# environmental institute of houston

## 2005 annual report

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# advisory board


Texas Envirothon, April 10-11, 2005

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## Contributors to Texas Envirothon Program

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# New Beginnings, Unfamiliar Places: the Changing Landscape of Houston

George Guillen

In February 2004, I was honored to be appointed as the executive director of the Environmental Insitute of Houston (EIH). I am indebted to Dr. Lisa Gossett, interim director 2002–2004, and Dr. Jim Lester who served as executive director for many years prior to then. I was fortunate to have inherited a dynamic, energetic staff of professionals dedicated to environmental education, research and outreach. More importantly, I have found that EIH is a significant program within the UH System that is strongly supported by the administration and faculty. I have been here for a little over a year and have come to appreciate the breadth and importance of the work EIH has done and continues to do within the community. EIH serves both the university and community by providing critical services, research and education in the field of environmental science. Thanks to my predecessors, EIH's reputation in the community and academia is solid and respected.

As an associate professor of biology and environmental science, Dr. George Guillen includes field trips in his curriculum for hands-on instruction.

It does not seem like much time has passed since I left Houston in 1998 and returned in 2004. One of the major visions that I encountered, which affected me deeply, when I returned to Houston was the massive change that had occurred to the landscape in less than seven years. I saw a complete change in the landscape from green space to housing developments, shopping malls and industry. Having grown up in Houston, I was always immersed in this rapid change and I did not notice the slight changes that were occurring every day to the landscape. When I got off the plane I was shocked to see many familiar "green" locations gone, replaced by buildings or parking lots. I recalled a line from "Big Yellow Taxi" by Joni Mitchell: "they paved paradise to put up a parking lot." Some might argue that Houston was never a paradise, but certainly some parts of it were arguably more aesthetically pleasing than a parking lot! Now, before anyone charges me with being an emotional environmentalist, I must provide you with some evidence that this reaction is not based only on emotion, but on some understanding of how this transition will affect our long-term environmental quality. Being a scientist who deals with physical quantitative data, I was always very uncomfortable with studies that focused on social values, preferences and even economics. I viewed these as "warm and fuzzy" concepts that had no place in a serious discussion regarding environmental issues side by side with topics like cancer and loss of species diversity. I came to realize that this is not true.

A few years ago, while I was living in California, I attended a seminar where a discussion started up regarding what is more important to people in deciding where to live and raise a family. Was this decision mainly based on economics or some measure of "quality of life?" A question was posed to a group of people that lived in many places, mostly rural and smaller towns. Basically, we were asked how much would we need to be paid to leave our houses in the country to live and work in Los Angeles. I cannot recall the exact numbers, but the answers ranged from four times their current salary to "I would never leave!" Knowing many of the people in the audience I would support the sincerity of their arguments. This kind of information is seldom captured or considered by traditional economists, urban planners and business leaders. You might wonder what variables drive this opinion. Obviously it is not money alone. Some of the respondents cited clean air, clear water, green space and no traffic congestion. I believe, many of our social preferences regarding a desire for green space, uncongested streets and clean water and air are linked with millions of years of our evolutionary history and our desire for a "safe" environment. For example, scientific evidence supports the hypothesis that humans evolved in open savannah systems. Therefore, we would expect humans to have certain habitat preferences that mimic our ancestral surroundings. For many people, this appears to be green open rolling fields, i.e., yards and open spaces. One might argue yes, but we actually live in many varied habitats including cities, mountains, artic regions, etc. But if you look closely you will find that as soon as we colonize these areas we try and start changing them to mimic our ancestral home.[1] For example, we partially clear forest lands for more open pasture, we plant gardens, and we place paintings in our homes of beautiful vistas. If you look at the landscaped communities of the world you will be struck by how much they resemble each other.

You can conclude, based on my arguments, that in addition to the ecological services that green space provides (e.g. preservation of biodiversity, clean air and water, reduction in flooding potential) there are other less obvious benefits such as promotion of less stress, i.e., good mental health. Nothing is guaranteed since genetics and other factors in our life also affect our health and well being. We must, however, acknowledge that green spaces provide our species many other services that includes enhancement of our overall mental and physical health. Our deep innate desire to be closer to nature or natural surroundings is probably based on millions of years of natural selection and should not be dismissed as trivial.

Recent work by various organizations have pointed to the need to more carefully plan our communities to minimize the impacts to our environment while maximizing social, economic, health and environmental benefits.[2] It has been documented throughout history that a society's inability to deal with environmental problems is often directly attributable to their downfall.[3] Although that statement may seem a little dramatic, it is, nonetheless, true. Careful planning for sustainability is a mission that most industrialized societies can no longer ignore.

The challenge in our community and elsewhere is to develop the appropriate social infrastructure and scientifically defensible solutions that will assist community planners and leaders in a way that allows for continued economic health while not jeopardizing our overall quality of life. This will require additional research and education within our community. Continued research is needed to better understand the impacts of habitat change and pollution on our health and critical resources.

Air quality in Houston continues to be a problem that not only affects human health, but may also be affecting plant and animal communities. Recent research funded by EIH and conducted at the UH Coastal Center by Dr. Sharon Zhong will provide critical information on the meteorology and transport of air pollutants. Associated with air pollution problems is our nation's need to have reliable, clean-burning fuels. There is a critical need to reduce green house gas emissions and reduce priority pollutants associated with production of ozone in the Houston area. Recent EIH funded studies by James T. Richardson, Ph.D., in the Chemical Engineering Department have focused on the development of clean, efficient hydrogen generators that can be used in smaller facilities. Development of a viable generator will help meet the goals of air pollution reduction.

New pollutants such as endocrine disrupting compounds (EDCs) have recently gained notoriety in the United States and the world. These compounds are biologically active in minute quantities and are capable of disrupting the normal development of various organisms. Changes in sex ratios, malformed organs and disruption of normal development are symptoms associated with exposure to elevated levels of these compounds. The sources of these compounds may include growth hormone additives in animal feed and human contraceptives. Many of these compounds are flushed down the toilet and are ultimately discharged from wastewater plants after treatment. The levels and fate of these compounds are poorly known and need to be quantified. Dr. Chunlong Zhang has begun to investigate new techniques designed to monitor levels of these compounds in domestic wastewater and receiving waters.

Very often new environmental regulations are implanted without any follow-up to determine if they are effective. For example, many restoration projects and permit limits on discharges have been implemented over the past 20 years. However, only limited studies have been conducted to determine whether they worked and where efficient in their design. Dr. Cynthia Howard has investigated the recovery of produced water discharges at sites where such discharges where banned approximately 10 years ago to determine if recovery has occurred. It is hoped that the findings of Howard's research will help in future restoration and permitting decisions.

Expanded environmental education of school teachers and their students is one of the many goals of EIH. We believe that an informed public is needed to deal with many of the complex environmental issues we face today. True risks are often not accurately depicted in the media, and citizens and decision makers are left in a difficult situation of either not responding to a real threat or over-responding to a perceived, unfounded risk by spending large sums of money. Therefore, more than ever, teachers need to be trained on the most current knowledge and techniques necessary to educate the next generation who will have to deal with a myriad of environmental issues.

During 2005, two environmental education projects were funded by EIH. Deborah J. Roberts, Ph.D., was the principal investigator responsible for the Development of Curriculum for an Environmental Education Module project. This program developed a curriculum on environmental engineering that focused on the monitoring and treatment of contaminants. It provided high school girls with an opportunity to train with and obtain hands-on experience from engineering scientists who monitor and deal with pollution.

The Texas State Envirothon: Taking the Natural Challenge was a project conceived by Brenda Weiser, Ph.D., director of environmental education at EIH. Dr. Weiser secured funding from EIH which was used to supplement funding from the Canon Corporation to support the Texas State Envirothon program. This program is unique in that it provides students from different schools a chance to compete in state and national competitions that challenge them to develop solutions to environmental programs. At each annual competition, school teams from across the state meet. An environmental issue or problem is selected that often mimics and/or incorporates a real world problem that exists within the community. After a brief training session, teams are asked to develop an approach that would solve the problem. Each team is then asked to present their findings and proposed solution to a panel of judges. The winning team is eligible to compete in the national competition. Winners of the national competition receive academic scholarships as incoming freshman at the college of their choice. This program encourages team building, problem solving and systems thinking. It also provides a fun atmosphere to students interested in environmental careers.

Many other important research and education projects are described in the 2005 Annual Report. In addition to these projects, EIH works closely with other organizations including universities, local primary and secondary school educators, the Galveston Bay Program, the Galveston Bay Foundation, the Houston Galveston Area Council, state and federal agencies, environmental organizations, industry and professional organizations such as the National American Association for Environmental Education. Projects range from public outreach seminars and workshops dealing with our area's cultural history to the design and implementation of ozone and water quality monitoring programs.

The diversity of critical environmental research, education and outreach needs that EIH tries to address is truly overwhelming. The unfortunate news is that in recent years, the EIH budget has been reduced because of state budget shortfalls. For example, during the 2005–2007 higher education special item funding was reduced. This budget category includes EIH. This resulted in an overall reduction of $20,000/year over two years. Although we would like to fund more environmental research and educational activities our resources are limited. We are however, constantly seeking support from other organizations who share similar research or education goals. Through these partnerships EIH has acquired an additional $150,000 in funding during FY2005. Organizations we have partnered with include HGAC, Canon Envirothon and others. We are hopeful that the recent trend in declining budgets does not continue. At the same time we continue to try to maximize our resources by leveraging them with other organizations who are interested in addressing some of the issues we have identified.

We thank our advisory board members, our benefactors, local community leaders, elected officials, local industry, local environmental groups, local, state and federal agencies and the University of Houston System for their continued support.

**References**

[1]M.L. Rosenzweig. *Win-win ecology*: *How the earth's species can survive in the midst of human enterprise*. New York: Oxford University Press, 2003.

[2]National Association of Local Government Environmental Professionals, Trust of Public Land and ERG. Smart growth for clean water: helping communities address the water quality impacts of sprawl. 2003.

[3]J. Diamond. *Collapse*. New York: Viking Press, 2005.

*George Guillen is the executive director of the Environmental Institute of Houston at the University of Houston-Clear Lake. He can be reached at guillen@uhcl.edu.*

# Promoting Inclusion Within an Elementary School Science Lab

Bonnie Mackey

Northside Elementary School serves traditional first through fourth grade students. In addition to these students, the campus is the Angleton ISD magnet school for the Living Skills (18 MR students), Adaptive Skills (seven medically fragile students) and Gifted and Talented (37 students) programs. This school is representative of the increasing implementation of inclusion for handicapped and disabled students within traditional elementary curricula and instruction. Couched within the goals of this magnet inclusion and magnet gifted and talented school are two over-riding themes: (1) the fierce commitment of the Northside faculty and parents to provide a learning environment where all students feel acceptance and success and (2) the desire to enhance the scientific and environmental knowledge base of Northside elementary teachers and students through experiential and hands-on instruction. This project addressed both goals by providing additional supplies for environmental and science activities within the lab and the campus garden/habitat and by designing differentiated lesson plans that enable special needs students to use both the science lab and the school habitat for their science inquiry. The grant facilitated the infusion of environmental education into the curriculum for Northside elementary students. In addition, 90 percent of the Northside faculty participated in a six-hour Project Learning Tree (PLT) workshop that aligned environmental education concepts with the science curricula for all Northside students.

The target audience of this grant consisted of first through fourth grade students, with enhanced attention addressed toward the special needs students at Northside. University of Houston-Clear Lake (UHCL) graduate students, within the outdoor habitat, designed and taught lessons that instilled environmental education within the elementary science curriculum. A second target audience for this grant consisted of the faculty at Northside. Faculty participated in a six-hour PLT workshop that was conducted at the Northside campus in the spring of 2005. Faculty can implement environmental education themes within their everyday teaching because they were given the tools and hands-on experiences at the workshop. This awareness of their campus environment enabled teachers and students to become more responsible and knowledgeable citizens who strive to respect and cherish Earth's ecological and geographical components.

A Northside student waters the yellow lantana that she planted in the habitat area.

### Objectives

The objectives of this project were:

(1) to organize the science lab by labeling supplies and cabinets with words and pictures;
(2) to utilize the science lab facility throughout the school day for all Northside students;
(3) to infuse environmental education issues within teacher professional development; and
(4) to utilize the garden as a classroom for teaching environmental education concepts for all Northside elementary students.

Through the hard-working and dedicated commitment of the UHCL graduate students, all of the objectives of this project were successfully completed.

### Products and Services Produced

Several final products resulted from this project, including:

(1) an organized, labeled (with words and photos) science lab (see photo on pg. 8);

(*Above*). Northside Science Lab supplies are organized, labeled and stored underneath colorful rainforest-themed curtains. (*Below*) An inflatable solar system is on display in the Earth/space area inside the lab.


An interactive bulletin board occupies the life science area.

(2) teacher training workshops that model the development and implementation of environmental education lesson plans which align with the Texas Essential Knowledge and Skills (TEKS) curriculum; and

(3) a colorful and informative 100-page guide given to Northside teachers. This guide includes information on science inquiry, photos and inventory lists of the science lab, lesson plans on environmental issues, modified lesson plans for special needs students and relevant information on the school habitat to encourage its use after the completion of the grant.

The dissemination of materials was completed in summer 2005. Graduate students from UHCL developed a teacher handbook for Northside faculty in grades first through four as well as for additional faculty and staff. This teacher handbook included: (1) an explanation and visual layout of the reorganized science lab, (2) exemplary lessons concerning environmental education concepts for each grade level (first through fourth grade), (3) alignment of those exemplary environmental education lessons with the state curriculum, TEKS, (4) lesson plan modifications for the special needs population at Northside and (5) information on habitats and butterflies to sustain the use of the habitat after the completion of this project.

Under the direction of two graduate students, all first through fourth grade students received hands-on science lessons in their habitat area. Northside students planted flowers known to attract butterflies. Students' research efforts produced a list of flowers—zinnia, lantana, salvia and verbena. Students also explored the values of earthworms in the soil as they introduced real worms into the garden. Also, students were given ladybugs to examine and release.

## Benchmarks

Progress was measured throughout the grant period by the completion of each task identified on the timeline. The following tasks were completed on their designated schedule:

November–December, 2004

Gathered input about desired science supplies and educator environmental workshops at several meetings with Northside Science Curriculum Team.

January–May, 2005

Initiated description and layout of science lab;

Developed and implemented lessons concerning environmental education;

Elementary students plant red salvia and yellow lantana to attract butterflies and humming birds to the Northside habitat.

Modified lesson plans for inclusion of special needs elementary students;
Procured supplies for teaching environmental lessons in the outdoor habitat;
Initiated development of teacher guides with emphasis on habitat themes and special needs students;

May–July, 2005
Conducted educator workshops about environmental education (PLT);
Organized and labeled items in the science lab;
Completed teacher guides for the Northside Elementary science lab and habitat.

**Publications**

Mackey, B. and T. Baker. “Including special needs students in the elementary school science lab,” *J. Early Childhood Teacher Education*. (Manuscript in progress.)

Mackey, B., M. Morgan, D. Lesh and T. Baker. “Transformation of two elementary school science labs,” *Young Children*. (Manuscript in progress)

**Presentations**

Mackey, B., M. Morgan, D. Lesh and T. Baker. “How two Environmental Institute of Houston grants transformed two elementary school science labs,” Annual Conference, Association of Science Teachers, Houston, TX, Oct. 2005.

*Bonnie Mackey is an assistant professor of early childhood education at the University of Houston-Clear Lake. She can be reached at mackey@uhcl.edu. Marlene Morgan, Diane Lesh, Rebecca Caplan, and Teia Baker are graduate students in the School of Education, UHCL.*

# Development of Curriculum for an Environmental Education Module for UH Cullen College of Engineering GRADE Camp

Deborah J. Roberts

A curriculum was developed to introduce high school girls to the fields of science and engineering through an inquiry-based approach. This curriculum focused on three issues: (1) What is in water? (2) Do we want it there? and (3) How do we get it out if we don't? A pilot of the proposed GRADE camp module was conducted in July 2005. The goal of the pilot camp was to determine the girl's response to the proposed laboratory projects. The pilot camp was a truncated version of the full camp, and did not include games, intensive instruction, or a final presentation, all of which will be included in the full camp scheduled for summer 2006.

Eleven girls representing a variety of high schools across the city attended the pilot camp. Girls were selected from students that had previously attended the robotics-based GRADE camp in 2004 or 2005. The girls volunteered to attend the camp and assess the new curriculum. All of the campers provided valuable off-the-cuff feedback as they worked through the labs, and filled out an evaluation form at the completion of the camp.

On the first day, the students made serial dilutions of bayou water, and spread each dilution on microbial growth medium in Petri dishes for plate count analysis. The students counted the number of bacterial colonies growing on the plates after two days of incubation. Plate count analysis is a standard method used in environmental microbiology for counting bacteria in a water sample. The purpose of the exercise was to introduce girls to the microbiological aspect of water quality. The girls seemed to enjoy the scientific nature of spreading the samples on the plates using modern pipettors.

A second method for determining the amount of bacteria in a water sample involved staining microbes and observing them under a microscope. A water sample was centrifuged to isolate the microbes. Excess water was poured off and the pellet of microbes at the bottom of the test tube was stained purple. The dyed pellet was then diluted until the water surrounding the pellet was clear while the microbes remained purple. The microbes in the sample were counted using a counting chamber under a microscope. This method was the source of major frustration for the students. They experienced difficulty focusing the microscope, and had very little patience. This exercise will be rethought. We did have more success studying algae that were growing in a sample bottle. If a mentor focused the microscope initially, the girls enjoyed making observations.

A GRADE camper uses a titration test kit to determine the chloride content of her water sample.

GRADE campers determine sulfate content of their treated water sample to test the effectiveness of their treatment process.

Another related aspect is the turbidity of water, caused by light scattering of particles. This was a good way to show how scientists and engineers use light to determine contaminant levels or turbidity of a water sample. A PowerPoint presentation explained the science in general and afterward we accompanied the presentation with a demonstration of a spectrophotometer and a turbidity meter.

GRADE campers pose with their colorimeter, a measurement tool that assigns a contaminant concentration a particular color.

The next challenge was to use water testing kits to determine characteristics of the water sample such as pH, alkalinity, hardness and turbidity, as well as any contaminants including sulfate, iron, chloride and nitrates. We provided five different challenge water samples spiked with various contaminants. Using an information guide, the girls were able to determine what their measurements told them about their water sample. For example, an extremely turbid water sample with a high nitrate reading might indicate that the water sample was taken from a surface water source near an agricultural area.

The final challenge was to treat the water. A distinction was made between treating groundwater and surface water, and the separate methodologies were detailed in the laboratory book. Following the laboratory book instructions and using their own judgment, the girls designed their own treatment process, treated their water samples and tested their treatment process' effectiveness.

*Deborah J. Roberts is an associate professor of environmental engineering at the University of Houston. Roberts is also the director of the Environmental Engineering Laboratories. She can be reached at roberts@uh.edu.*

*Monica Stiggins is a research assistant in the Department of Civil and Environmental Engineering, UH.*

# Texas Envirothon: Taking the Natural Challenge, Part II

Brenda Weiser

The Texas Envirothon is an academic, multidisciplinary, environmental problem-solving program that culminates in an annual series of competitions from local to state to national.

In Texas, the state Envirothon was launched in April 2001 where twelve teams participated. Nine teams participated in the 2005 Texas Envirothon competition. Schools that have participated over the last three years include the towns of Clear Lake, Lubbock, Brazosport, Hallsville, Nacogdoches, Miami, Magnolia, Lubbock, Mt. Pleasant, Canadian, Houston, Ft. Worth, Conroe, The Woodlands, Meridian, San Antonio, Grand Prairie and Paris.

This project helped to coordinate the 2005 Texas Envirothon competition, develop a marketing plan, develop a new brochure and develop and disseminate study materials to the participating teams.

The 2005 competition was held April 10 and 11. Teams of five high school students competed in the areas of soils, aquatics, wildlife, forestry and a current environmental issue, which changes yearly. The current issue for 2005 was managing cultural landscapes. Sunday, April 10, was the field portion of the competition, which took place on the Kirby Trail in the Big Thicket.

Sample questions included:

*Aquatics*.

(1) When you walked across the creek bridge, you may have noticed that it moves. It was designed that way. Why?
(2) What evidence do you see of sedimentation in this area?
(3) What forms of non-point pollution would you expect to possibly find in the river?
(4) Would you expect the dissolved oxygen to be high or low here? Why?

*Forestry*.

(1) Name the native pine tree that remains in the grass stage for 3–5 years while establishing its root system.
(2) Using the clinometer, measure the height of the flagged tree.
(3) Name one tree species at this site that is deciduous.
(4) What type of pine tree is well suited for this habitat due to its intolerance of fire?

*Soils*.

(1) What three limiting features prevent installing a septic tank absorption field on this soil? (TIP: use the ENG tables. Use the Caneyhead soil named in the BrA mapping unit descriptions and tables.)
(2) There are many brown and reddish iron concentrations along live roots and pores. What soil condition does this indicate?
(3) Name a soil property that could be affected by crayfish at this site.
(4) The soil at this site has very little organic matter in the surface layer. What visible soil property would be a good indicator of organic matter in soils?

The John Cooper School–Team B took home first place at the 2005 Texas Envirothon competition.

*Wildlife*.

(1) List two food items river otters would find at this site.
(2) Name two trees that provide mast for wildlife in this riparian forest.
(3) Is wildlife diversity higher or lower on the edge of two types of habitats? Explain.
(4) What animal is making the burrows (krotovina) in the soil?

*Current Issue*.

(1) What evidence do you find that provides clues that people lived here at one time?
(2) What are two species of animals that pioneers would have harvested from an area like this?
(3) Why is the Big Thicket National Preserve trying to eradicate exotic plant species?
(4) If you could build a cabin here, how would you design it to last for your grandchildren? What materials?

On Monday, April 11, the oral presentation portion of the competition was held at the Holy Spirit Mission Church followed by the awards luncheon.

Second Place—The John Cooper School–Team A

Third Place—Conroe Academy of Science and Technology–Team A

The winners for 2005 were:

Aquatics—The John Cooper School–Team A (The Woodlands, TX)
The John Cooper School–Team B (The Woodlands, TX)

Forestry—Paschal High School (Ft. Worth, Texas)

Soils—Chapel Hill High School–Team B (Mt. Pleasant, TX)
The John Cooper School–Team A

Wildlife—The John Cooper School–Team B

Current Issue—The John Cooper School–Team A

Oral Presentation—The John Cooper School–Team B


A score of 518.20 earned John Cooper High School (The Woodlands, Texas) fourth place in the 2005 Canon Envirothon competition held in Springfield, Missouri.

The top three places, determined by composite scores, were:

First Place—The John Cooper School–Team B

Second Place—The John Cooper School–Team A

Third Place—Conroe Academy of Science and Technology–Team A (Conroe, TX)

The five-member team from The John Cooper School won fourth place overall at the 17th Annual 2005 Canon Envirothon and tied for first place at the aquatics field station. Winners were announced Saturday, July 23, during closing ceremonies of the Canon Envirothon competition held at Southwest Missouri State University in Springfield, Missouri, July 18–24.

Team members from the The John Cooper School included: Melisa Pferdehirt, Thomas Comstock III, Joseph Rosenthal, Sannya Hede and Tony Valderrama. Team advisors accompanying the students were David and Tina Davies. Each team member received a $2000 scholarship from Canon USA to be used at a college or trade school of the student's choice. The National Association of Conservation Districts/National Conservation Foundation awarded $1000 to the state sponsoring agencies of states that won first place in each of the five field stations. The Texas Envirothon will use the $1000 donation to promote the state program.

**Acknowledgments**

A special thank you goes to the Big Thicket National Preserve in Kountze, Texas, for hosting this event. The competition's sponsors included EIH, Eastman Chemical Company, Texas Association for Environmental Education, Texas Association of Environmental Professionals, Harris County and Montgomery Soil and Water Conservation Districts.

*Brenda Weiser is the Director of Environmental Education for EIH. Weiser also lectures on teacher education through the University of Houston-Clear Lake's School of Education. She can be reached at weiser@cl.uh.edu.*

# Symposium on Energy History

Martin V. Melosi

More than 400 historians attended the national conference of the American Society for Environmental History (ASEH) in Houston on March 16–20, 2005. The theme of the meeting was "Energy, Space, Time."

The grant from EIH was used for the plenary session, "Energy and the World Environment" and was allocated to the speakers' traveling expenses and honoraria. Organized by Joseph Taylor of Simon Fraser University, the session was held on the second evening of the conference for an audience of about 250 attendees. The University of Pittsburgh Press and the Tenneco Lecture Series hosted a pre-plenary reception. Joseph Pratt, Cullen Chair, of the University of Houston presided over the panel, which offered a range of geographical and disciplinary perspectives. Judith Kimerling, environmental activist and professor of law at CUNY and Queens College, discussed the social and environmental impact of energy development in South America. Heather Turcotte, a political scientist from the University of California, Santa Cruz, addressed similar issues in Africa. David Nye, Professor of History at Warwick University in England, explored the technological and social implications of energy consumption in the last century.

Professor Nye extended his stay, and gave an informal seminar on his new research to interested faculty.

Support for the plenary session was an essential component in the ASEH Program and helped make the conference a success. It provided an opportunity to set the tone for the meeting and emphasize the theme related to questions of energy and environment worldwide.

*Martin V. Melosi is an associate professor of history at the University of Houston. He can be reached at melosi@uh.edu.*

# Microbial Mat Induced Sedimentary Structures (MISS), Texas Gulf Coast

Henry S. Chafetz

Field work primarily conducted by Sushanta Bose (Ph.D. candidate, Geosciences) along the tidal flats of the Texas Gulf Coast has focused on the variety of sedimentary structures produced and/or influenced by the presence of the ubiquitous microbial mats. Microbial mats colonies are composed primarily of prokaryotes that form dense meshworks of interweaving filaments of cyanobacteria, eubacteria and fungi. In addition to the dense mats produced by the microbial bodies, eubacteria secrete copious amounts of extracellular polymeric substance (EPS), which acts to bind the loose grains of the sediment. Sedimentary structures produced by these microbial mats in environments of carbonate accumulation, e.g., stromatolites, have been studied for over 100 years. However, the interaction between microbial mats and siliciclastic sediments (e.g., grains composed of quartz, feldspars) is a new area of investigation.

This investigation, still in progress, has recognized a variety of different microbial mat induced sedimentary structures (MISS). Several features have been recognized within the tidal flats of the Texas Gulf Coast.

*Wrinkle structures*, the most common MISS, are produced when microbially carpeted sediment surfaces undergo soft-sediment deformation. The presence of the mats act as a pliable binding agent, holding the sediment together while allowing deformation. Different types of wrinkle structures have been recognized based on their morphologies. Additionally, new environmental distributions of these structures have been recorded.

*Crinkled* and *wavy laminae* are important indicators of microbial mats in siliciclastics. These are defined by alternation of very fine light (siliciclastic) and dark (microbial) layers. The thickness of laminae appear to be an indication of location within the tidal regime.

*Microbial* "*sandchips*" are aggregates of mineral grains and pieces of microbially stabilized sediment layers. Similar structures have been recognized in carbonates and referred to as "carbonaceous flakes." The sandchips were probably torn-up by wave or current action and are associated with erosional pockets. Sandchips hold the promise of being readily recognized in ancient tidal flat deposits.

*Gas domes* are the product of decay of organic matter beneath an impermeable microbial mat—the gas pushes up the mat surface into a bulge. The gas-filled area may then be filled with an authigenic precipitate producing a new type of birds-eye structure.

Work in progress includes:

- The determination of the environmental constraints under which the different structures originate.
- Comparison of microbial mat induced structures in siliciclastic sediment with those that form under similar environmental conditions in carbonate accumulations. The first phase, partially complete, is a comparison with the abundant literature of structures formed under similar environmental conditions in carbonate terrains. In addition, field work is planned to study the sedimentary structures that form on the carbonate tidal flats adjacent to Baffin Bay, south Texas coast.
- Out crop study of the Cambrian (~500 my old) Hickory Sandstone of central Texas, which has been interpreted to be a tidal flat deposit, to evaluate the usefulness of the structures recognized in the modern environments in the study of ancient strata.

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# Benthic Macroinvertebrate Community Recovery After Cessation of Produced Water Discharge to Two Sites in the Galveston Bay System

Cindy Howard

In the process of recovering oil and gas, water is also withdrawn from underground formations. The American Petroleum Institute estimates that, in stripper oil well operations, approximately nine barrels of water are recovered for each barrel of oil. This water-oil mixture is usually separated by floatation or gravity separation in tank batteries, heat separation, skimming pits, or some combination of these methods. The remaining water, called produced water or oilfield brine, can be either deep-well injected or discharged to surface water, as permitted.

Prior to about 1994, a common method of brine disposal along the Texas coast was discharge to surface waters, either directly or by overland flow. Historically, brines discharged into freshwater or intermittent streams caused such obvious water quality problems that this disposal method was restricted to tidally influenced water bodies. Texas Railroad Commission (TRC) 1991 data indicated that the Galveston Bay system and its tributaries were permitted to receive ≤15.2 million gallons of produced waters per day from 93 permitted sources, although the actual volumes discharged to the bay varied widely.

Produced waters typically contain high levels of dissolved solids ranging in salinity from 12 to 180‰, heavy metal concentrations often significantly higher than those of receiving waters and up to 25 ppm oil and grease.[1] Brine concentrations of barium and strontium are characteristically elevated and can be used to identify discharges in natural waters. The TRC is responsible for issuing brine disposal permits, as the Environmental Protection Agency has not regulated brine discharges under its National Pollutant Discharge Elimination System (NPDES).

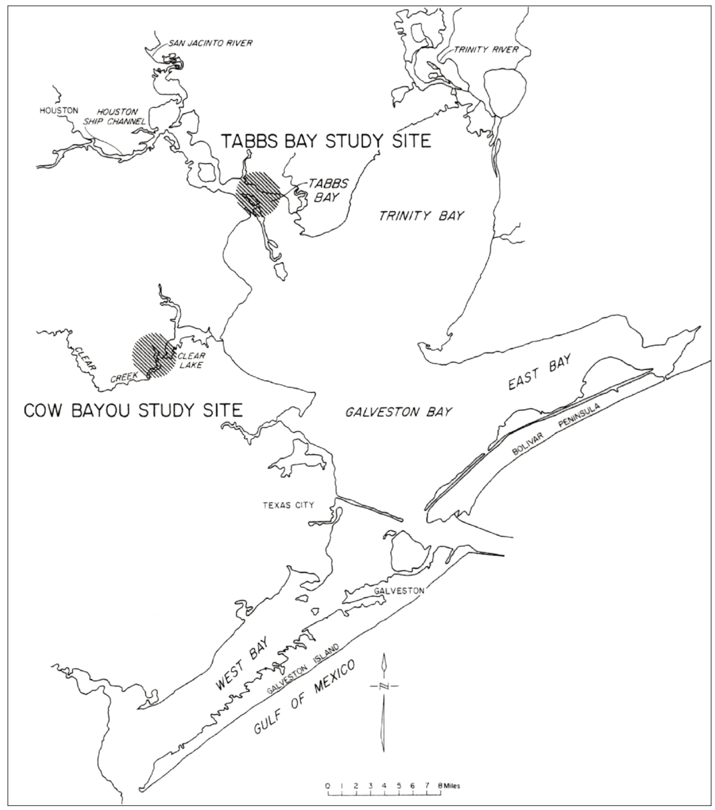


Figure 1. Locations of produced water discharge sites studied in 1991 (pre-cessation) and 2005 (post-cessation) for recovery of benthic macroinvertebrate communities

Studies of the effects of brine on estuarine systems[2-5] have shown that (1) high levels of dissolved solids allow the formation of a density gradient, especially in low energy systems such as bayous; (2) oil and chlorides are incorporated into sediments near discharges, severely depressing the abundance and richness of benthic infauna; (3) elevated salinities inhibit nekton movement; and (4) petroleum hydrocarbons are ingested and incorporated into the tissues of various aquatic organisms. King[6] found that migrant shorebirds accumulated PAHs 24-fold while overwintering and feeding in the vicinity of produced water discharges.

In 1991, Roach et al.[7] conducted a study of two sites in the Galveston Bay system that were at the time receiving discharge volumes of produced water: Cow Bayou (on Clear Creek) and Tabbs Bay (Figure 1). Using a sediment quality triad (SQT) approach, that study showed significant alterations in sediment chemistry and related adverse impacts on the benthic macroinvertebrate communities in these two brine disposal areas.

The discharges of produced water to Cow Bayou and Tabbs Bay were discontinued around 1994, due in part to the results obtained by Roach et al.[7] As is often the case, no environmental monitoring was conducted at either Cow Bayou or Tabbs Bay in the ensuing years. The purpose of the current study was to retrospectively assess the two sites to determine the nature and extent of any improvements in sediment quality, as well as any indicators of recovery of the benthic macroinvertebrate communities.

Sampling stations established in the 1991 study were revisited in October 2004 and May, July and August 2005:

four stations along a transect extending out 1000 m from the former brine discharge in Tabbs Bay (plus a reference station in Galveston Bay) and all five Cow Bayou stations (plus two reference stations in Robinson Bayou). Sediment samples were collected for analysis of sediment chemistry, toxicity and benthic macroinvertebrate communities.

Sediment samples were collected using a 4×4-inch Lexan plastic coring device. At each station, one set of core samples was composited and aliquoted into replicates for analysis of heavy metals, total PAHs and TOC, using standard EPA protocols. A second set of core samples was composited for 10-day whole sediment toxicity tests on *Palaemonetes pugio*, as in the 1991 study. Finally, four individual core samples were collected and preserved with 10% buffered formalin for analysis of the benthic macroinvertebrate communities.

The chemical, toxicity and benthic community analyses are currently in progress; however, results completed to date strongly suggest that the hypothesized recovery of the former disposal sites is occurring. For example, in 1991, benthic taxa diversity (H′) in Cow Bayou ranged from zero at CB01 (closest to the discharge) to 0.6 at CB04D—about half that of the Robinson Bayou (RB) reference stations (Figure 2). In 2005, benthic taxa diversity had increased over the length of Cow Bayou (H′ for all stations ≥1.0) and was similar to the reference stations. The diversity recovery correlates strongly with a drastic reduction in strontium from 1991 to 2005. High sediement strontium levels have been historically associated with active brine discharges. The Tabbs Bay samples are revealing similar trends. All analyses for the project will be completed by mid-October 2005.

Initial findings from this project were presented at the 26th annual national meeting of the Society of Environmental Toxicology and Chemistry (SETAC) in Portland, Ore., in November 2004. Results from the entire study will be submitted for publication in a peer-reviewed journal, such as Environmental Toxicology and Chemistry, and will be presented at the November 2005 meeting of SETAC in Baltimore, Md.

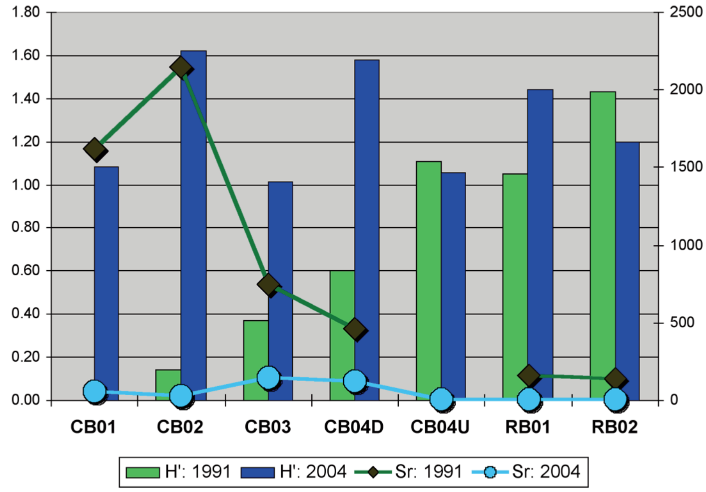


Figure 2. Comparison of benthic macroinvertebrate community diversity (H') and strontium levels in Cow Bayou sediments in 1991 (during produced water discharge) and 2005 (10-years after cessation of discharge).

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Howard, C. and R. Roach. "Oilfield brine discharge: Impacts and recovery at two sites in the Galveston Bay estuary," SETAC 26th annual aeeting, Baltimore, MD, Nov. 13–17, 2005.

Roach, R.W. and C.L. Howard. "Oilfield brine discharge: Impacts and recovery of a Texas coastal bayou," SETAC 25th annual meeting, Portland, OR, Nov. 14–18, 2004.

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# Development and Implementation of Remote Sensing Techniques to Monitor Chinese Tallow at UH Coastal Center

Shuhab D. Khan

For this work we utilized Quickbird, Landsat, Hyperion and DOQQ remote sensing data to identify and estimate the spread of Chinese tallow, which is one of the most invasive plant species in Houston area, at the University of Houston Coastal Center (UHCC). Due to the widespread extent and invasive nature of these plant species, remote sensing is ideally suited for the detection and delimitation of Chinese tallow.

Landsat TM images that were collected over twenty years—06/26/1974, 06/01/1985, 12/08/1990, 07/06/1992, 12/19/1994, 01/25/1997, 10/16/1999, 01/10/2000, 03/30/2000, 03/04/2002, 01/18/2003 and 03/23/2003—were used. In addition, Qucikbird, which is the highest resolution satellite imagery, and 1-foot resolution DOQQ data were used.

Quickbird was launched on October 18, 2001, by Digital Globe, Inc. The system is sunsynchronous at an altitude of 450 km. Quickbird has a 0.61 m-resolution panchromatic sensor and 2.4 m four-bands multispectral sensor. A multispectral (2.4 m resolution in nadir) Quickbird image of December 2, 2003 was acquired for the Coastal Center. Top-of-atmosphere spectral radiance was calculated using ENVI 4.1, the resultant data was scaled as floating points.


Figure 1. 1' DOQQ showing UH Coastal Center and GPS Locations

All the Landsat (E)TM data were brought to the same projection system using around 30 ground control and using first order polynomial with nearest neighbor method to warp image. This was followed by radiometric calibration of the Landsat (E)TM in order to convert radiance information to reflectance data. The GPS data collected in the field was overlain on satellite images to locate the site for Chinese tallow and four endmembers were selected, i.e., Chinese tallow, bare soil, stream and road (see Figure 1). Endmember was used for supervised classification of Landsat TM images, results are shown in Figure 2.

Quickbird data were classified using band ratio and supervised classification techniques. Band ratioing means dividing the pixels in one band by the corresponding pixels in a second band. There are four bands in Quickbird, resulting in 16 ratio combinations. Visual inspection showed band ratio 2/3, 1/3, 1/2 are good for Chinese tallow identification (see Figure 3).

The supervised classification method was also used to classify the Quickbird data. Four endmembers were selected

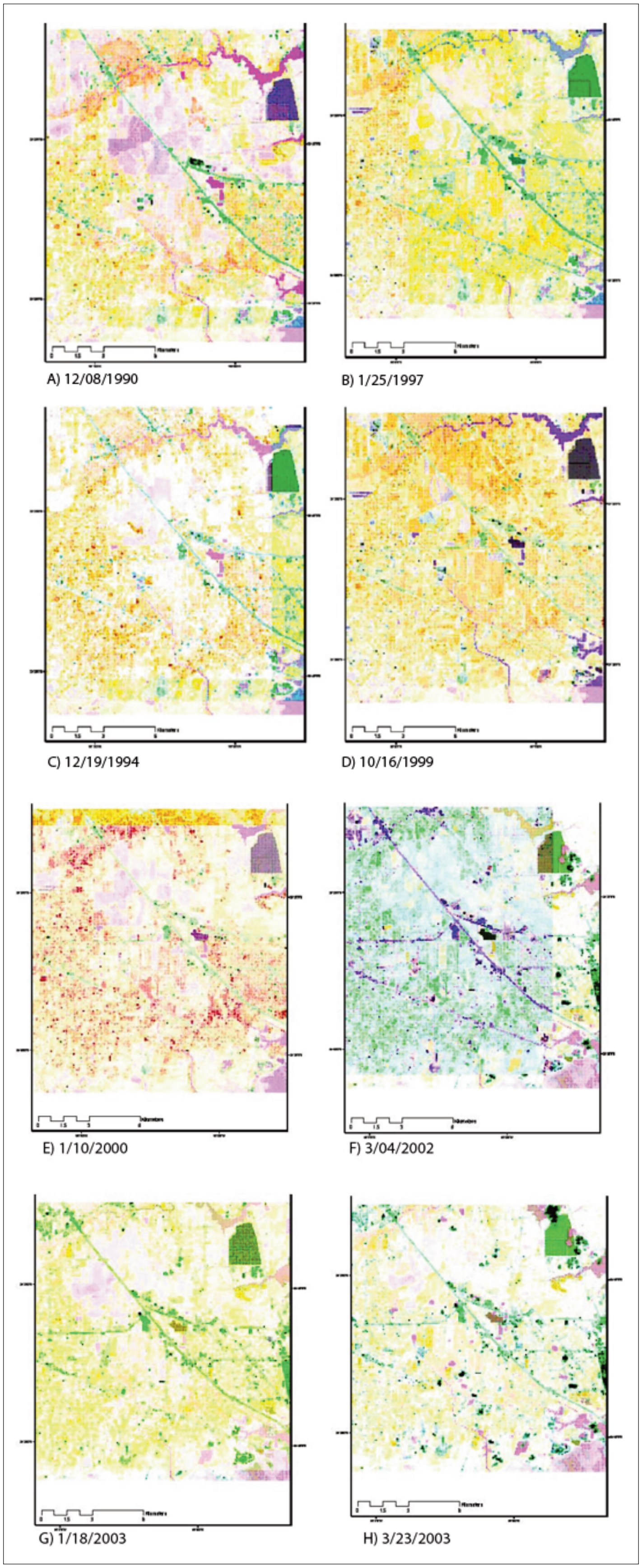


Figure 2. Results of supervised classification for Landsat data (from 1990-2003)

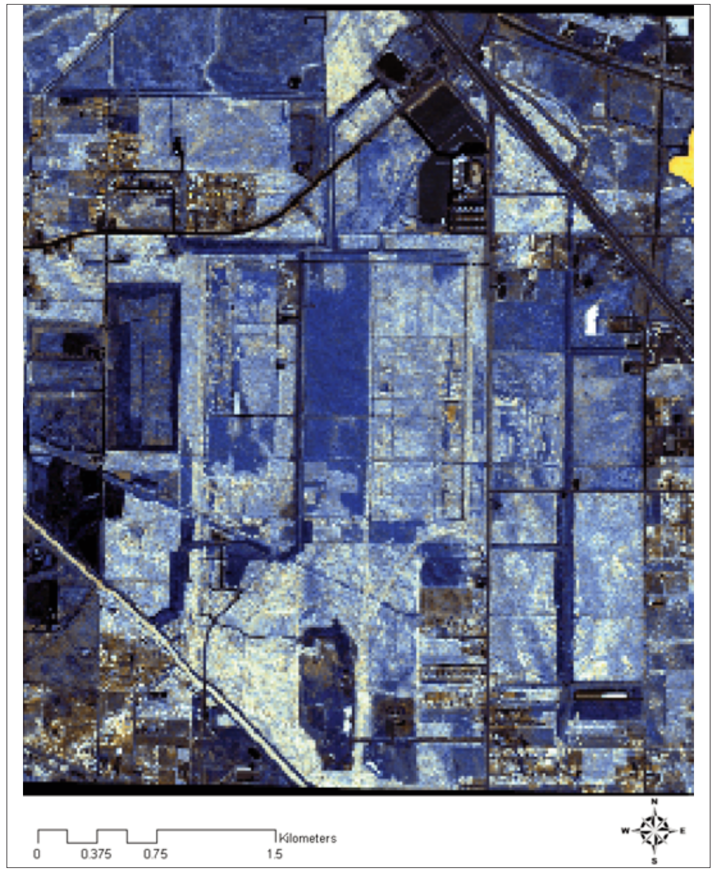


Figure 3. Quickbird band ratio image of Houston Coastal Center

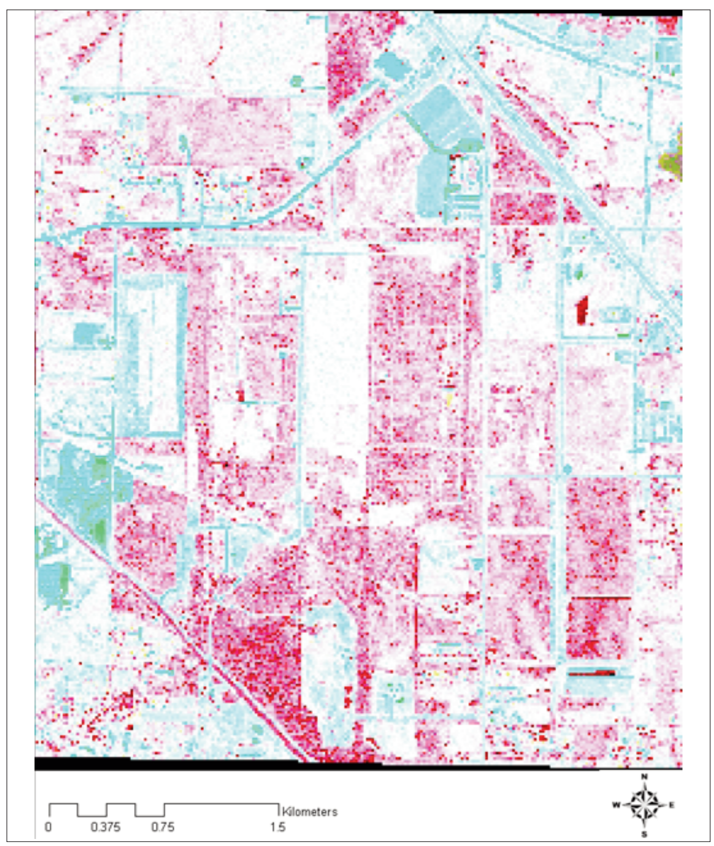


Figure 4. Supervised classification of Quickbird image

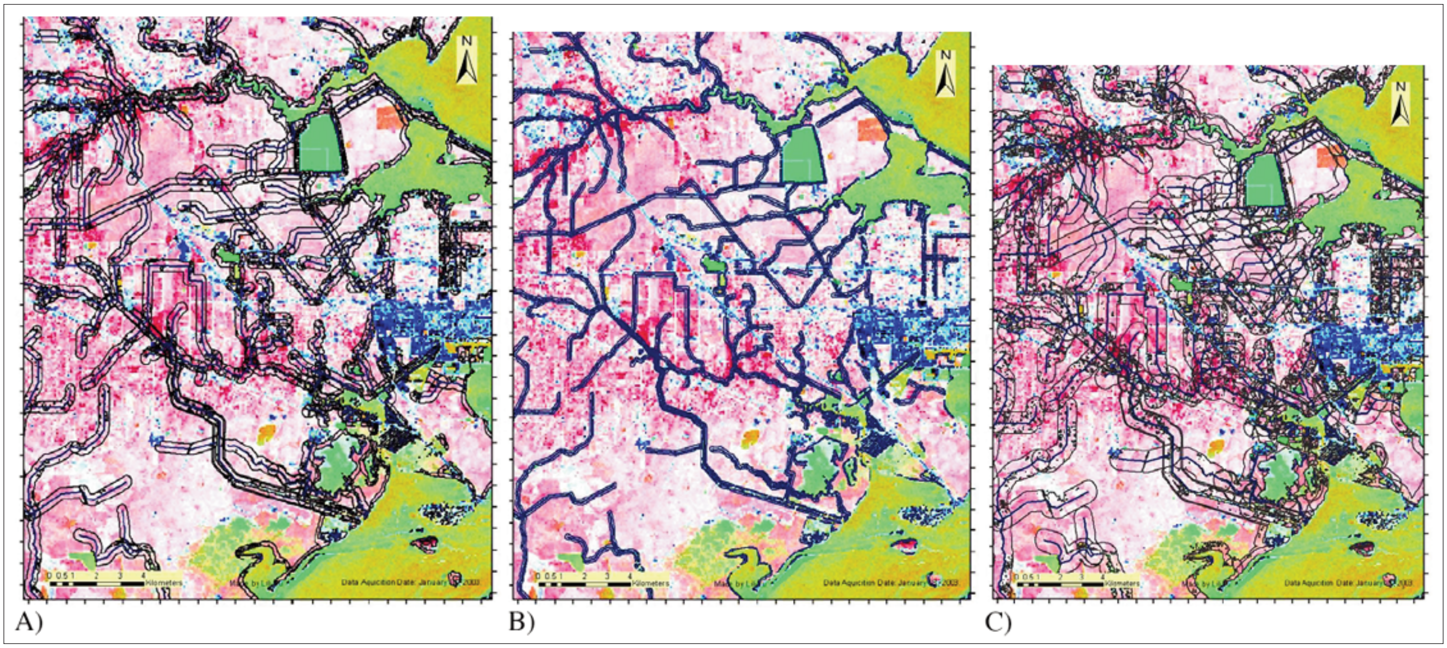

Figure 5. Buffer zone around streams; A) 100 meters, B) 250 meters and C) 500 meter

and maximum likelihood was chosen for supervised classification (see Figure 4).

Several spatial analysis techniques were used for analyzing the data for example append, clip and buffer. A buffer builds a new object by identifying all the area that is within a certain distance of the point, line or polygon. To see the distribution of Chinese tallow buffer zone were created within 100, 250 and 500 meter of stream (using hydrology data). Results show that the Chinese tallow density increases within 500 meters of the streams and at the intersection of streams. (see Figure 5).

We also acquired and processed hyperspectral Hyperion data; the image covers parts of the Houston area but does not inlude the UHCC. Supervised classification of Hyperion data seems very powerful for identification of Chinese tallow. Table 1 shows the summary of results indicating that the growth of Chinese tallow has increased 56.2406% in the last 13 years.

Table 1. Summary of Results

| Date of Image | Grid Code representing Chinese Tallow | Summary of Results (Total count) | Covered Area (m2) | %age |
|---|---|---|---|---|
| 2003/03/23 (Landsat ETM) | 255, 251, 243 | 629 | 556100 | 24.7% |
| 2003/01/18 (Landsat ETM) | 255, 235, 252 | 398 | 358200 | 15.92% |
| 2002/03/04 (Landsat ETM) | 255, 249, 247 | 979 | 1053900 | 46.84% |
| 2000/03/30 (Landsat ETM) | 255, 253, 247 | 637 | 573300 | 25.48% |
| 2000/01/10 (Landsat ETM) | 255, 247, 238 | 183 | 164700 | 7.32% |
| 1994/12/19 (Landsat TM) | 255 | 32 | 28800 | 1.28% |
| 1992/12/08 (Landsat TM) | 255 | 58 | 52200 | 2.32% |
| 1974/06/26 (Landsat MSS) | 255 | 2 | 1800 | 0.08% |
| 2003/12/02 (Quickbird) | 255, 237, 227, 217 | 283075.2 | 12.58% | |

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Khan, S.D. and L. Yu. "Quickbird, Landsat and Hyperion sensors in the study of Chinese tallow in the Houston area," *Comput Environ and Urban* (in review).



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# New Fire-Resistant Compounds for Construction Materials

Jack Y. Lu

Environmental pollution from flame-retardant related materials have recently become an important issue raised by environmental groups. Researchers have found a growing trend of halogenated compounds in the environment and in humans.[1] Some nations, and even states such as California, have banned brominated flame-retardants.[1] However, many of the polymeric construction materials manufactured from industry still contain volatile halogenated organic compounds, such as 3,4,5,6-Tetrabromo-1,2-benzene dicaroxylic acid (mixed esters with diethylene glycol and propylene glycol) making foams, which bear great potential threat to our environment. The pollution from these construction materials is caused by the flame retardants' vapor-phase mechanism and their solubility in the environment. These problems may be solved by designing and synthesizing new flame retardants that prefer condensed-phase mechanism and are insoluble in water. With the environmental concerns of flame retardants, metal-organic coordination polymers are very good candidates.

Among the new materials synthesized in our laboratory, UnHuClFr 1, UnHuClFr 2 and UnHuClFr 3 are insoluble in water and common organic solvents. The new material was blended into high impact polystyrene (HIPS), a commercial flammable polymer, and tested for ignition resistance using the industry-standard UL-94 flame test. A 30 and 28 wt% loading of UnHuClFr in HIPS gave a industry-standard UL-94 V-0 result. To obtain a V-0 rating, the plastic must self-extinguished within 10 seconds after each of two sequential ignitions (an ignition consisting of the bar being immersed in the flame for 10 seconds).

The research activities in our laboratory also produced large pore-containing porous materials for potential environmental applications. The copper-dipyridal complex, for instance, has a single-net open-framework structure. It exhibits very attractive anion exchange, as well as molecular exchange capabilities. Further research on potential applications is in progress.

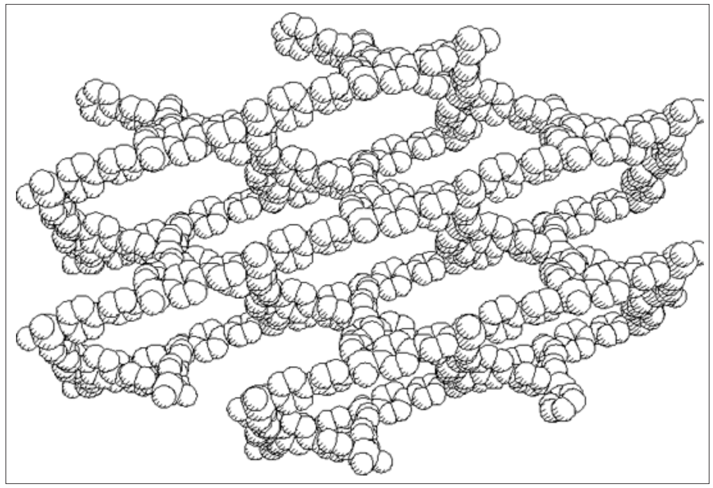

Figure 1. Space-Filling View of the 3-D Open-Framework in the Complex Down to [010] Direction

A new 3-D covalent open-framework coordination polymer uniquely structured (Figure 1) also has been synthesized and characterized in our laboratory.

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# Diversity Patterns in Texas Salt Marsh Plant Communities

Steven C. Pennings

Faced with widespread human impacts on biodiversity, ecologists are increasingly seeking to understand the causes of species diversity in natural systems. Salt marshes are ideal for diversity studies because their plant communities are comprised of a modest number of widespread species, making it easy to compare diversity among regions experiencing different conditions. My results indicate that salt marsh plant diversity patterns vary geographically. Salt marsh diversity patterns, particularly vegetation zones, are well documented in Georgia and elsewhere along the U.S. Atlantic Coast.[1-6] Although salt marshes along the coast of Texas have species pools that are similar to Georgia marshes (in both richness and species composition), they appear to differ in local (plot-level) diversity. By comparing these two geographic regions, I am exploring the factors mediating diversity while minimizing confounding effects from differences in the richness of the species pools or differences in the traits of the species that make up the floras.

The marshes of Georgia have discrete zones of vegetation that form across the edaphic elevational gradient created by the regular diurnal tidal schedule.[5,7] In contrast, the marshes of Texas have the same general vegetation zones, but the zones are less discrete. I hypothesize that this difference in vegetation patterns is a result of the unpredictable tidal flooding of the gulf coast. Hutchinson[8] speculated that, in temporally variable environments, local diversity is not reduced by competition between species. Rather, fluctuating conditions favor first one species, then another, allowing no one species to dominate over time. This may be the mechanism underlying the relatively high-diversity, mixed-species marsh plant assemblages found along the Texas Gulf Coast.

In a previous study, I compared the species-area relationship in zones common to Texas and Georgia marshes. Working at four sites per region, I documented slightly higher diversity at both the plot-level and the marsh level (species pool) in Texas versus Georgia marshes. These and other data collected in the same study provided a strong foundation for understanding the variation in diversity patterns in Texas versus Georgia salt marshes. Variation among sites within a region was high, and replication of sites was not sufficient to encompass the variation found in the entire state. Also, zones were chosen based on species composition; vegetation zones that occurred in only one geographic region were ignored. This work builds upon past results by using new methods to improve diversity estimates, and comparing geographic regions using a large number of sites. In addition, I will test hypotheses about how landscape position within each geographic region affect plant diversity patterns.

**Work Progress**

In the spring and summer of 2005, I sampled a total of 108 marsh sites, 59 in Georgia (Table 1) and 49 in Texas (Table 2). Each site was categorized according to the morphology of the marsh-upland interface and the influence of mainland connection (island vs. mainland). To further examine freshwater influence, Texas sites were categorized by bay system and position within the bay. Freshwater influence of Georgia sites will be determined by proximity to the nearest major river. Within each site, the presence of each plant species was scored in a series of nine nested plots of increasing area placed at each meter along a single transect that was run from the water's edge to the terrestrial border of the marsh. I also scored the relative abundance of each species in the 0.5 × 0.5 m plot at each 1 m interval along each transect. From these data, I will determine (1) species amplitude (horizontal range) within the marsh as well as the species range according to landscape position, (2) the average species-area curve for each marsh as well as that of each vegetation zone and (3) diversity measures as a function of both richness and evenness. I will compute diversity indices incorporating both richness and evenness using Biotools. Distributional limits of species, slopes from species-area relationship, and diversity indices will be compared between regions, among sites of each region according to landscape position, and among zones within each marsh site.

All data have been entered into spreadsheets. I am currently running QA/QC checks on the data, and will soon begin statistical analyses. A manuscript based on this work will be submitted for publication in the spring semester.

**Preliminary Results**

Several observations were made while collecting data. Texas marshes were dominated by salt-tolerant pan species (*Batis maritima*, *Salicornia virginica*, *S. biglovii* and a few shrub species), while Georgia marshes were dominated by grass and rush species, especially the competitive dominants *Spartina alterniflora* and *Juncus roemerianus*. This suggests that Texas marshes contain a higher percentage of high marsh habitats (which are more diverse) than do Georgia marshes. Confirming my previous work, I encountered more species overall in Texas. The average marsh amplitude (horizontal distance from creek to terrestrial border) of Georgia sites was much larger than the amplitude of Texas sites, indicating that the high diversity of Texas marshes was not simply a function of greater area.

Table 1. Study sites in Georgia.

| Region | GPS | Site Name | Position |
|---|---|---|---|
| GA | 31° 25' 13"N, 81° 17' 38"W | Airport | island |
| GA | 31° 31.59'N, 81° 13.84'W | Apex West | island |
| GA | 31° 29.90'N, 81° 13.57'W | Bourbon Field West | island |
| GA | 31° 26' 45"N, 81° 14' 50"W | Cabretta North | island |
| GA | 31° 26.29'N, 81° 14.36'W | Cabretta South | island |
| GA | 31° 30.09'N, 81° 15.28'W | Chocolate | island |
| GA | 31° 23' 54"N, 81° 16' 25"W | Dean Creek Lower | island |
| GA | 31° 23' 36"N, 81° 16' 84"W | Dean Creek Upper | island |
| GA | 31° 17' 73"N, 81° 20' 67"W | Hampton Point | island |
| GA | 31° 28.85'N, 81° 16.27'W | Hunt Camp NW | island |
| GA | 31° 28.70'N, 81° 16.22'W | Hunt Camp SE | island |
| GA | 31° 6.84'N, 81° 24.99'W | Jekyll ISP Pier | island |
| GA | 31° 3.08'N, 81° 25.30'W | Jekyll Boathouse | island |
| GA | 31° 4.96'N, 81° 25.48'W | Jekyll ISP Path | island |
| GA | 31° 27' 10"N, 81° 16' 70"W | Kenan Field | island |
| GA | 31° 23' 33"N, 81° 17' 13"W | Lighthouse | island |
| GA | 31° 23' 22"N, 81° 16' 58"W | Lighthouse Pan | island |
| GA | 31° 31.16'N, 81° 13.76'W | LTER Northend | island |
| GA | 31° 24' 99"N, 81° 17' 61"W | Marsh Landing | island |
| GA | 31° 24.52'N, 81° 15.72'W | Old Beach | island |
| GA | 31° 10.74'N, 81° 21.78'W | Sea Island | island |
| GA | 31° 24' 03"N, 81° 17' 21"W | Shell Hammock | island |
| GA | 31° 30.89'N, 81° 14.66'W | Shell Ring | island |
| GA | 31°27'48"N,81°16'66"W | Timber Dock | island |
| GA | 31°12'37"N,81°21'91"W | Village Ck. | island |
| GA | 31° 9.93'N, 81° 26.95'W | Back River | hammock |
| GA | 31° 29.81'N, 81° 19.60'W | Creighton Island | hammock |
| GA | 31° 10' 15"N, 81° 25' 04"W | Golden Isles Marina | hammock |
| GA | 31° 26.06'N, 81° 18.05'W | Lil Sapelo West | hammock |
| GA | 31° 24.48'N, 81° 19.27'W | North River 1 | hammock |
| GA | 31° 27.66'N, 81° 19.28'W | Old Teakettle | hammock |
| GA | 31° 27.38'N, 81° 20.69'W | Patterson Island | hammock |
| GA | 31° 30.95'N, 81° 17.86'W | Piling Hammock | hammock |
| GA | 31° 27.28'N, 81° 17.26'W | Pumpkin Island | hammock |
| GA | 31° 38.20'N, 81° 20.23'W | Bakers Creek | mainland |
| GA | 31° 26' 13"N, 81° 22' 82"W | Baywood | mainland |
| GA | 31° 33.80'N, 81° 21.71'W | Belle Bluff Marina | mainland |
| GA | 31° 31' 74"N, 81° 21' 61"W | Belleville Rd | mainland |
| GA | 31°22'15"N,81°24'08"W | Black Island | mainland |
| GA | 31°24'48"N,81°23'78"W | Blue-n-Hall | mainland |
| GA | 31° 32' 39"N, 81° 25' 44"W | Buck Hill Swamp | mainland |
| GA | 31° 29' 73"N, 81° 21' 51"W | Culvert | mainland |
| GA | 31° 7.49'N, 81° 28.69'W | DNR Brunswick | mainland |
| GA | 31° 37.46'N, 81° 17.33'W | Harris Neck NWR | mainland |
| GA | 31° 38.57'N, 81° 23.66'W | I95 | mainland |
| GA | 31° 27.52'N, 81° 21.96'W | Kittles Island | mainland |
| GA | 31° 27' 27"N, 81° 21' 52"W | Meridian | mainland |
| GA | 31° 27' 30"N, 81° 21' 88"W | Meridian VC | mainland |
| GA | 31° 36.41'N, 81° 19.67'W | Old Shellman | mainland |
| GA | 31°33'12"N,81°22'25"W | Pine Harbor | mainland |
| GA | 31° 10' 57"N, 81° 27' 91"W | Riverside | mainland |
| GA | 31° 38.84'N, 81° 23.38'W | RV Park | mainland |
| GA | 31° 33.63'N, 81° 19.74'W | Sapelo Golf Club | mainland |
| GA | 31° 33.06'N, 81° 20.06'W | Sapelo Golf SBP | mainland |
| GA | 31°22'47"N,81°24'45"W | St. Andrews Cem. | mainland |
| GA | 31°28'47"N,81°20'55"W | Valona | mainland |
| GA | 31°26'87"N,81°22'54"W | Webster's | mainland |
| GA | 31° 35.03'N, 81° 21.59'W | White Chimney | mainland |
| GA | 31° 37.57'N, 81° 19.63'W | Young man | mainland |

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Table 2. Study sites in Texas

| Region | Site Name | GPS | Position | Bay system | Bay position |
|---|---|---|---|---|---|
| TX | Yacht Basin | 29° 30.75'N, 94° 30.70'W | island | Galveston | primary |
| TX | Steve's Landing | 29° 28.00'N, 94° 38.69'W | island | Galveston | primary |
| TX | Fort Travis | 29° 21.91'N, 94° 45.64'W | island | Galveston | primary |
| TX | Golf Course | 29° 15.29'N, 94° 51.86'W | island | Galveston | primary |
| TX | Dana Cove GISP | 29° 12.72'N, 94° 57.30'W | island | Galveston | primary |
| TX | Clapper Rail GISP | 29° 12.05'N, 94° 57.74'W | island | Galveston | primary |
| TX | San Luis Pass | 29° 04.16'N, 95° 07.89'W | island | Galveston | primary |
| TX | Ernie's Too | 29° 03.23'N, 95° 09.54'W | island | Galveston | primary |
| TX | Cedar Break | 29° 02.17'N, 95° 10.77'W | island | Galveston | primary |
| TX | Stilt House | 29° 00.96'N, 95° 12.42'W | island | Galveston | primary |
| TX | No Dumping | 29° 00.46'N, 94° 13.18'W | island | Galveston | primary |
| TX | Fireworks | 29° 59.33'N, 94° 14.49'W | island | Galveston | primary |
| TX | Crabbing Pier | 28° 58.45'N, 95° 15.75'W | island | Galveston | primary |
| TX | Surfside1 | 28° 57.60'N, 95° 16.70'W | island | Galveston | primary |
| TX | Tarpon Lane | 28° 57.66'N, 95° 17.77'W | island | Galveston | primary |
| TX | Beach Resort | 28° 57.12'N, 95° 17.39'W | island | Galveston | primary |
| TX | Spoonbill RV Park | 29° 32.71'N, 94° 46.88'W | mainland | Galveston | secondary |
| TX | Miller Point | 29° 26.70'N, 94° 55.03'W | mainland | Galveston | primary |
| TX | Waterman's Harbor | 29° 27.46'N, 94° 58.42'W | mainland | Galveston | primary |
| TX | Hitchcock | 29° 19.89'N, 94° 56.89'W | mainland | Galveston | primary |
| TX | 45 Bridge | 29° 18.57'N, 94° 54.52'W | mainland | Galveston | primary |
| TX | Beach and Tackle | 28° 57.70'N, 95° 18.13'W | mainland | Galveston | primary |
| TX | Tiki Island | 29° 17.94'N, 94° 5.51'W | mainland | Galveston | primary |
| TX | Matagorda1 | 28° 40.81'N, 95° 57.23'W | island | Matagorda | primary |
| TX | Allen's landing | 28° 38.96'N, 95° 57.74'W | island | Matagorda | primary |
| TX | Matagorda4 | 28° 38.47'N, 95° 57.95'W | island | Matagorda | primary |
| TX | Matagorda2 | 28° 37.52'N, 95° 58.27'W | island | Matagorda | primary |
| TX | Matagorda3 | 28° 36.53'N, 95° 58.47'W | island | Matagorda | primary |
| TX | Palacios East | 28° 44.25'N, 96° 24.10'W | mainland | Matagorda | secondary |
| TX | Palacios West | 28° 44.25'N, 96° 24.10'W | mainland | Matagorda | secondary |
| TX | Olivia West | 28° 38.66'N, 96° 27.57'W | mainland | Matagorda | secondary |
| TX | Magnolia Beach | 28° 33.58'N, 96° 32.24W | mainland | Matagorda | primary |
| TX | Powderhorn Lake | 28° 30.60'N, 96° 30.51'W | mainland | Matagorda | tertiary |
| TX | Indianola | 28° 31.10'N, 96° 30.29'W | mainland | Matagorda | tertiary |
| TX | Port O'Conner | 28° 27.56'N, 96° 24.88'W | mainland | Matagorda | primary |
| TX | Goose ISP Trout | 28° 07.52'N, 96° 58.82'W | island | Aransas | primary |
| TX | Goose ISP Redfish1 | 28° 07.70'N, 96° 59.36'W | island | Aransas | primary |
| TX | Goose ISP Redfish2 | 28° 07.69'N, 96° 59.24'W | island | Aransas | primary |
| TX | Rockport Park | 28° 02.03'N, 96° 02.17'W | island | Aransas | tertiary |
| TX | Port Aransas | 28° 01.85'N, 96° 02.78'W | island | Aransas | primary |
| TX | Goose ISP Ramp | 28° 07.78'N, 96° 59.13'W | mainland | Aransas | primary |
| TX | Copano Pier North | 28° 08.13'N, 96° 00.06'W | mainland | Aransas | secondary |
| TX | Copano Pier South | 28° 06.68'N, 96° 01.53'W | mainland | Aransas | secondary |
| TX | Holiday Inn Exp | 28° 01.85'N, 96° 02.78'W | mainland | Aransas | tertiary |
| TX | Shell Ridge | 28° 01.85'N, 96° 02.78'W | mainland | Aransas | tertiary |
| TX | Port Bay | 27° 59.65'N, 97° 10.02'W | mainland | Aransas | secondary |
| TX | Highway 136 | 27° 03.55'N, 97° 13.29'W | mainland | Aransas | secondary |
| TX | Egery Island | 28° 04.22'N, 97° 13.16'W | mainland | Aransas | secondary |
| TX | Black Point | 28° 04.22'N, 97° 13.16'W | mainland | Aransas | secondary |


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## Funding and proposals

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Lyons, P., S.C. Pennings and M.A. Moran. “UMEB: Ecological research from the summit to the sea,” National Science Foundation. (Resubmission is pending.)

Pennings, S.C. “Constraints on host use by a parasitic plant,” Houston Coastal Center, $14,537.


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# Clean, Efficient Hydrogen Generator

James T. Richardson

Fuel cells are more efficient than combustion of fossil fuels, and promise to conserve natural resources while reducing emissions. Fuel cells for distributed power or vehicles require cost-effective, localized production of hydrogen from fossil fuels, primarily from steam reforming of natural gas. High temperatures (>800°C) are required and heat management is a problem. Although large-scale plants achieve high efficiencies (80%), current designs make this difficult for small ones.

The objective of this research is to develop a compact, efficient and cost-effective natural gas fuel processor by integrating technologies from past research in this laboratory: sodium heatpipe reforming and catalytic combustion with ceramic foams. A heat pipe comprises an evacuated tube containing material that evaporates at the temperature of interest. Energy is absorbed at one end through vaporization. Vapor molecules diffuse at sonic velocities to the opposite end of the pipe, where condensation removes energy. Liquid flows back to the evaporator along the inner surface of the tube. Past research demonstrated the advantages of heat pipe reactors for steam reforming.[1-4] Important characteristics are more efficient heat transfer, compact heating configurations and improved control. Further improvements are possible using catalytic combustion instead of flame burners[5] and ceramic foams for the catalytic beds. Ceramic foams exhibit high porosities (85 to 90%), and this high tortuosity leads to heat transfer rates up to five times greater than equivalent packed beds, resulting in smaller reactors.[6] These features make heat pipe reformers ideal for clean, efficient, compact hydrogen production.

Initially, 2-D models were developed for reforming and combustion reactors, using kinetic equations measured for reforming combustion catalysts. Previously determined heat transfer correlations for ceramic foams were also incorporated. Simulations were checked against experiments to confirm conversion and temperature predictions.

Six configurations for integrating catalytic combustion with steam reforming were examined, and the best is shown in Figure 1. The reforming reactor is a tube separated from a concentric combustion bed by an annular sodium-vacuum space. The evaporator is the outer and the condenser is the inner surface of this space. This design is simple, catalyst beds are minimized, and the reactor walls remain isothermal, a feature not found in other types of reformers.

The next phase was to simulate a small-scale (1 kg/h) hydrogen processor. This indicated a reformer tube two meters in length and 10 cm in diameter, with an annular combustion bed of 1.5 cm thickness. Reformer feed comprised 60 SLPM of $CH_4$ and 180 SLPM of $H_2O$ at 500°C and 5 atm. Combustion feed was 30 SLPM of $CH_4$ and 1000 SLPM of air at 400°C and 5 atm.

The heat pipe operated at 850°C, giving 94.3% $CH_4$ conversion and 1.02 kg H2/h. Axial and radial temperature pro-

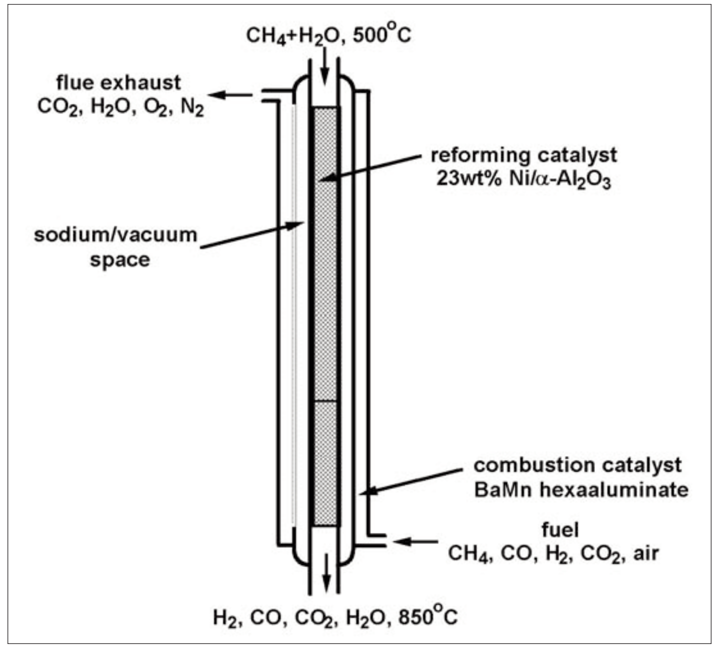


Figure 1. Optimized configuration for the heat pipe reformer

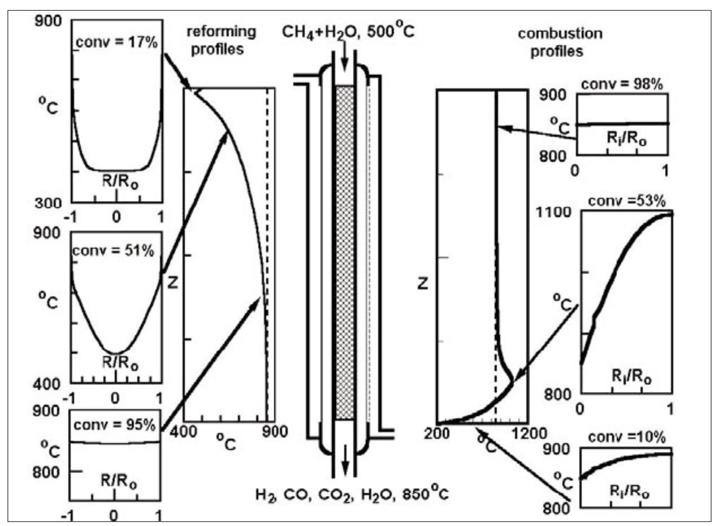


Figure 2. Temperature profiles in the heat pipe reformer

files (Figure 2) show sharp endothermic and exothermic profiles at the beginning of each bed, but uniform levels for over half thereafter.

Ten of these tubes deliver 250 kg/day, and preliminary calculations indicate an overall process efficiency of 92%, compared to DOE's target of 75%.[7] Costs are $2.50/kg, compared to the DOE target of $3.00/kg for 2007 and $2.50/kg for 2010.

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# Investigating the Metabolic Pathway of Anaerobic Biodegradation of Unsaturated Hydrocarbons in Marine Sediment

Deborah J. Roberts and Ken Butler

Synthetic based drilling fluids (SBF) can contain olefins and are used to lubricate drill bits during deep-sea drilling operations. Concern about the environmental impact of the discharge of drill cuttings by the EPA has resulted in the enactment of rules requiring that all SBF be certified as biodegradable by microorganisms indigenous to the marine sediment. Knowledge of the metabolic intermediates of the biodegradation of SBF may provide a rapid and sensitive means to reveal intrinsic biodegradability potential. In addition, this research should advance the state of knowledge concerning the fate of hydrocarbon pollutants in the natural environment.

The pathway investigations were performed by looking for suspected metabolites in ocean sediments collected near drilling platforms in the Gulf of Mexico. Based on the literature review,[2-5] it was anticipated that some or all of the following metabolites could be present: *C*14, *C*16 and *C*18 alcohols; *C*14, *C*16 and C18 ketones; *C*14, *C*16 and *C*18 aldehydes; *C*14, *C*16 and C18 epoxides; *C*14, *C*16 and *C*18 alkylsuccinates; and *C*4 to *C*21 carboxylic acids (saturated and unsaturated).

Hydrocarbons were extracted in triplicate samples of twelve sediments obtained near (within 100 meters), and far (from 3000 to 6000 meters) from six drilling platforms in the Gulf of Mexico. For each sediment collected near a drilling platform (near-field sediment) its corresponding far-field sediment was also collected. Dichloromethane was used as the extraction solvent and a 50/50 (wt/wt) mixture of octanoic acid and 1-octanol was used as an internal extraction standard. Each extract was evaporated to approximately 1.8 ml and split by volume. Half of each concentrated extract was reacted with *N*, *O*- bis [trimethylsilyl] trifluoroacetamide (BSTFA) to from trimethylsilyl (TMS) esters of any acids or alcohols. Each concentrated extract (derivatized and nonderivitized) was analyzed by gas chromatography mass spectrometry (GC/MS).

Possible metabolites were identified by examining the spectra of each peak found in the samples and comparison of the mass spectra obtained with those contained in the National Institute for Standards and Technology (NIST) mass spectral library and/or the Palisade mass spectral library (Palisade Corporation, Newfield, NY).

To date, the following possible metabolites of anaerobic degradation of SBF have been observed in the extractions:

1. acids:
   a. saturated *C*6 (hexanoic) (two structural isomers)
   b. saturated *C*14 (tetradecanoic) (two structural isomers)
   c. saturated *C*15 (pentadecanoic) (three structural isomers)
   d. saturated *C*16 (hexadecanoic)
   e. unsaturated *C*16 (hexadecenoic)
   f. saturated *C*17 (heptadecenoic) (two structural isomers)
   g. saturated *C*18 (octadecanoic)
   h. unsaturated *C*18 (oleic)
   i. unsaturated *C*18 (linoleic)
2. alcohols:
   a. saturated *C*14 (tetradecanol)
   b. saturated *C*16 (hexadecanol) (two structural isomers)
   c. saturated *C*18 (octadecanol)

The presence of ketones, aldehydes, epoxides, or alkylsuccinates has not been confirmed. Two sample mass spectra along with their library matches are presented in Figures 1 and 2.

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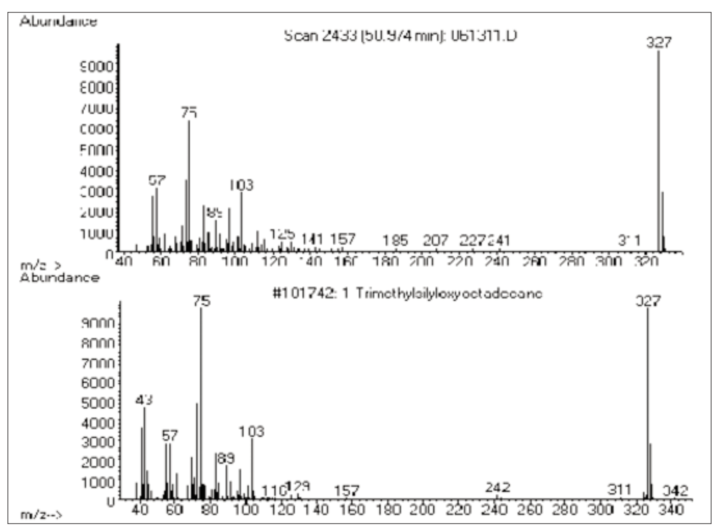


Figure 1. Mass spectrum of peak at retention time: 51.0 minutes compared to spectra of the TMS derivative of 1-octanol obtained from the NIST database.

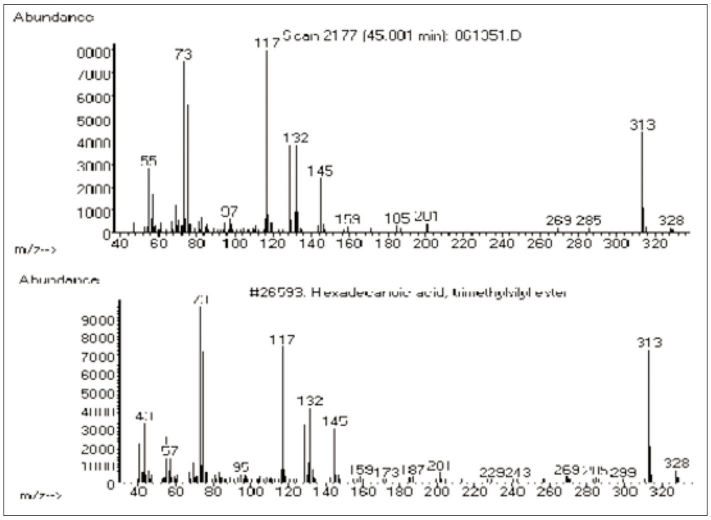


Figure 2. Mass spectrum of the peak at retention time: 45.0 minutes compared to spectra of the TMS derivative of hexadecanoic acid obtained from the NIST database.

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# Dissipation of Selected Estrogens and Alkylphenols in Waters and Domestic Wastewaters

Chunlong Zhang and Zlata Grenoble

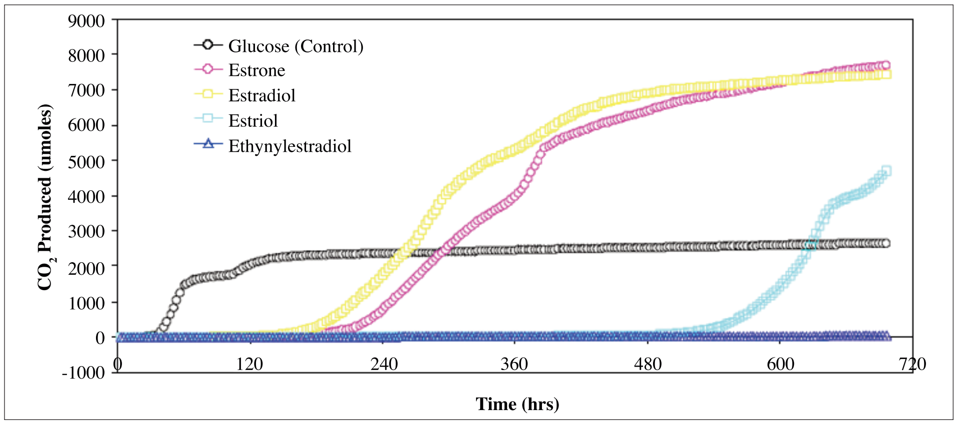


Figure 1. Mineralization of selected endocrine disrupting compounds (EDCs)

Several recent studies provide various results regarding the dissipation (sorption and biotransformation) of endocrine disrupting compounds (EDCs). Lee et al.[1] concluded that hydrophobic partitioning is the dominant sorption mechanism for testosterone, 17$\beta$ estradiol (E2) and 17$\alpha$ ethynylestradiol (EE2). The large $K_{oc}$ values (≈3-4) imply that leaching from soil is limited whereas runoff of soil- and land-applied biosolids are most likely the inputs into surface water, and significant fraction of these compounds is associated with sediments. The sorption of nonylphenol (NP) in terrestrial soils was found to fit linear isotherms and the partition coefficient was correlated with organic carbon contents of the soils.[2] On the contrary, using organic colloids (humic acids and fuvic acids), Yamamoto and Lijestrand[3] did not find a significant trend nor linear correlation with log Kow for several test estrogenic compounds. A weak correlation between testosterone sorption and soil organic matter was also observed by Casey et al.[4] who indicated that testosterone has a greater potential to migrate in soil because it was not as strongly sorbed as E2.

The same disparity exists among various investigators regarding the removal of these compounds in sewage treatment plants employing aerobic activated sludge process. In a review, Johnson and Sumpter[5] concluded that 85% of E2, estriol (E3) and EE2 can generally be removed in activated sludge process. The removal efficiency for estrone (E1) appears to be less and is more variable. Alkylphenols have the greater tendency to be accumulated in sludge due to their bacterial recalcitrance and hydrophobicity. In a more recent study in a German municipal sewage treatment plant, Andersen et al.[6] determined that natural estrogens (E1 and E2) exceeded 98% elimination efficiency, and EE2 reached more than 90% reduction. Only 5% of the estrogens were sorbed onto digested sewage sludge.

The objective of this study was to investigate two potential removal mechanisms (mineralization potential by respirometer study and sorption by batch study) of selected EDCs from the environment. The work has been focused on six specific compounds including 17$\beta$ estradiol (E2) (one of the most common steroid estrogens), estriol (E3) (an important pregnancy estrogen as well as a metabolite of E2), 17$\alpha$ ethynylestradiol (EE2) (the main component of contraceptive pills), estrone (E1), testosterone, and *p*-nonylphenol (a synthetic estrogenic compound as well as the intermediate from anaerobic degradation of widely used nonionic sufactants). A better understanding of these removal processes will be helpful to improve existing treatment technologies and identify optimal wastewater treatment plant operating conditions.

Substantial mineralization has been achieved for all naturally occurring EDCs with varying bacterial lag phases, whereas two xenobiotic compounds (EE2 and NP) have shown resistance to biodegradation under experimental conditions when they served as the sole carbon source (Fig 1). The percent mineralization and kinetic rates indicate that the retention times of the conventional activated sludge treatment systems are insufficient to allow for complete mineralization of the steroids. A comparison of the experimental data found at the beginning of the experiment with those generated later in the experimental stage show that bacteria acclimated to the steroidal compounds exhibit a significantly shorter lag phase.

The respirometer experiments further tested the effects of EDC concentration in the presence of clay used as model sorbent for testosterone and estradiol. The results obtained from the testosterone experiments show that sorption to clay had an impact on the biodegradation. Kinetic rates and overall mineralization decrease with increasing amounts of clay. Additional experiments including the effects of a cosubstrate (easily degradable glucose) show that testosterone degradation and kinetic rates were not significantly influenced by the presence of a cosubstrate. Similar experiments with estradiol are in progress at this time. Analytical methods (LC-MS) were used for the analysis of the experimental samples in support of the experimental work to evaluate the sorption mechanisms as well as the biodegradation products and intermediates formed during the degradation process. Compound specific methods for analysis of the six compounds have been developed for identification and quantitation of these compounds.

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Zhang, C. and M.A. Kaulen. "A Chemodynamic Sediment Flux Model in TMDLs Determination of PAHs in Patrick Bayou, Texas," SETAC 26th Annual Meeting, Baltimore, MD, Nov. 13–17, 2005. (*Platform.*)

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### Funding and proposals

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—. "Teaching environmental sciences," Texas Commission on Environmental Quality (TCEQ), May–Aug. 2005, $18,000.

Zhang, C. and A. Morse (Co-PI). "Fate of estrogenic compounds during wastewater solids processing," Texas Tech University, Water Environmental Research Foundation, Sept 2005–Aug 2007, $200,000. (*Not funded.*)

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