implemented in the manner in which it is written, Illinois teachers are expected to 1) review older content, 2) introduce new content and implement with saturation, and 3) scaffold to a higher level of content within one school grade. The subsequent grade level will review the previous year's content saturation level, and expand the content in an in-depth examination of the next stage (Figure 3).

Model: Water Education Best Practices

We originally identified search terms for water education incorporation in the curriculum. Thirteen search terms, and a state-specific features category were investigated in each Gulf Coast state's science content curriculum. The original 13 terms were not meant to be completely inclusive for water education, but were what we considered to be the most relevant terms for citizen understanding of water quality. Other than Louisiana, the Gulf Coast states we investigated did not incorporate even 50% of our "foundation knowledge" for water education. Water science content is notably absent from Gulf Coast states' science curricula.

Also absent in our research of Gulf Coast states' curricula, and even within our expanded research of water education curricula within all 50 US states, was consistency of water education study. The Illinois model offered a good method for reinforcement of water content in the public school system, but this method appears to be an exception rather than the consensus for water content implementation.

While there are notable organizations working diligently to address watershed and water quality education, we noted that the efforts of the initial 22 Gulf Coast NGOs had not resulted in a developed science curriculum for the individual Gulf Coast states. Some NGOs have, however, been quite successful for water education implementation, and a prominent exception is the Chesapeake Bay Foundation. Through the consortium of collaborating states and government agencies, a noticeable water education component is included in the science curriculum in the participating states.

From our exploratory research, we propose that a model for water education in public school systems should incorporate the best practices that we uncovered in this study, and focus upon three C's: Collaboration, Content, and Consistency. Watersheds and their partnering NGOs should collaborate with other watersheds, other states' NGOs, and science educators to develop appropriate water education curricula that can provide meaningful learning opportunities for their public school students. For example, all Gulf Coast states should be concerned with coastal erosion. A consortium of Gulf Coast states could produce a highly effective model for addressing the National Science Education Standards through water education—and particularly coastal erosion—which could be implemented in all coastal states.

It is productive for individual states to focus upon water issues relevant to their local communities, and implement these issues in the classroom through state science education standards. Place-based learning and incorporation of local environments tap into students' previous experiences and existing knowledge (Clary & Wandersee, 2006). However, we also think that a broad base within water education is important, and the content introduced in K-12 science classrooms should address multiple issues in water education content. Our 13 original search terms were not meant to be comprehensive for water education, and we were disappointed that most states incorporated fewer than half of these topics in their curricula. Water education that proceeds through only one or two isolated topics probably will not result in a well-educated citizen with respect to water quality. Our science classrooms will require a more in-depth approach to water education, and more inclusive water content.

While implementation of several water topics in the classroom will be an improvement in water education, we further advocate consistency in implementation of water content, across several grade levels. Following an introduction to science content, greater sustained learning for our future citizens will result when content is reviewed, and reinforced. The Illinois model seems to adopt this strategy.

Discussion and Concluding Remarks

Although water education is important for all citizens, it is not being adequately addressed in school science curricula by the vast majority of US states we investigated. For the Gulf Coast states, only a small amount of water education content is mandated through the state-required science content standards. Louisiana's students fared better than the other coastal states, but there is still important content in water education that is not being addressed: Louisiana only implements 7 of the 13 water topics we initially identified, or about 54%.

NGOs of the Gulf Coast watersheds had differing areas of concentration, which may be related to the types of properties included in their watersheds. However, regardless of each watershed's focus, the NGOs' efforts appear to be unrealized in more inclusive water education content, as part of their states' science curriculum standards, benchmarks, or competencies. While the efforts of NGOs may be contributing greatly to individual schools, counties, or parishes with respect to watershed and water quality education, there is little mandated water education inclusion at the state level. Without mandatory science content directives, water education is not assured of being included in all public schools within a state. More research is needed to ascertain the effects of NGOs on water education science content outside the Gulf Coast states.

We advocate that future efforts of watersheds, their associated NGOs, and interested environmentalists and educators include collaboration for implementation of water education in public schools through required science content standards. The National Science Education Standards should serve as the guiding policy for content implementation via the eight identified science content strands. Not only should water education be addressed with sufficient content, but the implementation of water education should be consistent over various grade levels for reinforcement. The collaboration, content, and consistency model may facilitate water education within our public schools, and perhaps result in greater scientific literacy of the general public toward water quality, watersheds, pollution, and other associated issues. For all interested in water education, this research indicates that our work is just beginning.

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Table 1: Water Education Content in Louisiana. Several water education topics are included in Louisiana's Comprehensive Curriculum (Louisiana Department of Education, 2008). Topics that are covered and reinforced at more than one grade level are highlighted in blue.

Topic	Grade Level	Standard
Aquifers	5-8	ESS-M-A-10
Coastal Loss	8	GLE 20
Flooding	6	
Groundwater	5-8, Biology core	ESS-M-A10
Pollution	5-8	
Quality	9-12	SE-H-C1
Soil Erosion	5-8	ESS-M-B3

Table 2: Water Education Content in Alabama. Only four of our water education search terms were included in Alabama's curriculum (Alabama Department of Education, 2006). The curriculum search revealed that each topic was only covered at one grade level, and was not subsequently reinforced.

Topic	Grade Level	Standard
Coastal Loss	6	Content 2
Flooding	6	Content 3
Groundwater	Biology Core (9)	Content 14
Quality	Biology Core (9)	Content 14

Table 3: Water Education Content in Florida. Six water education topics are introduced in Florida's state science curriculum (Florida State Department of Education, 2005). Topics that are covered and reinforced at more than one grade level are highlighted in blue.

Topic	Grade Level	Standard
Aquatic organisms	9-12 Life Science	SC.912.L. 17.3
Flooding	7	SC.7.L.17.3
Groundwater	9	SC.912.L.17.16
Pollution	7	SC.7.3.6.6.
Quality	7,9	SC.7.E.6.6., SC.912.L.17.7
Soil Erosion	4,7	SC.4.E.6.4, SC.7.E.6.6

Table 4: Water Education Content in Mississippi. An impressive nine water education topics are introduced in Mississippi's state science curriculum (Mississippi Department of Education, 2001). However, items marked with superscript 1 are not required courses, and are not offered in every school system in the state. Objectives are marked with superscript 2. Objectives are suggested for a classroom, but are not required to be taught.

Topic	Grade Level	Standard
Aquatic Organisms	Aquatic Science[1]	Competency 2, 4
Coastal Loss	Aquatic Science[1], Environmental Science[1]	Competency 6b,7; Competency 3e
Flooding	Aquatic Science[1]	Competency 6b, 7
Pollution	4, Aquatic Science[1]	Competency 7b, Competency 6a, c
Quality	4	Suggested objective[2]
Run-off	Aquatic Science[1]	Suggested objective[2]
Soil Erosion	4, Aquatic Science[1]	Objective 5a[2], Competency 3
Surf Your Watershed	4, Aquatic Science[1], Spatial Information Science[1]	Objective[2] Competency 2
Urban Development	Aquatic Science[1]	Competency 6d

Table 5: Required Water Education Content in Mississippi. After elective courses that are not available in all school districts are removed, as well as those suggested objectives that are not mandated to be taught, the only required water education topic in the state of Mississippi's 2001 curriculum is pollution, at grade level 4.

Topic	Grade Level	Standard
Pollution	4	Competency 7b

Table 6: Chesapeake Bay watershed in Maryland's curriculum. Maryland is one of the state partners of the Chesapeake Bay Foundation, and the foundation has been successful in ensuring that some curriculum content standards directly address the watershed and water education. Note that Indicator 6.3.2 of Goal 6, Environmental Science directly addresses the Chesapeake Bay watershed. Content material that is directly relevant to water education is highlighted in yellow. This is one excerpt only from Maryland's state science curriculum. (Maryland Department of Education, 2009)

Expectation 6.3	**The student will analyze the relationships between humans and the earth's resources.**
Indicator 6.3.1	The student will evaluate the interrelationship between humans and air quality. At least—ozone, greenhouse gases, volatile organic compounds (smog) acid rain, indoor air, human health
Indicator 6.3.2	The student will evaluate the interrelationship between humans and water quality and quantity. At least—freshwater supply, point source/nonpoint source pollution, waste water treatment, thermal pollution, Chesapeake Bay and its watershed, eutrophication, human health.
Indicator 6.3.3	The student will evaluate the interrelationship between humans and land resources. At least—wetlands, soil conservation, mining, solid waste management, land use planning, human health.
Indicator 6.3.4	The student will evaluate the interrelationship between humans and biological resources. At least—food production/agriculture, forest and wildlife resources, species diversity/genetic resources, integrated pest management, human health
Indicator 6.3.5	The student will evaluate the interrelationship between humans and energy resources. At least—renewable, nonrenewable, human health

Table 7: Water Education Content in Illinois. Although only five water education topics are specified in Illinois' Performance Descriptors, the methods by which they are covered in the classroom involved reinforcement through several grade levels (Illinois State Board of Education, 2001) Topics that are covered and reinforced at more than one grade level are highlighted in blue.

Topic	Grade Level	Standard
Groundwater	7,8, 9-12	12B Stage G2, 12B Stage J1; 12 B Stage J1
Pollution	8-10	13B Stage H3
Soil Erosion	6	12E Stage E1
Surf Your Watershed	6, 7-8	12E Stage E3, Stage G3
TMDLs	7-8, 11-12	12E Stage &, 13B Stage H

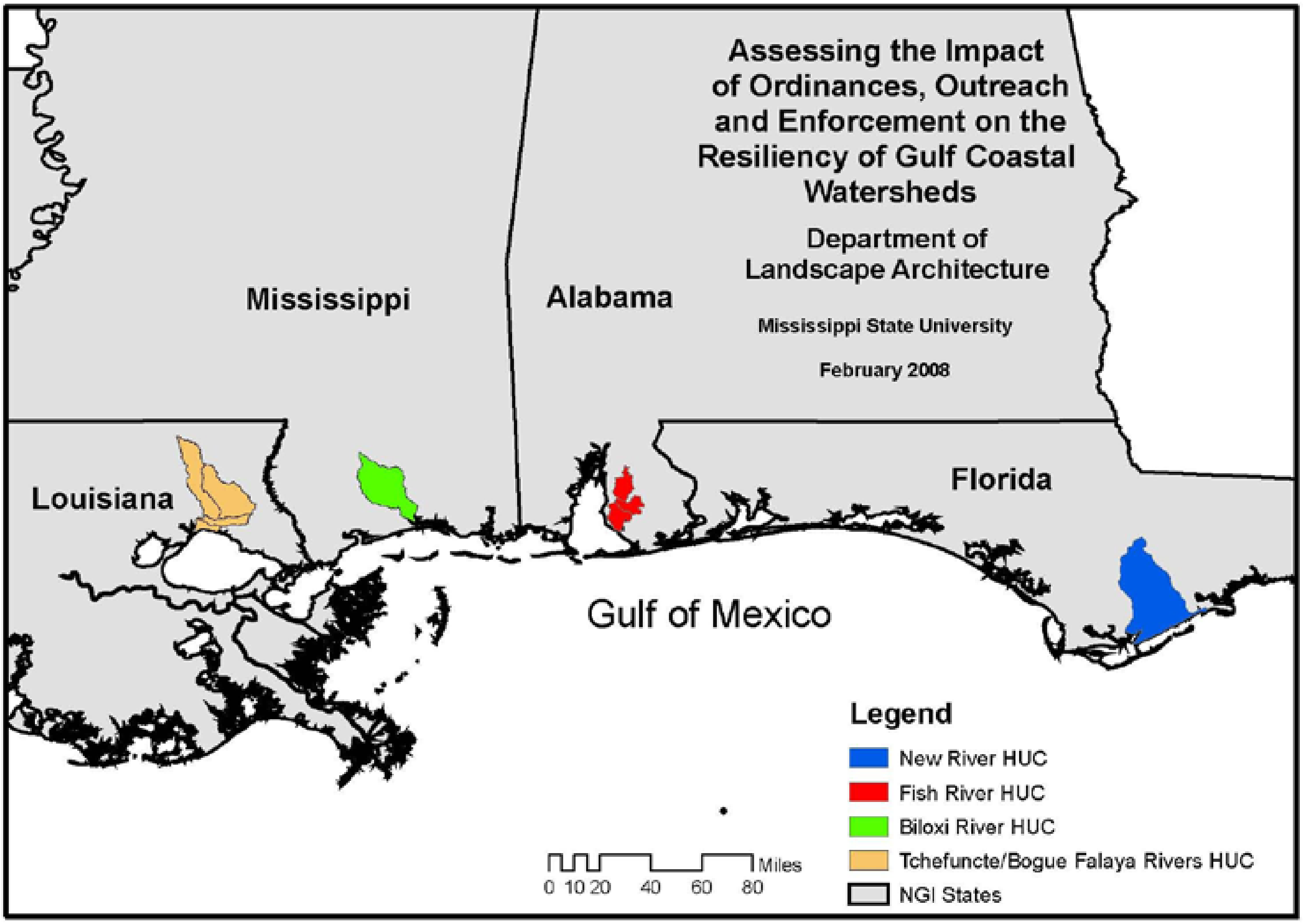

Figure 1: Coastal watersheds in Louisiana, Mississippi, Alabama, and Florida were identified, and NGOs associated with each watershed were surveyed on several topics, including water quality monitoring, environmental education, habitat restoration, conversation easements, and watershed management. (The figure is reproduced courtesy of the Journal of Extension, in which this figure appeared in volume 47, number 6 in 2009.)

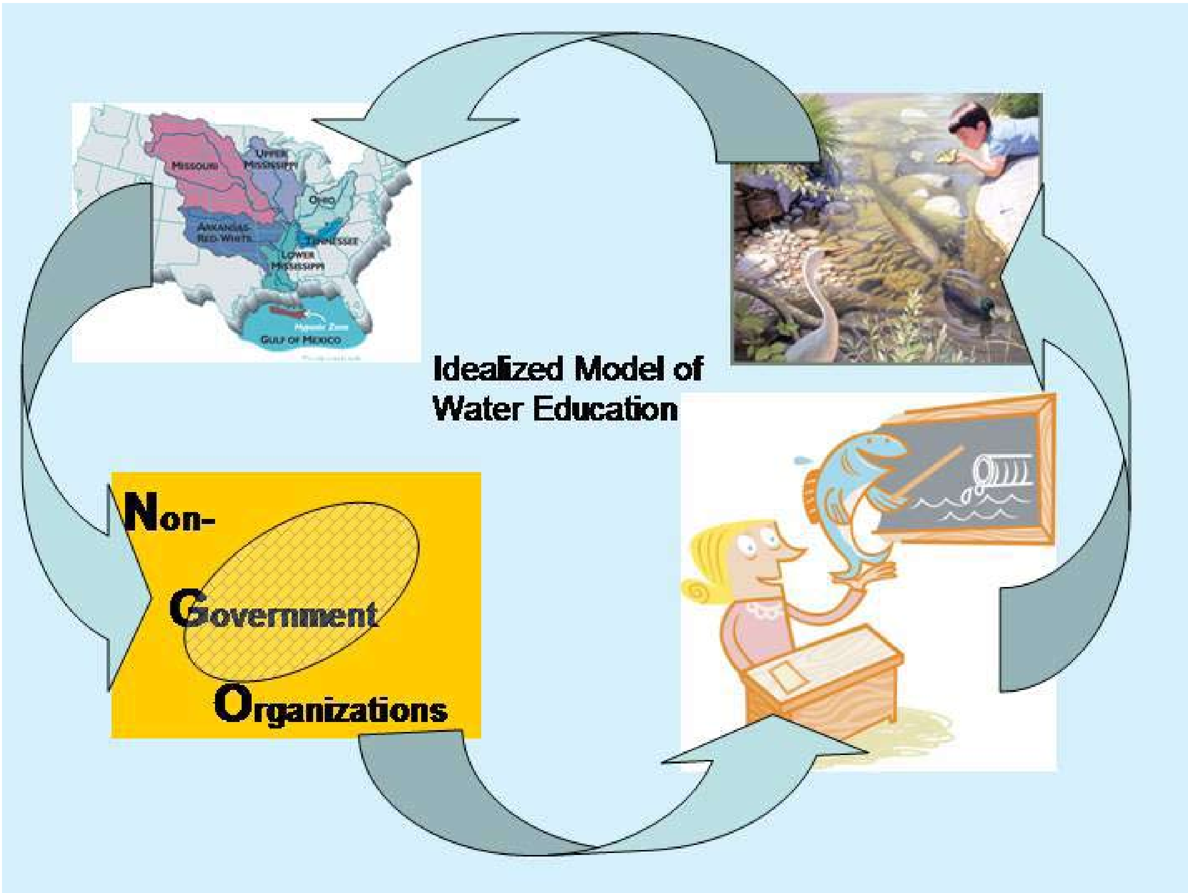

Figure 2: An idealized feedback loop between a watershed, supporting NGOs, classroom water education, and the development of our future concerned citizens. (Original images modified by authors, courtesy of URLs: http://upload.wikimedia.org/wikipedia/commons/b/b3/Gulf-mexico-watershed.gif, , http://ci.santa-rosa.ca.us/SiteCollectionImages/pwstorm_education1.jpg; http://www.co.pierce.wa.us/xml/services/home/environ/ed/teacherandfish2.jpg).

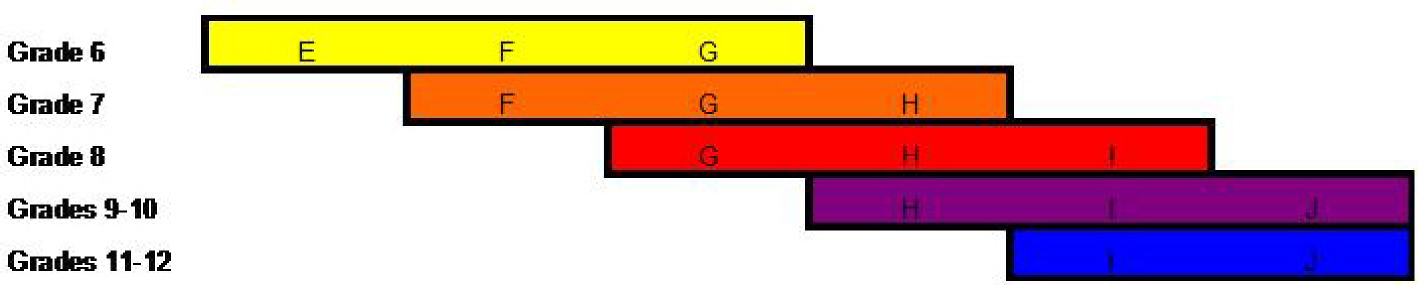

Figure 3: The Illinois' model for science content standards uses the Illinois Performance Descriptors (Illinois State Board of Education, 2001) to review content from a former grade level, implement and thoroughly study content at a higher level, and then briefly introduce the next highest level of content at the conclusion of the topic. If implemented properly, there is substantial overlap as content is reinforced at various grade levels.