New Waves
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## *Texas A&M Works with Golf Courses to Enhance Environment, Wildlife Habitat*

When rural, overgrown land north of Houston was purchased in the late 1950s for a golf course, many a saw blade got dull making the place look "civilized."

"Now we know we're in the city, and we've gone 180 degrees -- we are trying to make the place be more like it was in the natural setting," says Charles Joachim, superintendent at Champions Country Club which now is surrounded by urban sprawl. "It's the right thing to do."

How to take golf courses from the manicured, pesticide-laden image of a few decades ago towards well-managed, pristine courses that permit quality play among wildlife and natural plant settings is the stroke many course superintendents are now after.

*Richard White of the Texas Agricultural Experiment Station works with this golf course near Houston.*

More than 70 golf courses in Texas, including Champions, are pursuing certification as wildlife sanctuaries under a program by the Audubon Society and the United States Golf Association. Lake Side Country Club in Houston is the first fully certified course in Texas, according to Audubon ecologist Marla Briggs.

A unique boost to the effort in Texas, where long sunny days have sparked a passion for golf played on some 900 courses, comes from Texas A&M University (TAMU). For many golf courses, researcher Richard White and students are providing the first step toward certification. The group conducts initial resource assessment surveys documenting the wildlife and plant species that already exist on the course.

White said working with golf courses -- where many turf majors hope to land jobs after graduation -- is an excellent teaching tool. "The students know this is important for the environment," White said. "They see the golf course as a whole, not just the turf, and start thinking about ways to make it better. They get to begin applying principles they are learning in class."

TAMU students begin the process by dividing into teams for photography, land use, plant inventory, wildlife inventory and superintendent information. White said that by working in teams the group can complete the resource assessment in a day. Other steps of the program involve learning about and practicing environmental planning specific to each course as well as such issues as water quality management, water conservation, integrated pest management, wildlife and habitat management, and outreach and education. Full certification may take one to three years.

For details, contact White at (409) 845-3496 or rh-white@tamu.edu.

## *NIWR Awards TAMU Researchers Grant to Study Pollution from Landfills*

Researchers at Texas A&M University (TAMU) have been awarded a grant to study the movement of pollutants from landfills into groundwater supplies. The grant was awarded through the National Institutes for Water Resources (NIWR) Western Region competitive grants program, which is funded by the U.S. Geological Survey (USGS).

*Ethan Grossman (right) and Luis Cifuentes at the College Station landfill.*

Ethan Grossman of the TAMU Geology and Geophysics Department and Luis Cifuentes of the TAMU Oceanography Department will work with J. Suflita of the Botany and Microbiology Department at the University of Oklahoma and George Briet of the USGS in Denver, CO to investigate issues associated with contamination of groundwater supplies from landfill leachate.

The project will determine how hydrological, microbiological, and geochemical processes influence the movement of toxic chemicals throughout aquifers. Many older landfills are unlined and located above alluvial aquifers. As a result, the downward flow of landfill leachates could contaminate groundwater supplies. The project team will examine the terminal electron-accepting microbial processes active within aquifers and define how the dominant redox zones and zone boundaries vary over space and time.

For details, contact Grossman at (409) 845-0637 or e-grossman@tamu.edu, or Cifuentes at (409) 845-3380.

## *Is Agriculture Sustainable in Semiarid Regions?*

**Researchers:** Bobby Stewart and Clay Robinson, Dryland Agriculture Institute, West Texas A&M University, Canyon, TX.

**Problem:** Because of global population growth and resulting demands for food, many experts feel that agricultural production will increase on marginal lands in semiarid ecosystems. There are imbalances between natural resources, populations, and basic human needs in these areas. Semiarid regions comprise 15% of the world's population and 13% of global lands, and produce 11% of the worldwide food supply. Since 1989, the amount of new agricultural lands has grown less than 1% annually, prompting increased use of pesticides and fertilizers. These factors are causing increased questions about whether agricultural production can be sustainable over the long-term, especially on marginal semiarid lands.

**Objective:** To examine some of the more important plant-soil-water relationships in semiarid regions, so the steps required to sustain agroecosystems will be better understood.

**Background Information:** Agroecosystems are defined as ecological systems modified by humans to produce food, fiber, or other agricultural products. Agroecosystems address three major issues -- productivity, stability and sustainability. These factors may conflict. Agroecosystems can be managed to increase short-term benefits (productivity), but in the process may shorten the useful life of the ecosystem (stability and sustainability). Semiarid regions have four unique characteristics: 1) precipitation, temperature, and other climate factors are highly variable from year to year, 2) crops cannot be managed the same way from one growing season to another, 3) soil resources and the water-holding capacity do not remain the same once agroecosystems are introduced, 4) abundant sunny weather creates conditions for rapid growth when moisture is favorable, but these water-rich conditions are typically not sustained throughout the growing season. Semiarid regions throughout the world were defined using the United Nations Aridity Index, and the length of the growing season. Sustainability was discussed in terms of agroecosystem processes, the effects of agriculture on climate and soils, and the socioeconomic status of individual producers. Technologies for increasing plant available water were discussed including lengthening the fallow period,

the use of mulches, tillage practices, and the use of crop calendars to match planting and harvesting dates with the climate of a region. Tillage practices, residue management, and shortening the fallow period were investigated as strategies to maintain soil organic matter.

**Discussion:** Increasing population and living standards may force agricultural development into semiarid regions that are not favorable for crop production. Agroecosystems can be developed and sustained in these regions, but careful management is required. Preventing soil degradation is a chief concern. Soil organic matter must be preserved so that soils will continue to be productive. Another challenge is that semiarid regions often receive little precipitation. This, combined with warm weather throughout much of year, accelerates the decomposition and loss of native soil organic matter. There are many potential solutions that need to be investigated and employed to make agricultural production in these regions sustainable, including reduced tillage practices and methods to capture and make the best use of available water supplies.

**Reference:** W.A. Stewart and C. Robinson, "Are Agroecosystems Sustainable in Semiarid Regions," *Advances in Agronomy*, Vol. 60, pp. 191-228, 1997.

**NOTE:** Stewart can be contacted at (806) 656-2299 or bstewart@wtamu.edu.

## *Relationships Between Property Rights and Reservoirs*

**Researcher:** Lisa Gossett, Environmental Management Department, University of Houston-Clear Lake, Clear Lake, TX.

**Problem:** Many existing dams, canals, and other water developments were constructed many years ago. Since that time, the actual uses of these projects may have changed significantly (a dam originally built for flood control may be used today primarily for a water supply). In addition, the basic premises on which these structures were originally built (the extent to which nearby properties would flood if water reached a key level in a reservoir, for example) may have changed as a result of urbanization and development. As circumstances and operating procedures change, there can be legal ramifications if property owners can show they have been damaged by operational changes and decisions affecting their property.

**Objectives:** To examine many recent case studies in which lawsuits have been filed over property rights issues associated with the construction, management, and operations of Texas water projects.

**Background Information About "Takings" Issues:** The takings clause of the 5th Amendment of the U.S. Constitution applies when property is appropriated by a government entity. For example, owners should be paid fair market value when their lands are permanently flooded by a reservoir. Other takings issues can result when land uses are restricted by the finding of wetlands that need to be protected and the presence of endangered species. Such extreme events as floods and droughts can trigger lawsuits that

relate to takings. Property owners may pursue a takings-related lawsuit if their lands have been flooded after a dam was constructed, but they were consistently not inundated previously.

**Texas Case Studies:** Many case studies involving lawsuits related to takings were presented in the paper. Only a brief recap will be shown here. In one instance, residents sued the Harris County Flood Control District after their homes were flooded for the first time in the early 1990s. They claimed that modifications in the watershed (increasing drainage systems, while a planned detention pond was not built) increasing flooding downstream. They filed a takings claim and the case was settled, with payments being made to flooded residents. Another situation focused on Eagle Mountain Lake near Fort Worth. In the 1920s, reservoirs were built for multiple purposes, including flood control . Later, the Tarrant County Regional Water District made improvements in the reservoir system and offered lakefront tracts for sale to the public as homesites. As a result of flooding in 1989 and 1990, many residents sued the District. They argued the District failed to respond to concerns raised by residents before, during, and after both floods about how lake waters should be managed. The Court of Appeals ruled in the District's favor based on a flowage easement in the initial deeds from the District, the facts in this case, and sovereign immunity. However, the court stated that a taking would occur if the facts showed that the District's operation of the dam "caused intermittent, frequent, and inevitably recurring flooding in excess of the scope of the easement." Other case studies cited by the author involved actions by homeowners in Central Texas to manage levels of the Highland Lakes for recreation, and increased floods caused by damage to irrigation canals.

**Discussion:** Takings claims can be successfully pursued against government entities which manage water resources. Awareness of potential liabilities is a key step if future problems are to be avoided. Overoptimistic assumptions about the performance of flood control and water supply facilities can lead to false high expectations. When dams and other structures fail to meet expectations, the likelihood of lawsuits based on takings issues may increase.

**Reference:** Gossett, L., "Property Rights Issues by Recreational and Residential Uses Near Water Resource Projects," *Aesthetics and the Constructed Environment, American Society of Civil Engineers*, 1997.

**NOTE:** Gossett can be contacted at (281) 283-3257.

## *Findings from the 1996 Texas Environmental Survey*

**Researcher:** Stephen Klineberg, Sociology Department, Rice University, Houston, TX.

**Problem:** During the past 25 years, environmental concerns have become a profound and enduring social theme throughout the world. Recently, the American environmental movement seems to be in decline and many of its largest organizations have suffered steep falls in membership and funding. On-going surveys of public opinion are needed to determine how Texans feel about environmental issues and to guide public policy.

**Objectives:** 1) to survey Texans about their attitudes toward the environment; 2) to gather information about how Texans feel about political issues; and 3) to determine trends between the 1996 survey and previous surveys.

**Methods:** Rice University has conducted the Texas Environmental Survey in 1990, 1992, 1994, and 1996. Interviews were conducted in Spanish and English in November and December, 1996. A representative sample of 1,001 Texas residents were interviewed over the telephone. Interviews lasted an average of 18 minutes. Questions that were used in previous surveys were also employed in the 1996 survey. In general, many of the questions asked respondents to evaluate the seriousness of pollution, to make choices between protecting the environment, economic growth, and the size of government, and to identify the extent they take part in environmental activities.

**Results:** In 1996, roughly 54% of respondents said pollution is not much of a problem in their area. Roughly 48% of Texans said that too little is being spent on environmental protection. More than 60% of respondents disagreed with a statement that pollution control measures are unfair to industries. Only 44% of Texans said that they would spend $200 more each year to buy products that would control pollution. Nearly 70% of respondents said they were willing to pay $0.25 more each month in their water and wastewater bill to build more storm sewers. Roughly 63% of Texans said that stronger government regulation is needed to control industrial pollution. More than 60% of respondents disagreed with the suggestion that there is too much of an emphasis on conserving natural resources. Less than 40% of Texans said that people worry too much about threats to the global environment. Only 12% of respondents said that they or anyone in their family had ever personally suffered from an environmental problem. Those respondents who said they had a favorable impression of radio talk show host Rush Limbaugh evidenced less concern about environmental issues than those who had a mixed or unfavorable impression of Limbaugh.

**Reference:** Klineberg, S., "Trends in Stakeholder Opinions: Findings from the Texas Environmental Survey (1990-96)," *Proceedings from the International Conference on Sustainable Development*, Energy and Environmental Systems Institute, Rice University, 1997.

**NOTE:** Klineberg can be reached at slk@rice.edu or (713) 527-8101. To buy a copy of the proceedings, contact EESI at ( 713) 527-4700 or eesi@rice.edu.

## *Analysis of Riparian Vegetation in the Lower Rio Grande*

**Researchers:** Robert Lonard and Frank Judd, Biology Department, University of Texas-Pan American, Edinburg, TX, and James Everitt, David Escobar, and Michael Davis, U.S. Department of Agriculture Research Service, Weslaco, TX.

**Problem:** Few studies have been conducted to characterize the riparian vegetation along the Lower Rio Grande. Information about riparian communities is needed because 90% of the vegetation near the river has been cleared since 1900. The riparian zone along this stretch of the river has been identified by state and federal agencies as a critical habitat that needs to be preserved as a wildlife corridor for threatened and endangered species. Resource managers will benefit from additional information about riparian vegetation and trends.

**Objectives:** 1) To provide a quantitative description of the vegetation structure of the riparian zone; 2) to determine if dominant species displayed characteristic signatures so that they could be identified through multispectral video images, and 3) to analyze patterns of variation.

**Methods:** Video images were obtained during the 1996 drought. A three-camera multispectral imaging system was mounted onto a fixed wing Aerocommander plane. The system consists of three video cameras and a computer equipped with an image digitizing board. The cameras can acquire both visible and near-infrared (NIR) data. Two cameras were equipped with yellow-green filters while the other used a visible/ NIR filter. The video images were supplemented with ground surveys. Three sites were studied: 1) the Sabal Palm Sanctuary southeast of Brownsville; 2) near the Santa Ana National Wildlife Refuge (NWR) south of Alamo, and 3) the Lower Rio Grande NWR southwest of LaJoya. The video images were verified by ground truthing, which consists of using line intercept techniques to quantify vegetation abundance.

**Results:** At the Sabal Palm Sanctuary, the dominant tree species was sugar hackberry, the shrubs that were found most often include correhuela, Texas mallow and *C. laevigata*, and the dominant grass species was Guineagrass, which is not native to the region. At the Santa Ana NWR, the most important tree species were cedar elm and anacua and the shrubs were characterized by a dense tangle of such armed brush species as colima and granjeno. Again, Guineagrass was the dominant grass. At the Lower Rio Grande NWR, the most often found trees were *C. laevigata* and huisache, there was no clear dominant shrub, and a vine, old man's beard, was found throughout the area. The findings were surprising because it had been reported previously that Guineagrass was not commonly found in the region. The methods used to analyze the riparian vegetation worked well to assess the population of various tree species, but were not as useful to measure differences in shrub and grass species.

**Reference:** Lonard, R., F. Judd, J. Everitt, D. Escobar, and M. Davis, "Using Multispectral Videography in Distinguishing Species Composition and Vegetation Pattern in Riparian Forests of the Lower Rio Grande," Presented at 16th Biennial

Workshop on Color Photography and Videography in Resource Assessment, Weslaco, April 1997.

**NOTE:** Judd can be contacted at fjudd@panam.edu or (210) 316-7001. Lonard can be contacted at rlonard@panam.edu or (210) 381-3656.

## *Arsenic Retention and Release in Oxide-Dominated Systems*

**Researchers:** Richard Loeppert, Amita Jain, Klaus Raven, and Jianlin

Wang, Soil and Crop Sciences Department, Texas A&M University, College Station, TX.

**Problem:** Heavy metals from oil fields, mines, agricultural production, and industrial sites can pollute surface water. Arsenic is a heavy metal that poses an especially high pollution risk and has been found at sites in East and Central Texas. There are some difficulties in accurately measuring arsenic levels and potential biohazard. For example, arsenic concentrations in suspended sediments are often poorly correlated to levels in fish tissues. In addition, heavy metal concentrations in pore waters of bottom sediments often vary highly with space and time. Finally, arsenic speciation and solubility are strongly influenced by environmental conditions such as pH and redox potential. Existing methods recommended by the U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey (USGS) often do not provide a reliable measure of arsenic bioavailability.

**Objectives:** 1) To characterize the concentrations and chemical forms of arsenic and the factors which influence its release, 2) to evaluate the role of the oxidation/reduction processes that may occur

in sediments on the retention and release of arsenic, 3) to evaluate

the retention and release of arsenate and arsenite by oxidized sediments, and 4) to develop surface dissolution procedures to assess heavy metal mobilization potential in sediments in aquatic environments and calcareous streambed sediments.

**Methods:** Bottom sediment cores, suspended sediment samples, pore water samples, and bulk water samples were obtained from an arsenic-contaminated lake in Bryan, TX. Samples were also obtained from arsenic-contaminated sites in Houston and Beaumont. Water samples were filtered and analyzed for pH, Fe, $SO_4$, $S^2$-, and As by potentiometric and atomic absorption procedures. Sediment samples were split into two fractions: one part was maintained in a reduced state in sealed bottles while the other was allowed to air dry.

Air-dried samples were separated into sand, clay, and silt particles, the particle size was determined, and the mineralogy was determined. The total arsenic contents of the oxidized and reduced sediments were determined by soil digestion and atomic absorption. Selective extraction procedures for arsenic were utilized to obtain information concerning the dominant bonding modes for various arsenic species. The selective extractions also

provide clues concerning the role that biological agents may have on arsenic mobilization and uptake.

Infrared spectroscopy was used to gather information on the mode of bonding of arsenic to colloidal surfaces in wet environments. Arsenic retention and release was evaluated in selected natural sediments and synthetic colloidal systems. The adsorption and release of arsenic was evaluated under changing redox regimes.

**Results:** Arsenic was retained by the sediment solid phases in the largest amounts under either strongly reducing conditions or under strongly oxidizing conditions. Under reduced conditions, arsenic is retained predominantly by association with sulfide. This arsenic is readily released upon oxidation of the iron sulfide minerals. Under oxidizing conditions, arsenic is predominantly retained by adsorption of arsenate and arsenite by iron oxides. Dissolved arsenic concentrations were greatest under shifting redox conditions, i.e, during the oxidation of reduced sediments and the resulting release of arsenic from sulfide bonding, or during the reduction of oxidized sediments and the release of arsenic during dissolution of the Fe oxides. Therefore, arsenic is more mobile and a greater environmental liability under intermediate or shifting redox conditions, which has important implications to the management of arsenic-contaminated sediments. Sediment pH strongly influences adsorption of arsenate and arsenite by Fe oxide, which also has important implications to the management of arsenic contaminated sites. Chemical extraction is a useful tool for the assessment of arsenic form and mobilization potential. For example, $KH_2PO_4$ is a useful extractant to assess the arsenic release potential from oxidized sediments.

**Reference:** *Arsenate and Arsenite Retention and Release in Oxide and Sulfide Dominated Systems* (TR-176), TWRI, TAMU, 1997.

## *TAMU, USGS Work to Help Graduate Student*

Recently, Texas A&M University and the U.S. Geological Survey teamed up to help a graduate student earn his degree, aid a government agency, and gain valuable on-the-job experience.

The project worked like this. Karl McArthur was a masters' degree candidate in the TAMU Civil Engineering Department. While in school, he was accepted as an intern with the USGS Austin office. Part of his work for USGS ultimately turned into his master's thesis.

The project McArthur conducted for USGS involved investigating and comparing the use of computer models to simulate the hydrodynamics of the Upper Laguna Madre. McArthur evaluated SWIFT2D (the USGS Surface Water and Transport Model in Two Dimensions) and the TxBLEND model, which was developed by TWDB. SWIFT2D is a two-dimensional model that can be used for well-mixed estuaries, coastal embayments, harbors, lakes, rivers, and inland waterways. The model solves finite differences for vertically integrated equations of the conservation of mass and momentum in conjunction with equations for heat, salt, and constituent fluxes. TxBLEND employs triangular

elements with linear basis functions to solve equations for waves and shallow waters. McArthur performed the SWIFT2D computations while TWDB staff did the TxBLEND analysis.

Both models were calibrated for a June 1991 data set from a TWDB intensive survey. Velocity and water data were available for three days of the survey. Results were compared at seven tide stations, eight velocity stations, and 11 cross flow sections. Results of the study suggest that TxBLEND may be more efficient model to use to study the Laguna Madre.

The study was jointly funded by USGS and the Texas Water Development Board. Ralph Wurbs of the TAMU Civil Engineering Department was McArthur's academic advisor, while Marshall Jennings supervised his USGS internship. McArthur graduated from TAMU with a master's degree in Civil Engineering in December 1996 and now works for Espey Huston and Associates in Austin and can be contacted at (512) 327-6840. For more details about this study or the USGS co-op program, contact Jennings at (512) 873-3068 or mejennin@maildtxast.cr.usgs.gov.

## *TAEX Helps Combat Galveston Bay Pollution*

The Texas Agricultural Extension Service (TAEX) is providing solutions to prevent pollution of Galveston Bay and teaching Galveston County residents time- and money-saving "bay friendly" practices.

Studies have determined that run-off from residential streets and lawns has been a major contributor to contamination in the bay. With 70% of the county's residents living within two miles of the coastline, even small changes in individual lawn and home care practices could make a measurable difference in water quality.

For the past three years, TAEX has offered the Galveston Bay Yards & Neighbors program -- a series of workshops about alternative home and lawn care practices to reduce residential pollution in the bay. The educational programs cover landscaping, disease and pest control, tree care and selection, alternative household products and water preservation.

In 1995, Julie Massey and William Johnson of TAEX offered the program to three neighborhood associations who participated in a survey of lawn care practices, water consumption, and use of household cleaning products. In 1996, the program was attended by more than 1,000 people.

Informal evaluations indicate that those who complete the series adopt more appropriate fertilizing practices and pesticide use.

Besides presenting the workshops, the agents wrote articles for newspapers and 13 neighborhood association newsletters and developed a household reference of Bay-friendly tips.

The program's long-term goal is to improve water quality in the Galveston Bay, but the benefits to the participants are immediate. "They see immediate cost savings," Johnson said. "They spend less on pesticides, fertilizer and water, conserve energy, and reduce time on lawn maintenance."

For details, contact Johnson at (713) 534-3413 or wm-johnson@tamu.edu.

## *SHSU Studies Ways to Measure Environmental Costs*

A researcher at Sam Houston State University (SHSU) is working to develop a method to track the true cost of environmental projects in "real world" situations.

The work is being led by Ross Quarles of the Accounting Department at SHSU. The research was performed for the Texas Regional Institute for Environmental Studies, which is based at SHSU.

The thrust of the research is to develop an analytical method that can be applied to environmental cost analysis. The method, environmental activity cost analysis (ECAC), is a process through which environmental costs associated with the life cycle of a process can be identified and measured. The ECAC method is based on assessing the costs of specific environmental activities.

The ECAC process supplements a currently used method which has been approved by the U.S. Environmental Protection Agency, called life cycle assessment (LCA). Quarles says ECAC provides a more detailed framework to assess environmental costs than LCA. ECAC has already been used to project and assess environmental costs associated with U.S. Army and U.S. Navy environmental projects.

For details, contact Quarles at (409) 294-1846 or aac_nrq@shsu.edu.

## *Baylor Researchers Study Disinfection of On-Site Wastewaters*

Researchers at Baylor University (BU) are evaluating the performance of systems used to chlorinate wastewater effluent and remove coliform bacteria in on-site wastewater systems. The work is led by Dudley Burton and David Jumper of the BU Department of Environmental Studies.

"We feel this research is important because there are concerns that wastewaters from aerobic systems are often not properly chlorinated and may pollute rivers, streams, and groundwater supplies," Burton says.

Basically, a few types of homemade and commercial designs are utilized to chlorinate wastewater in on-site systems. Chlorine tablets are a simple and inexpensive method. Typically, a stack of flat, chlorine tablets is placed by the homeowner into a basket sited in an aerobic treatment unit. Each time water pulses through the system (after a toilet is flushed) the water level rises slightly. Wastewaters wash against the bottom tablet and chlorine flows from the tablet and is diluted throughout the wastewater supply. The goal is to provide a rapid dose of chlorine to treat the wastewater and remove coliform

bacteria without leaving a residual dose of chlorine that would be harmful to the environment.


*Dudley Burton (right) discusses a wastewater sample with a araduate student.*

"Strangely enough, units used to chlorinate on-site wastewater systems have never been evaluated by any regulatory or standard-setting agency," Burton says. "We hope that our efforts to evaluate the performance of existing and proposed systems may lead to the development of standards and design criteria that could be utilized in many on-site wastewater applications." Burton and Jumper are now designing the protocols to test systems. They hope to receive domestic wastewater from the Brazos River Authority. That wastewater will be used for testing that will be performed at BU. Burton and Jumper hope to collect wastewater samples from existing on-site wastewater systems throughout the region, and to field test the performance of disinfection units that are now in operation.

For details, contact Burton at (254) 710-3405 or Dudley_Burton@Baylor.edu.

## *Texas Industries Reduced Waste by 30%, TNRCC Says*

The amount of waste from 163 Texas facilities that participate in the "Clean Industries 2000" program dropped by 30% from 1987-94 while manufacturing output grew 20% during that time, according to the Texas Natural Resource Conservation Commission (TNRCC).

A recent study by the TNRCC shows program members reduced waste from their facilities from 204 million pounds to 144 million pounds (a decline of 29%). At the same time, Texas manufacturing output grew by 20%. The data were reported to the EPA under the "Right-To-Know Act."

"These reductions and achievements should be saluted by all Texans," said Commissioner Ralph Marquez of the TNRCC. "These facilities reduced waste by almost a third at the same time they were fueling the Texas economy."

"Clean Texas 2000 is one of the largest voluntary membership waste reduction programs in the nation," said TNRCC Chairman Barry McBee. "It has led to participation in more than 500 community environmental projects, including environmental education programs, recycling events, community cleanups, household hazardous waste collections, and scholarships."

For details, contact the TNRCC Clean Texas 2000 Program at (512) 239-3187.

## *Boating-Related Deaths Are Declining, TPWD Reports*

Through this summer, boating-related fatalities were down roughly 22% compared to 1996, according to the Texas Parks and Wildlife Department (TPWD). In addition, boater compliance increased to 95% during that same period.

Law enforcement officials are pleased with the numbers. "Considering that more boaters seem to be out on the water now that lake levels are up significantly, we are extremely pleased that boating-related fatalities are down compared to last year," said Jim Robertson, TPWD law enforcement director. "It is gratifying to know that the majority of Texas boaters are in compliance with the law. We will continue the stepped-up boat patrols through Labor Day in order to reach the reckless boaters who endanger others out on the water."

The compliance rate is based on boat checks conducted by Texas game wardens since the TPWD "Don't Be A Pain In The Boat" initiative began May 1, 1996. During the initiative in 1996, the compliance rate was 94%.

Carlos Vaca of TPWD attributes the increased compliance rate among boaters to the thousands of boat inspections conducted by game wardens the past two summers. "Boat operators know that game wardens are out each and every weekend checking boats for compliance of water safety laws. Many of those who received a citation have since obtained the proper equipment and are now in compliance with the Texas Water Safety Act laws."

Since the boating safety initiative began in May, nearly 150,000 vessels have been inspected for compliance and game wardens have made contact with more than 415,000 people.

## *Texas Department of Agriculture Awards IPM Grants*

The Texas Department of Agriculture (TDA) recently awarded $170,000 in grants to 16 research projects to help farmers expand their use of biological pest control and other methods based on integrated pest management (IPM) techniques.

IPM is a farming system that curbs pest populations by using biological pest controls, pest-resistant crops, crop rotations, planting date adjustments and crop residue destruction. When these methods fail to control pests, farmers use pesticides as a last resort.

In one project, Kevin Heinz of the Texas A&M University (TAMU) Entomology Department will study how natural enemies of the bollworm move from sorghum fields to cotton fields in the Southern Rolling Plains. In another project, Christopher Sansone of the Texas Agricultural Extension Service (TAEX) in San Angelo will develop a video to teach farmers on how to properly monitor cotton crops for pests.

For details on these and other projects, contact TDA at (512) 463-8536 or http://www.agr.state.tx.us/IGA/ipm.htm.

## *New TWRI Reports Discuss Dry-Year Option, Spatial Water Balance, Arsenic Testing Methods*

Three new technical reports are available from the Texas Water Resources Institute (TWRI).

*Evaluation of "Dry-Year Option" Water Transfers from Agricultural to Urban Use* (TR-175) was written by Bruce McCarl, Lonnie Jones, and Ronald Lacewell of the Texas A&M University (TAMU) Agricultural Economics Department. It describes how to develop a dry-year option strategy to compensate agricultural producers for reducing irrigation during dry years. The report covers the level of compensation that ought to be paid to agricultural produces who reduce irrigation and the effect on "third parties," including public entities, businesses, individuals, and agricultural industries.

*Spatial Water Balance of Texas* (TR-177) was written by David Maidment, Sean Reed, and Jerome Pateux of the Civil Engineering Department of the University of Texas at Austin (UT). Sections of the report describes efforts to develop an atmospheric water balance, a soil-water balance, and a surface water balance. The report also discusses how to estimate actual evapotranspiration and how to budget soil moisture, and compares potential evaporation versus potential evapotranspiration. Many tables, figures, and maps are also included.

*Arsenate and Arsenite Retention and Release in Oxide and Sulfide Dominated Systems* (TR-176) was written by Richard Loeppert, Amita Jain, Klaus Raven, and Jianlin Wang of the TAMU Soil and Crop Sciences Department. The report describes research to evaluate different methods to detect arsenic in aquatic environments and other settings. The report compares methods now used by the U.S. Environmental Protection Agency and the U.S. Geological Survey with new and potentially more accurate testing procedures. It discusses data gathered from sampling of arsenic-contaminated sites in Bryan, Houston, and Beaumont.

Summaries of these reports are on the TWRI WWW site at http://twri.tamu.edu. TWRI will publish the full text of the reports on-line in the near future. For details, contact TWRI at (409) 845-1851 or twri@tamu.edu.

## *TCU Press Book Describes Trinity River with Photos, Essays*

The Texas Christian University (TCU) Press recently published a book which describes the Trinity River with photographs and essays. The book, *The Trinity River*, includes photographs by Luther Smith, a researcher in the TCU Art Department. It features an essay about the river by Mike Nichols and an essay about photography by Thomas Southall.

The book features more than 50 of Smith's photographs, which were taken over seven years of various stages and locations on the Trinity. The photos capture the river's many personalities: the meandering West Fork in Archer County, the pollution-littered shore

where the West Fork runs through Fort Worth, and the flooding which occasionally spills into cities and over highways.

Mike Nichols' essay on the river provides an insightful look into how the Trinity was shaped by generations of Texans. Thomas Southall's essay, "Reflections on a River's Convergence," discusses Smith's photography and landscape photography.

*This photo displays the Trinity River as it approaches Dallas.*

Smith can be contacted at L.Smith@tcu.edu or (817) 921-7643, ext. 6718. The book can be ordered from the Texas A&M University Press at (800) 826-8911.

## *ASCE Book Discusses Aesthetics, Constructed Environments*

The American Society of Civil Engineers recently published a proceedings titled *Aesthetics in the Constructed Environment*. It contains papers that were given at an ASCE water resources planning and management conference in Houston in April 1997.

The proceedings focuses on challenges facing water resources engineers in incorporating aesthetic design and function in the planning and implementation of water resources projects. Other subjects include water quantity and quality interactions, groundwater pollution and remediation, watershed management, integrated water resources planning, economics and finances of water resource projects, urban drainage projects, and incorporating recreation in flood control projects.

Some papers focusing on Texas issues include: "Aesthetics, Creativity and Innovations for a Raw Water Intake at Lake Lewisville," "Legal Restraints on Recreational Uses in Texas," "Land Use Analysis and Water Surface Profile of Sims Bayou Bridges," and "Best Water Management Practices Used in the Houston Area."

The 800-page book can be ordered from ASCE at (800) 548-2723. For more details, visit their WWW site at http://www.asce.org.

## *Mauro Describes GLO Work in Beaches, Bureaucrats, and Big Oil*

Texas General Land Office (GLO) Commissioner Gary Mauro has published a new book titled *Beaches, Bureaucrats, and Big Oil*. The 245-page book was published by Look Away Books in Austin. Major sections deal with clean beaches, clean air, and policy issues. The book chronicles Mauro's efforts to develop many GLO programs including Adopt-A-Beach and the Coastal Management Plan. The book can be ordered from many sources, including the Texas A&M University Bookstore. To order the book from the TAMU bookstore, call (409) 845-8681 or (800) 523-5184.

## *TTU Scientist Evaluates Methods to Measure Ozone Concentrations in Water, Wastewater*

More and more utilities are turning to ozone to provide water and wastewater treatment. In part, the appeal of ozone is that it can be generated on-site and decomposes rapidly without leaving a significant residual that has to be treated. Recently, a Texas Tech University (TTU) researcher evaluated different automated methods to continuously measure ozone levels in waters. The studies were led by Pernendu Dasgupta of the TTU Chemistry and Biochemistry Department.

In the project, which was funded by the American Water Works Association Research Foundation (AWWARF), Dasgupta evaluated different processes to detect ozone concentrations throughout the water treatment process. The goal of the project was to recommend a testing procedure that reliably yields accurate ozone levels and can be used in a variety of settings.

Two of the major systems that were tested included the manual indigo trisulfonate (ITS) method and the flow injection analysis (FIA) method. The ITS process is now widely used. It is based on fast decolorization reactions between indigo trisulfonate and ozone. The FIA process uses dual photometric detectors that detect ozone levels in the presence of permanganate.

Dasgupta believes that the FIA process developed in this project may be the most promising. He says the FIA method has proven to be a simple, fast, and effective tool to detect aqueous ozone levels. Other advantages of the FIA process are that it detects low levels of ozone and that it can be directly related to manual measurements.

For details, contact Dasgupta at (806) 742 3064 or veppd@ttacs.ttu.edu or visit the AWWARF WWW site at http://awwarf.com.

## *TAMU-Commerce Studies Composting of Poultry Wastes*

Up until now, the many chicken farms and processing plants throughout East Texas have been seeking an environmentally friendly way to dispose of poultry wastes. Now, a researcher at Texas A&M University-Commerce (TAMU-C) is investigating if waste by-products from these operations can be converted to an environmentally safe compost product that could be used in greenhouses to improve the texture and fertility levels in problem soils, and for livestock feed.

*TAMU-Commerce researchers are trying to find environmentally friendly applications for poultry litter.*

The research is led by Don Cawthon of the TAMU-C Agricultural Sciences Department. The basis for the research is that poultry growing and processing operations in East Texas generate significant levels of waste which include high concentrations of nitrogen and phosphorus. These elements could contaminate surface and groundwater supplies.

Cawthon has already led efforts to develop a prototype, pilot-scale, in-vessel, aerobic mechanical composting device for many types of agricultural wastes and has been experimenting with different waste treatment methods for many years. In this project, he is testing whether chicken carcasses and poultry litter can be composted simultaneously and stabilized using thermophilic decomposition processes (high levels of heat generated when composting). Preliminary results suggest that co-composting both types of poultry wastes substantially increases protein and iron levels in the finished compost product, which may also make it more attractive for use as livestock feed.

For details, contact Cawthon at (903) 886-5350 or Don_Cawthon@tamu-commerce.edu.

## *UH Creates Method to Estimate Short-Term Rainfall Events*

Researchers at the University of Houston (UH) are developing new, computerized methods to simulate short-term rainfall events. The project is being conducted by graduate student Daniel Qiu and researchers Ted Cleveland, Keh-Wang, and Deborah Roberts of the UH Civil and Environmental Engineering Department.

The research is part of a larger UH project to develop a rainfall runoff computer simulation model that can be used to simulate the runoff of sediments from highway construction sites. This type of research aids construction planners and managers and policy makers who develop stormwater pollution prevention plans.

The goal of the project is to develop computer-generated daily and 15-minute estimates of rainfall and runoff. Unlike extreme event models (such as those used for storm

drainage design) that consider rare events, this model is developed to estimate behavior of relatively common events.

Rainfall data for 109 stations in Texas were analyzed and stored in a geographic information system that allows users to determine the distance from the highway construction sites to nearby rainfall monitoring sites. Data on the length of construction activity and the distance between highway construction sites and rainfall stations are supplied to the model by users. A boot-strapping technique then resamples the historical data and assigns a weighted rainfall sequence to the construction site. These rainfall sequences can then used to help design stormwater pollution prevention plans.

For details, contact Cleveland at (713) 743-4280 or Cleveland@uh.edu or Wang at (713) 743-4277 or KHWang@uh.edu or Roberts at (713) 743-4281.

## *TCU Faculty, Students to Participate in Biosphere 2 Project*

Texas Christian University (TCU) and Columbia University's Biosphere 2 Center have finalized plans that will enable the school to partner with the unique facility outside Tucson, AZ as a teaching tool and a research platform. TCU is the first of many institutions which will work with Columbia to develop a new, experimental campus as a shared venture. The three-year agreement was signed in June, 1997.

Beginning in the spring of 1998, several TCU students will travel to the Biosphere 2 campus in Oracle, AZ each semester . They will participate in "Earth Semester" -- an interdisciplinary, 16-hour credit course dealing with global climate change, conservation, and water resources management.

All courses will be team-taught in biology, geology and earth policy and will include field trips across Arizona. Sessions will be taught by Columbia faculty and visiting lecturers, including TCU faculty.

Leo Newland, director of Environmental Sciences at TCU, says, "from an educational point of view, the Biosphere 2 opportunity is very stimulating. Students' eyes light up. This is very futuristic.".

For details, contact Newland at (817) 921-7271 or newland@gamma.is.tcu.edu.

## *UH, UTMS-H Study Marine Snails to Learn How Memories Form*

A team of researchers from the University of Houston (UH) and the University of Texas Medical School-Houston (UTMS-H) are studying a marine snail to learn more about memory formation in humans and other animals. The studies center on the transforming growth factor-beta (TGF-beta), which is a factor in the development of an organism and plays a key role in the formation of memory in some learning situations.

"This study demonstrates more clearly than any other study to date that a growth factor may very well be involved in learning and memory," says Arnold Eskin of the UH

Biology and Biochemistry Department. Eskin and Jack Byrne of UTMS-H led the research.

The scientists used *Aplysia* (a type of marine snail) in their study of a non-associative form of learning. *Aplysia* is a choice model organism used in learning and memory research. The snails are particularly useful because they have a simple nervous system that is easily accessible, exhibit simple behaviors, and can learn. By observing changes in transmission between nerve cells, the scientists were able to determine that TGF-Beta participates in the changes that take place in nerve cells during learning and the formation of long-term memory.

Other project participants include Shogo Endo, a researcher in the UH Biochemistry Department, and Fan Zhang, a UTMS-H graduate student who did much of the lab work. The results of the research were published in the February 28, 1997, issue of *Science*.

For details, contact Eskin at (713) 743-8381 or eskin@uh.edu.

## *TTU Studies Impact of Low Levels of Herbicides on Fish*

How do aquatic herbicides affect largemouth bass and other fish species? That's the research question that was recently investigated by researchers Jimmy Winter and Reynaldo Patino and graduate student Elizabeth D'Silva of the Range, Wildlife, and Fisheries Management Department at Texas Tech University (TTU).

Many experts believe that aquatic herbicides often have little adverse effect on fish in lakes and reservoirs. That's because the concentrations that are typically applied are lower than the levels that are known to kill many species. Few studies have examined the impact of low concentrations of herbicides that may cause sublethal effects in aquatic species.

In this project, the researchers measured the response of young largemouth bass to five aquatic herbicides over a 2-day period. They also monitored the bass to observe whether a herbicide that is known to stress fish would cause changes in growth and gonadal development over a three-month timeframe. Initially, the bass were exposed to up to 10 times the recommended rate for each herbicide. Blood, plasma, cortisol, osmolality, and glucose levels were sampled. The fish were measured and weighed every week for 3 months.

According to Winter, the project shows that 2 4-D caused the greatest amount of stress in juvenile largemouth bass, followed by diquat, fluridone, endothall, and glyphosate. The study suggests that lake managers may want to consider choosing herbicides that will not stress fish, especially when populations of some species are at critically low levels.

For details, contact Winter at (806) 742-1983 or c7wjd@ttacs.ttu.edu or Patino at (806) 742-2851 or r.patino@ttu.edu.

## *UHCL Uses NASA Data to Study Galveston Bay Water Quality*

Researchers at the University of Houston -- Clear Lake (UHCL) are taking to outer space to learn more about pollution in Galveston Bay.

In the study, which is led by Theron Garcia of the UHCL Natural Sciences Department, researchers wanted to determine levels of total suspended solids (TSS) in waters of Galveston Bay. Garcia collaborated with scientists from the National Aeronautics and Space Administration (NASA) Johnson Space Center (JSC). Garcia and UHCL colleagues took water samples at various sites in the bay and noted the exact position of these sites using a global positioning system (GPS). The water samples were centrifuged so that the precise TSS concentrations at key sites could be determined. Shortly afterwards, images of Galveston Bay were taken from NASA space shuttles which were orbiting the earth. Those images were digitized and georeferenced. The last step in the process was to place the TSS data on the image and to correlate TSS values obtained through water quality sampling to the patterns of pixels on the computer-generated maps.

Garcia says that preliminary results look promising. Multiple regression analyses showed that there was a 70% match between water quality data and the satellite maps. In the future, Garcia hopes to repeat the study on many occasions and to use this process to study other pollutant patterns in regional waters.

For details, contact Garcia at (281) 283-3776 or garcia@uhcl4.uh.cl.edu. The study was sponsored by the Environmental Institute of Houston which is part of UHCL.

## *TAMU Assesses Activity in `Dry-Year' Option*

Last year, researchers at Texas A&M University (TAMU) developed a computer model to simulate what may happen if a "dry-year option" were developed to allocate scarce water supplies in the region. This year, as this management tool is implemented in the San Antonio region, they get a unique opportunity to examine what really happened.

"It's exciting to be in a situation where we can compare our predictions with immediate real world results," says Bruce McCarl of the TAMU Agricultural Economics Department, who is leading the research with Keith Keplinger of the TAMU Public Policy Research Institute. "Having the dry-year option in place gives us a chance to evaluate our modeling theories and to reassess our predictions."

In the project, which is funded by the Texas Water Resources Institute (TWRI), Keplinger will assess and document the number of farmers and water suppliers that participated, the prices that were paid and received, the mix of crops that were planted, and the amount of water that was freed up. Data from the Edwards Aquifer Authority suggests that 37 farmers took part in the dry-year option this year, reducing irrigation on 10,000 acres of land and conserving more than 22,000 acre-feet of water. Later, McCarl and Keplinger will assess the costs and benefits of other methods to reallocate water in the region, including subsidizing agricultural water conservation, purchasing agricultural

lands, and buying water rights. The research also involves predicting the economics of these strategies under a variety of weather conditions and target aquifer levels.

For details, contact McCarl at (409) 845-1706 or mccarl@scout.tamu.edu or Keplinger at (409) 862-4507 or keith@ppri-nw.tamu.edu.

## *Hot Topics' Provide Straight Talk About Water, Environment*

People needing "straight talk" about commonly asked questions on water and environmental issues may want to take a look at the "Hot Topics" section of the Texas Water Resources Institute (TWRI) World Wide Web (WWW) site.

This summer, TWRI hired Texas A&M University (TAMU) Agricultural Development student Lisa Kelley to create home pages for the Hot Topics section. In the process, she worked with TAMU researchers and extension specialists including Marty Matlock and Ann Kenimer of the Agricultural Engineering Department; Ron Kaiser of the Recreation, Parks and Tourism Sciences Department; and Don Steinbach of the Wildlife and Fisheries Sciences Department. TWRI student worker Jonathan Jones helped format the quizzes that are associated with each Hot Topic.

"Our reason for developing the Hot Topics is that we know many Texans are asking questions and need answers about complex environmental issues," says TWRI Director Wayne Jordan. "We want to give people a resource they can turn to that provides a comprehensive and easily understood overview of these matters."

*Jonathan Jones and Lisa Kelley of TWRI review materials that will go into a 'Hot Topic.'*

Some of the topics that Kelley developed focus on such issues as wetlands and endangered species. Earlier this year, a Hot Topic dealing with private property issues was developed by Kevin Hunt, a research assistant in the Wildlife and Fisheries Sciences Department. Mark McFarland, a researcher with the Soil and Crop Sciences Department, created a home page dealing with microbiological contamination of water supplies. The Hot Topics also contain links to many other related pages, numerous photographs and illustrations, and quizzes that readers can take before and after they have gone through the home pages. "This could make them a great resource for public school teachers and students," Jordan says. Other Hot Topics now being developed focus on water availability, the hydrologic cycle, the Edwards Aquifer, and water rights.

The effort to develop the Hot Topics was a joint project between TWRI and the TAMU Environment and Natural Resources Program (ENRP). The Hot Topics can now be found on the TWRI WWW site at http://twri.tamu.edu. In the future,they will also be available on the ENRP WWW site at http://cnrit.tamu.edu/enrp/.

## *TAMU Thesis Examines Perceptions About Water Reuse*

What concerns do San Antonio-area residents have about reusing water and wastewater to expand the amount of water resources available for the region? How would those concerns influence whether the public could accept reuse projects? Which types of reuse would people in San Antonio most prefer? These questions were recently investigated in a Texas A&M University (TAMU) master's thesis. The research was conducted by Michele Foss, who graduated with a master's degree from the TAMU Recreation, Parks, and Tourism Sciences Department earlier this year. The project was supervised by TAMU researcher Ron Kaiser.

In the study, Foss conducted lengthy interviews with more than 40 San Antonio residents and asked them a wide range of questions about reusing water and wastewater for a variety of purposes, including drinking water and landscape irrigation.

The research focused on indirect, direct, potable, and non-potable reuse. Foss gathered data about the public perception of the health impacts of reusing wastewater; the mistrust of many people concerning the reliability of wastewater treatment and distribution; and if wastewater reuse could pollute existing water supplies.

Results suggest that more than 76% of individuals who participated said they were willing to accept non-potable, indirect, reuse. In addition, 43% of respondents said they had no concerns about drinking or using recycled water if it met current drinking water quality standards, and that 52% of those surveyed had no concerns about drinking or using recycled water if it was recycled with other water supplies. More than 70% were willing to use recycled water for recreational supplies, while nearly all (96%) were more willing to accept recycled water than to conserve more or do without.

For details, contact Kaiser at (409) 845-5303 or rkaiser@rpts.tamu.edu, or Foss at mgarteis@rpts.tamu.edu.

## *TAMU Site Describes Arroyo Colorado Water Quality*

Water quality in the Arroyo Colorado watershed of South Texas is the emphasis of a World Wide Web (WWW) site recently developed by Guy Fipps of the Texas A&M University Agricultural Engineering Department.

The WWW site, titled the "Arroyo Colorado Water Quality Database," contains four major components: a report describing an investigation of water quality in the region, a database, water quality indicators for key stream segments, and detailed maps. The report summarizes a water quality assessment conducted by Fipps and others that evaluated levels of dissolved oxygen, sulfate, nitrate, fecal coliform, dissolved phosphorus, total phosphorus and chloride in the region's surface water. The database portion of the site

allows users to query information from individual locations in the watershed. It lists sampling points and describes data files and water quality parameters.

The URL for this site is http://arroyo.tamu.edu. For details, contact Fipps at (409) 845-7454 or g-fipps@tamu.edu.

## *TAMUCC Publishes On-Line Science Journal*

A new, on-line, student-published journal, the *South Texas Journal of Science*, has been created by the College of Science and Technology at Texas A&M University-Corpus Christi (TAMUCC). It is managed and edited by undergraduate and graduate students under the direction of Suzzette Chopin of the TAMUCC Biology Department.

"We want to give undergraduate and graduate students, as well as area high school students, an opportunity to publish original research and review articles," Chopin says. Recent issues of the journal includes several articles of particular interest to water and environmental researchers, such as "The Brown Tide and Ozone," "Science and the Internet," and "Do Retrofits and Signs around the House Help to Conserve Water?"

Information about the journal is available at http://www.sci.tamucc.edu/stjs/. You can contact Chopin at schopin@falcon.tamucc.edu for more details.

## *TAMUG Ports and Waterways Center Now On-Line*

Information about a wide range of issues affecting Texas ports is available from the World Wide Web (WWW) site of the Center for Ports and Waterways at Texas A&M University -Galveston (TAMUG). The Center is part of the Texas A&M University System's Texas Transportation Institute.

The WWW site contains an overview of the Center and its research projects and a newsletter, *Texas Ports and Waterways News*. The newsletter describes current research conducted by the Center on a wide range of issues. Some of the features in the current issue include technologies to improving piloting and navigation, the economic importance of ports, the volume and significance of barge transportation along the Gulf Intracoastal Waterway, legislative issues, and dredging and disposal alternatives. The newsletter describes real-time offshore data collection and monitoring at Texas A&M University-Corpus Christi, and maritime administration classes offered at TAMUG that give students hands-on involvement in such "real world" issues as the ecological impact of barge transportation and navigation.

The URL for the Center is http://tti.tamu.edu/cpw/news.html. For details, contact Center Director John Basilotto at (409) 740-4883 or basilj@tamug.tamu.edu.

## *THC, TAMU, WWW Sites Features LaSalle Shipwreck*

Two World Wide Web (WWW) sites feature detailed information on efforts to recover the shipwreck of Rene Robert Cavalier, Sieur de La Salle, in Matagorda Bay.

The Texas Historical Commission (THC) WWW site contains a wealth of information about Texas history and culture, including details about LaSalle and his ship, *The Belle*. The THC site contains information on a wide range of topics including Texas history, places to travel in Texas to learn about history, essential Texas history trivia, and THC projects.

One section of the WWW site describes THC work on the LaSalle shipwreck project. This part of the site contains information on LaSalle and his times, classroom exercises for public school students, and work to preserve artifacts from the shipwreck.

The THC WWW site address is http://www.thc.state.tx.us. The LaSalle portion of the site can be accessed at http://www.thc.state.tx.us/belle/index.html.

Meanwhile, the Texas A&M University Nautical Archeology Program features information on how TAMU researchers are conserving and preserving many of the artifacts recovered from *The Belle*. The WWW site of the program's Conservation Research Laboratory describes work to restore a human skeleton, pole arms, and partisans that were recovered from this site, as well as details of many other projects from throughout the world. The URL is http://nautarch.tamu.edu/napcrl.htm. You can contact the laboratory at (409) 845-6354 or nautarch@tamu.edu.