New Waves
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Sul Ross State Biologists Explore Whether Antibiotic-Resistant Bacteria Are Breeding in the Rio Grande

Are tough antibiotic-resistant bacteria living in the Rio Grande? Investigations conducted by researcher Keith Sternes of the Biology Department of Sul Ross State University in Alpine points to this possibility. His research has led to the discovery of bacteria in the Rio Grande River near El Paso which are resistant to vancomycin, which is a powerful antibiotic used by hospitals as a last resort to combat bacterial infections.

The bacteria under investigation are called enterococci, a type of bacteria that normally reside in the gut of healthy people and are among the most antibiotic-resistant bacteria known to man. However, if spread into the environment they can cause minor to moderate urinary tract and wound infections. Enterococci can also cause severe infections of the brain, heart valves, and bloodstream in severely ill patients.

Keith Sternes of Sul Ross State samples the Rio Grande for antibiotic-resistant bacteria.

The vancomycin-resistant enterococci (VRE) bacteria are also resistant to penicillin and other antibiotics. From a medical perspective, the inability to treat enterococcal infections with vancomycin will make those infections extremely difficult to treat, since several proven treatment options have been eliminated. Of even more concern, resistance to vancomycin has been shown to be genetically transferable to other bacteria such as *Staphylococcus aureus*, which can cause bloodstream and surgical-site infections as well as pneumonia. No treatments for VRE have been found, and the search is difficult because VRE are so adaptable and easily acquire antibiotic resistance.

This project is the continuation of a three-year study of bacterial levels in the Rio Grande. Sternes' studies led him to notice heightened levels of bacteria resistant to several types and concentrations of antibiotics near Presidio, Texas, which is close to the Big Bend National Park. The next step was to collect samples of water and sediment from the river starting at the headwaters in Colorado and proceeding at 50-mile intervals south to the

Big Bend area. These samples showed low levels of resistance to vancomycin at various sampling sites, but the greatest proportion of the resistant organisms occurred downstream of El Paso.

Sternes believes that the high concentrations of VRE found near El Paso may be directly correlated with the level of human population, since samples taken from less populated areas do not show this same kind of resistance. He also believes that the VRE population may be caused by human exposure to and pollution of the river. For details, contact Sternes at ksternes@sulross.edu or at (915) 837-8217.

Texas A&M University Researcher Updates Water Rights Analysis Program Software, Manual; Available from TWRI

An extremely timely and useful new tool which can be used to analyze water availability under a priority-based water allocation system has been published as a new technical report (TR) by the Texas Water Resources Institute (TWRI).

Reference and Users Manual for the Water Rights Analysis Package (WRAP) was written by researcher Ralph Wurbs of the Texas A&M University Civil Engineering Department. The report was published in August 1999 as TR-180.

According to Wurbs, recent major improvements in WRAP and its application to each of Texas' river basins have been sponsored by the Texas Natural Resource Conservation Commission (TNRCC) as part the Water Availability Modeling (WAM) project. This project is carried out by the TNRCC, its partner agencies, and contractors pursuant to Senate Bill (SB) 1. The evolution of the WRAP model over the past decade has involved several projects which have been administered by TWRI, including the recent SB 1 work.

"An exciting aspect of WRAP is that it provides state agencies and water managers with a way to look at water management within a river basin in an integrated fashion with everyone being able to use the same tools," Wurbs says. "Previously, everyone worked separately and it was difficult to assess the effect that a proposed reservoir or a significant change in water use may have on an entire river basin. Now, we have a method in place that different agencies and groups can use to objectively and independently assess the potential impact of water projects and changes in water use."

According to TWRI Director Wayne Jordan, this project represents a major success for Texas A&M University and the Institute. "We always hope that the information scientists are working on may make a difference in the lives of Texas citizens. In this case, Wurbs' efforts in developing WRAP will help many water managers do a better job of getting the most out of our scarce water resources. The fact that WRAP has been designated by the State of Texas as the official methodology to analyze water rights availability means we will have a continuing impact for years to come."

The WRAP reference and users manual is being distributed in a three-ring binder, which is accompanied by a diskette with the software. Individual copies cost $35. The floppy

disk contains compressed files for three computer simulation programs -- WRAP-SIM (a simulation model), WRAP-HYD (used to develop hydrologic inputs for WRAP-SIM), and TABLES (which creates output tables to organize and summarize results). The program is written in FORTRAN, but can be compiled to be used with personal computers which utilize DOS as well as mainframe computers. Subjects described in detail in the binder include WRAP-SIM Input and Output, WRAP-HYD Input and Output, TABLES Input and Output, Hydrology Features of the Simulation Model, and Water Rights Features of the Simulation Model.

WRAP is a generalized simulation model which can be applied to any river basin. Hydrology and water rights input data sets for each river basin in Texas are being developed by consulting firms under contract with the TNRCC. As individual river basins are modeled, these data files will be available from the TNRCC.

To inquire about additional information on the WAM project, contact Lann Bookout at the TNRCC at (512) 239-4609 or lbookout@tnrcc.state.tx.us. Wurbs can be contacted at r-wurbs@tamu.edu or (409) 845-3079.

Determining Microbiological Concentrations in Commercially Bottled Waters

Researchers: Rebecca Penland and Kirk Wilhelmus, Department of Ophthalmology, Baylor College of Medicine, Houston, TX.

Background: Commercially available bottled water is often thought by the public to be safer and more pure than tap water. Bottled and tap water are routinely tested for fecal coliform bacteria as an indicator of contamination by animal or human waste. However, routine testing for other types of microorganisms is not required for filtered or disinfected municipal or bottled water. Several microbiological studies of bottled water have reported microbial counts of more than 500 colony-forming units (CFUs) per milliliter (mL), depending on the source and processing of water and time of storage. The researchers have dealt with patients whose perception of the safety of bottled water led them to clean contact lenses with it.

Objectives: To analyze commercially available bottled water as a possible source of microbial contamination of contact lenses.

Methods: The researchers tested two different lots of 23 brands of bottled water for contamination by fecal coliform bacteria, non-coliform bacteria, fungi, and amoebae. Seventeen of these brands stated on the label that they had been processed by one or more methods to remove microbiological contaminants. Samples of the bottled water were vacuum-filtered, and different kinds of broth were used to culture the various types of microorganisms. Bacteria and yeasts were identified by the City of Houston Health Department, filamentous fungi were identified by the Sid W. Richardson Ocular Microbiology Laboratory, and amoebae were identified by Rescon Associates, Inc. Any sample with a bacterial count above 500 CFUs per milliliter was classified as being of

poor microbiological quality. Tests were conducted to determine if bottled water could contaminate contact lenses.

Results and Discussion: Tests indicated that 17 of 46 samples (37%) representing 11 of 23 brands of bottled water (48%) were contaminated with viable microorganisms. Bacteria were discovered in 12 samples of eight brands, yeasts or molds were recovered from seven samples of five brands, and seven of the 23 brands (30%) had a total coliform count of 500 CFUs per milliliter or greater. Free-living amoebae were found in two samples, freshwater algae were found in two samples, and fungi were found in seven samples. The most commonly detected type of organism was pseudomonads, a rod-shaped bacteria. Seven of 14 (50%) tap water samples yielded bacterial growth versus eight of 24 (33%) bottled water samples, while six of 14 (43%) tap water samples had a bacterial count of more than 500 CFUs per mL compared with three of 24 (13%) bottled water samples. As for the contact lenses, tests showed that 108 CFUs per mL had developed 24 hours after a one-minute exposure to two brands of contaminated bottled water. Since the EPA considers drinking water with a non-coliform count of 500 CFUs per mL to be inadequately disinfected, the number of CFUs developed with the bottled water on contact lenses may pose an ophthalmic hazard since the eye may not be able to fight off that many bacteria. This study emphasizes the necessity of using a sterile solution for cleaning contact lenses in order to avoid eye problems.

Reference: Penland, R. and Wilhelmus, K., "Microbiologic Analysis of Bottled Water: Is it Safe for Use with Contact Lenses?" *Ophthalmology* Vol. 106 (1999), pp. 1500-1503.

Note: Wilhelmus may be contacted at kirkw@bcm.tmc.edu or (713) 798-5952.

Developing A Behavioral Assay for Identifying Endocrine Disruptors in Fish

Researchers: M. Kent Rylander and Ashley Campbell, Department of Biological Sciences, Texas Tech University, Lubbock, Texas.

Background Information: An endocrine disruptor is an environmental pollutant that disrupts the endocrine system of an organism. The endocrine system is a group of organs and tissues of the body that release many hormones, including testosterone and estrogen. The endocrine glands and the hormones they produce regulate the growth, development, and function of various tissues and coordinate many metabolic processes. The U.S. Congress and the Environmental Protection Agency (EPA) have recently paid much attention to the presence of endocrine disruptors in waters, and legislation has been passed mandating the development of methods to screen manufactured chemicals for endocrine disruption activity. This project sought to develop a test which may indicate the presence of endocrine disruptors in water by measuring reproductive behavior in fish as a function of the concentration of endocrine disruptive chemicals in the water. The behavioral assay developed by this project tested endocrine-disruptive chemicals at sublethal concentrations that may lower wild fish populations over time by disrupting reproductive activity.

Objectives: 1) To measure normal reproductive behavior in untreated fish, 2) To detect abnormal reproductive behavior in the presence of known endocrine disruptors, and 3) To correlate these changes in behavior with morphological and hormonal changes.

Methods: Zebrafish were used as the test subjects because they are widely used in genetic and toxicity experiments, their life history is well known, and they reproduce rapidly. Their spawning cycles are synchronized to the night/day light cycle and their reproductive behaviors ensue when the light cycle begins. The researchers videotaped the reproductive behaviors of zebrafish in aquariums, which was easily controlled by the light cycle. The fish were exposed to different concentrations of the chemicals octylphenol (commonly found in detergents, shampoos, and industrial wastes), and diazinon (a common pesticide). A social interaction software program was used to determine the number and duration of contacts between fish. This program converts the videotaped images of the fish into contrasting figures whose movement can be traced and evaluated.

Results and Discussion: The average number of reproductive contacts for a fish population without an endocrine-disrupting chemical over a five-minute period was approximately 90-100. In the presence of octylphenol, the number of contacts dropped to 20 during the same time span. The results showed that the disruption was directly correlated with the dose of the inhibitor. The results of the drop in reproductive contacts may also be used to predict how much of a chemical is present in the environment. Changes in the chemical concentration as low as 100 parts per billion (ppb) caused significant negative effects on the fish. Collie notes that some urban wastewaters contain as much as 11,000 ppb. The investigators hope that this behavioral assay may turn out to be useful in testing a broad range of chemicals -- not just the two used in the research project. The test developed by this project is computerized, quick, easy, and reproducible.

Note: Collie may be contacted at n-collie@ttu.edu.

Occurrence and Distribution of the Invasive Brown Mussel, Perna perna, *in Texas Coastal Waters*

Researchers: Michelle McGrath, Larry Hyde, John W. Tunnell, Jr., Center for Coastal Studies, Natural Resources Center, Texas A&M University-Corpus Christi.

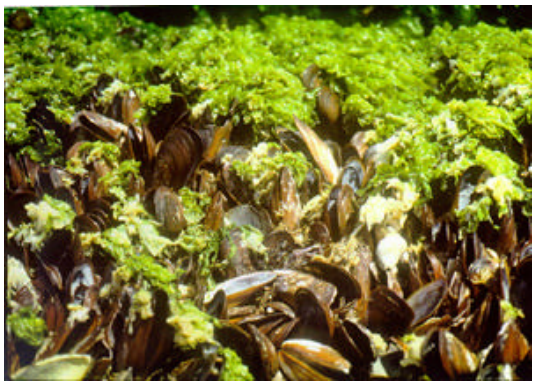
Background: The brown mussel, *Perna perna*, is native to the Atlantic coast of Venezuela, Brazil, and Uruguay. Two specimens of the brown mussel were found in 1990 on jetties at Port Aransas, TX. Scientists believe the most likely cause of the introduction of the brown mussel to Texas waters is from Venezuelan ships, which likely carried them on hulls or in

ballast water. After the discovery of the mussels in Texas waters, it was reported that they had colonized available hard substrates (surfaces to which they attach to live) such as jetties, oil rigs, and navigation buoys. By 1992, the mussels were found as far south as Mansfield Pass, TX (91 miles south of the original collection site in Corpus Christi). By 1993 they ranged as far north as the mouth of the Colorado River (58 miles north of the original collection site and near Matagorda Pass). Although this species has been known as a potential disease carrier, no negative environmental effects have yet been reported in Texas

Objectives: 1) To determine a geographical baseline range for the brown mussel in 1995 and 2) to monitor its subsequent range expansion along the Texas Gulf Coast. The data gathered by this study should help to predict potential negative impacts to the area such as displacement of native species and the encrustation of water intakes, navigation buoys, and offshore oil rigs by the mussels.

Methods: The baseline geographic range for the brown mussels was determined by inspecting available substrates such as jetties, buoys, and pilings at 13 sites located as far south as the Brownsville Ship Channel and as far north as Freeport Pass, between June and August 1995. When mussels were located, additional areas located between Freeport Pass and Sabine Pass were surveyed to determine the extent of the range expansion. The original 13 sites were inspected on a quarterly basis between January 1996 and March 1997 to determine if mussels were still present and if so, how far they had moved. Test plates consisting of wood, aluminum, ceramic, and Plexiglas were deployed at five sites between Aransas Pass and the Brazos River where no mussels had been previously located. These areas lacked available substrate, and the test plates were deployed to determine if the mussels would settle there if suitable substrate existed.

Results and Discussion: During the range expansion survey, the brown mussel was found at each site except for the three northernmost locations. Range expansion was only detected at one site. At five sites, mussel populations present during the baseline study were no longer present at the end of the range expansion study. The findings that the brown mussel populations have either reached equilibrium levels or have declined suggests that the mussel is not currently a threat to coastal lands or to industries. The researchers recommend monitoring on an annual or semiannual basis until more is known about the populations. Survey areas should include Gulf passes, the Intracoastal Waterway and offshore oil rigs.



Reference: McGrath, M., L. Hyde, and J. W. Tunnell, Jr., Occurrence and Distribution of the Invasive Brown Mussel, *Perna perna* in Texas Coastal Waters, Center for Coastal Studies, Texas A&M University-Corpus Christi, March 1998.

Note: Tunnell can be contacted at (361) 994-2768 or jtunnell@falcon.tamucc.edu.

Evaluating Methodologies to Distribute Naturalized Streamflows from Gaged and Ungaged Sites

Researchers: Ralph Wurbs and Emery Sisson, Department of Civil Engineering, Texas A&M University, College Station, TX.

Problem: In order to determine the amount of water which is available at individual sites, one needs to know or to be able to estimate water flows. In Texas, roughly 7,000 permits have been issued by the State to use, store, or divert water resources. On the other hand, there are only roughly 250 to 300 sites where stream gages are now used to record hydrologic data. In order to get a better idea of streamflows, techniques need to be developed which can be used to estimate flows at the many sites where gages are not currently being utilized. Accurate information about flows from ungaged sites is critical in order to assess the availability of water to satisfy applications for new water rights.

Background Information: Senate Bill 1, passed by the 75th Texas Legislature directs the Texas Natural Resource Conservation Commission (TNRCC) to develop water availability models for the 22 river basins of the state, excluding the Rio Grande. Models for six river basins are to be completed by December 1999 and the 16 others completed by December 2001. The Water Availability Model (WAM) Project being conducted by the TNRCC, its partner agencies, and contractors, involves developing WRAP input data sets and applying the model to each river basin as well as developing supporting database management systems. The flow distribution study is a part of the WAM Project.

Objectives: 1) To analyze relationships between flows from different subwatersheds of river basins and the watershed characteristics governing these relationships, 2) To evaluate alternative methodologies and associated parameters for transposing flows at gaged locations to flows at ungaged locations, 3) To develop a recommended set of procedures for transposing flows from gaged to ungaged locations for incorporation into WRAP.

Methods: The investigation consisted of identifying, developing, and evaluating alternative approaches for estimating sequences of monthly naturalized streamflows at ungaged sites based on known naturalized flows at gaged locations. The primary product is a recommended set of flow distribution methodologies which can incorporated into the Water Rights Analysis Package (WRAP) model. A literature review was conducted. Meetings were held with personnel of the TNRCC, the Texas Water Development Board, the Texas Parks and Wildlife Department, the Center for Research in Water Resources at the University of Texas at Austin, the U.S. Geological Survey, the U.S. Department of Agriculture (USDA) Agricultural Research Service, the Texas Agricultural Experiment

Station, and several consulting firms. Flow distribution approaches were identified and evaluated. Available naturalized flows (estimates of the streamflow without manmade intrusions) at selected gaging stations in the Brazos and the San Jacinto River Basins were used to investigate relationships between flows at different locations and to evaluate alternative methods for distributing flows. Streamflow data from the Sulphur River Basin were used to supplement the initial analyses.

Results and Discussion: The study reveals that subwatershed versus watershed flows in individual months are not closely correlated, and that long-term average flows are much more closely related than the flows in specific months. Flow predictions for a specific month using any flow distribution method are not highly accurate. However, averages and other flow characteristics can be accurately estimated. The study shows that the most important watershed parameters for use in modeling are the drainage area, land cover, soil type, and average precipitation. The validity of the modeling effort depends upon capabilities for accurately estimating values for the watershed parameters as well as the flow distribution methodology selected. Flow distribution procedures based on drainage area ratios and the USDA/ Natural Resource Conservation Service precipitation-runoff relationship are recommended for the WAM Project.

Reference: Wurbs, R., and E. Sisson, *Comparative Evaluation of Methods for Distributing Naturalized Streamflows from Gaged to Ungaged Sites* (Technical Report 179), TWRI, TAMU, 1999.

Utilizing Data on Fish Communities to Assess Changes in Water Quality in the Davy Crockett National Forest

Researchers: Jess P. Kelly, Biology Department, Baylor University, Waco, Texas.

Background: The Davy Crockett National Forest (DCNF) is one of four national forests in Texas. Use of land by park visitors near the streams in the National Forest has increased. This study is an effort to determine how this heightened land use and visitation has affected stream quality within the park.

Objectives: The primary objective of this study was to estimate quality and environmental stress levels of 10 streams based on characteristics of the fish community. The secondary objective was to compile a species list for the streams under study and to develop baseline data for future studies in the DCNF.

Methods: The U.S. Forest Service chose 10 streams located in the DCNF for study. One sampling site that contained at least one riffle, run, and pool was chosen for each stream. The fish communities in these 10 streams were sampled every three months from May 1994 to May 1995 in order to compare seasonal variations with a prior study. Fish samples were collected by electrofishing and seining. Data on the fish samples was compiled in the laboratory and evaluated by the Index of Biotic Integrity (IBI), which is a testing technique to determine stability of biological communities, as well by other tests

for biodiversity and species richness. Similarity of fish assemblages among streams was determined by cluster analyses.

Results and Discussion: During this study, 2,867 fish representing 53 species were examined. The black-spotted topminnow and the western mosquitofish were the most abundant species. The IBI indicated that the fish communities surveyed were stable. Water chemistry was found to be at the levels necessary for optimum fish production. Seven of the ten streams surveyed appeared to be environmentally unimpacted, while three showed signs of moderate impact based upon the data from the fish surveys.

Reference: Kelly, J. P. "An Icthyological Survey of the Davey Crockett National Forest, Texas." *The Texas Journal of Science*, Vol. 51, No. 2, May 1999.

Note: Kelly performed this research while completing a Master of Science program under Jack McCullough at Stephen F. Austin State University. He is now a Ph. D. candidate in the Biology Program at Baylor University and can be contacted at Jess_Kelly@Baylor.edu.

UTMB, TAES Researchers Develop Pilot Facility to Demonstrate "Biosecure" Shrimp Aquaculture

Phillip Lee of the Marine Biomedical Institute at the University of Texas Medical Branch (UTMB) and Addison Lawrence of Texas Agricultural Experiment Station are now working to develop and implement management practices that could help maintain the "biosecurity" of marine shrimp broodstock utilized in aquaculture.

This project is funded by the Texas Higher Education Coordinating Board's Advanced Technology Program as well as the Technology Transfer Program. Lee and Lawrence are collaborating to develop technology to create a facility to breed shrimp that can be certified to be disease-free.

Lee and Lawrence have teamed with Wood Brothers Shrimp Farm of Arizona. The company provided an initial source for broodstock and a site near Phoenix, AZ, where biosecure marine shrimp broodstock will be produced. This project provides the researchers with an opportunity to demonstrate the technology in a commercial setting. The first two years of research have been promising, and shrimp have been grown through the entire life cycle on the farm without disease. Some coastal shrimp farms in the Western Hemisphere have had disease problems and lost millions of dollars. Critics contend they may also pose a threat to natural shrimp stocks.

According to Lee, this technology may be ideal for use in West Texas. With the use of recirculating systems in raceways under greenhouses, the growing season for shrimp can last year-round. "The coastal region of Texas is too cold to allow for an extended growing season of shrimp. Shrimp ponds will be enclosed within greenhouses which can store the heat 24 hours a day," Lee said. Potential benefits of aquaculture, Lee said, are that inland land prices may be less expensive than coastal sites, and that shrimp grown in an aquaculture setting may be better protected from diseases and water quality constraints which occur naturally in the Gulf of Mexico. Many suitable sites for inland shrimp culture are available in the Southwest. Often, the locations already have saline water wells which may enable rapid expansion of shrimp farms.

The overall goal of this project is to demonstrate that shrimp broodstock can be commercially produced in biosecure, environmentally-isolated laboratories, using patented, closed, recirculating aquaculture filtration systems. This has been accomplished and the technology has been licensed to Wood Brothers. Currently, work is going on to develop dry feeds for the production of broodstock for these systems, and to design and build an inland shrimp hatchery to provide the seedstock needed to meet the demands of the shrimp farming industry. Ultimately, the researchers hope to develop best management practices which can be useful for commercial aquaculture production.

For more information contact Lee at (409) 772-3660 or pglee@utmb.edu, or Lawrence at (512) 749-4625 or smpall@electrotex.com.

TOWTRC Funds Research, Training, Education Projects Relating to On-Site Wastewater Treatment Systems

In many instances, rural and suburban Texans utilize septic tanks and drainfields and other on-site wastewater treatment and distribution systems instead of centralized sewers. Researchers should be aware that Texas has a funding mechanism in place which can provide small grants to investigate the performance of these technologies, the use of innovative methods, and related issues, as well as the development of training and education resources.

The Texas On-Site Wastewater Treatment Research Council (TOWTRC) receives funds from the Texas Legislature, which are generated by a small fee individuals pay when an on-site system in installed. Using these funds, the Council can then issue a request for proposals in which researchers and public health agencies can compete for research awards.

Recently, the Council has funded many investigations, including an assessment of the performance of subsurface drip irrigation systems (led by Andrew Ernest and Duane Gardiner of Texas A&M University-Kingsville), and a field study to examine the performance of chlorinators used with aerobic treatment units near Lake Livingston (carried out by Richard Gerard of the Trinity River Authority). Other investigations which have been recently awarded by the Council include a project to develop a method which uses data on evapotranspiration and soil absorption to develop drainfield sizes (led by Lloyd Urban and Heyward Ramsey of Texas Tech University), and a literature review about organic loading rates associated with the long-term application of effluents (led by Raghava Kommalapati of Prairie View A&M University). In addition, the Council has also provided funding to Bruce Lesikar of Texas A&M University to assist the development of training centers in Bryan, Weslaco, and El Paso. The Council has also awarded contracts to Ric Jensen of the Texas Water Resources Institute to produce a newsletter (*Texas On-Site Insights*) about these issues, as well as a World Wide Web site (http://towtrc.tamu.edu) which communicate information about Council activities to the public.

For details about the Council and how to participate in its research program, contact Executive Secretary Warren Samuelson at (512) 239-4799 or wsamuels@tnrcc.state.tx.us.

Texas-Israel Exchange Funds Water-Related Research

Four research projects which will examine water-related issues have recently been funded by the Texas-Israel Exchange (TIE) research and development program. The program, which is administered by the Texas Department of Agriculture, encourages cooperative research projects and works to enhance trade and business relations between scientists in Texas and Israel.

In one study, TIE awarded a grant to Daniel Leskovar, Jose Peña, and Mark Black of the Texas A&M University Research and Extension Center in Uvalde , Leonard Pike of the Texas Agricultural Extension Service (TAEX) Horticulture Department in College Station, and Penelope Perkins-Veazie of the U.S. Department of Agriculture Research Service (USDA/ ARS) in Lane, OK, to develop subsurface drip irrigation strategies to improve the yield and quality of watermelons and other crops. A grant was also awarded to Richard Zartman of the Plant and Soil Science Department of Texas Tech University to investigate whether irrigation efficiency could be improved by using synthetic polymers to control soil crusting. TIE also funded an investigation that will be led by Addison Lawrence of the Texas Agricultural Experiment Station in Corpus Christi to develop and implement an "environmentally friendly," pilot-scale facility to produce an edible sea urchin. Finally, a project was funded to Jobaid Kabir of the Lower Colorado River Authority to assess the economic aspects of irrigation with recycled wastewater.

In future issues of *New Waves*, we will publish detailed descriptions of these projects. More information about TIE can be obtained from the TDA by calling (512) 475-1615, or by visiting their World Wide Web site at http://www.agr.state.tx.us/IGA/tie.htm.

SWT Researches Movement of Edwards Aquifer "Bad-Water Line," Associated Water Quality Changes

Since 1996, a team of researchers from the Edwards Aquifer Research and Data Center (EARDC) at Southwest Texas State University (SWT) in San Marcos has been studying the movement of the Edwards Aquifer "bad-water line"-- the boundary which separates freshwater from saline water to the south and southeast of the Aquifer. The research is funded by the Texas Water Development Board (TWDB).

In basic terms, salinity is present in part of the aquifer because waters accumulate dissolved minerals as they contact limestone. An additional problem is that water flows more slowly in the area of the bad water line. This slow rate of flow causes the water to pick up more dissolved minerals, and levels of total dissolved solids (TDS) have been found which are greater than 1000 parts per million (ppm). Some wells drilled beyond the bad-water line have TDS levels of up to 6,000 ppm. In contrast, TDS concentrations in freshwater wells in the Edwards are only 250 to 350 ppm. Many experts fear that major droughts may cause the bad-water line to migrate, with potentially disastrous results. Droughts have the potential to decrease the speed at which water flows throughout the aquifer and may also lessen water pressure. Eight of 21 water wells which were sampled experienced increased salinity during the drought of the 1950s, and 11 out of 60 sampled wells in the late 1960s showed increased salinity.

In this project, researchers Glenn Longley and Marshall Jennings and graduate student John Burch are conducting a project to obtain solid data about the bad-waterline. Phil Nordstrom is managing the project for TWDB. A series of six wells is being monitored for specific conductance, water temperature, dissolved oxygen, and pH. Data are taken daily from probes placed in the wells and recorded via a phone telemetry system that

transmits data from field sites to a computer at SWT. Data from the project are logged to a World Wide Web site (http://www.eardc.swt.edu/bwl/).

So far, results from monitoring conducted between 1996 and 1999 show that there has been no saltwater intrusion into freshwater portions of the aquifer. The researchers believe that the large amounts of rainfall have provided enough recharge to the aquifer to maintain water pressure in the artesian zone and to prevent the bad-water line from migrating. This project is scheduled to continue until September 2000.

For more information, contact John Burch at txpescador@yahoo.com or (512) 245-3544, Jennings at mj09@swt.edu or (512) 245-3544, or Nordstrom at (512) 936-0838 or pln@twdb.state.tx.us.

A&M-Kingsville Works with South Texas Shrimp Farm to Improve Wastewater Treatment, Reduce Shrimp Disease

A researcher at Texas A&M University-Kingsville is cooperating with a South Texas shrimp farm to develop management methods that may improve wastewater quality and lessen the threat of shrimp disease. In this effort, Ron Rosati of the A&M-Kingsville Department of Agronomy and Resource Sciences is working with the El Sauz Ranch (located near the small South Texas town of Loma Alta) to manage the shrimp farm, perform water quality analyses, and communicate results. The Ranch provides the physical location and funding for the construction and operation of the project.

According to Rosati, Texas has many advantages that may allow the success in the shrimp-farming industry, such as year-round warm temperatures, the availability of brackish and salt water, and inexpensive land. There is an established shrimp farming infrastructure in place, which includes processing plants, buyers, hatchery seed production, and veterinarians. However, the shrimp farming industry has recently experienced problems with properly managing wastewater quality and preventing shrimp disease. Often, wastewater discharges from shrimp farms have been criticized because they contain high loads of nutrients (nitrogen and phosphorous) and suspended solids. There have also been concerns about shrimp disease and the possible introduction of exotic shrimp species.

As a result, Rosati is working with the Ranch to implement the Loma Alta Shrimp Farm Effluent Mitigation Project. The goal of the project is to develop methods to better treat shrimp waste streams as well as to reduce viral loads. The Ranch uses a series of four five-acre ponds, each of which is connected to a settling basin. Wastewater first flows through the ponds, then to the settling basins, and eventually into a 15-acre constructed wetland. Later, it can be sent back to the ponds or discharged across a mud flat. The Hidalgo County Drainage Ditch provides the water for the ponds. The system treats flows of less than 5 million gallons per day, and wastewater can only be discharged on 30 days or less per year

Rosati says that he expects that water quality may actually improve as it flows through the shrimp farm and the system, in large part because of the effectiveness of the settling basins and the constructed wetlands. For example, water has been recirculated through the wetland and back to the ponds since June and levels of total suspended solids have been roughly cut in half.

The project will counter the problem of disease by using only certified healthy Specific Pathogen-Free shrimp stock. Regular monitoring for disease is being conducted. No wastewater will be discharged until a laboratory analysis has been conducted to see that effluents are disease-free. Although the project is using an exotic shrimp species (*Lidoenaeus vannamei*), the project will safeguard native shrimp populations by screening wastewater three times before it is discharged.

The farm was first stocked in April 1999. No disease has been yet found, and no wastewater has been discharged. Harvest is slated to occur this fall and the project will continue through the year 2000. If the project goes as planned, the Ranch may become a commercial enterprise.

For more details, contact Rosati at (361) 593-381 or by e-mail at r-rosati@tamuk.edu.

TWRI Publishes New Technical Reports

Two new technical reports have been published by the Texas Water Resources Institute.

TWRI technical report (TR) 180, *Reference and Users Manual for the Water Rights Analysis Package (WRAP)*, was written by Ralph Wurbs of the Texas A&M University Civil Engineering Department (see article on page 1 of this issue). This report includes both a user's manual and software for the WRAP computer simulation program. This report is being sold by TWRI for $35.

Another new report which focuses on efforts to model streamflows is titled, *Comparative Evaluation of Methods for Distributing Naturalized Streamflows from Gaged to Ungaged Sites* (TR-179). This report was written by Wurbs and Emily Sisson. An abstract of this report is provided on page 3 of this issue.

Finally, TWRI is now updating the Institute's publications catalog. It should be noted that both TR-179 and the publications catalog are free.

TAEX Fact Sheet Discusses Groundwater Districts

The Texas Agricultural Extension Service (TAEX) has developed a new fact sheet describing how conservation districts can be used to manage groundwater supplies. The fact sheet, *Managing Texas' Groundwater Resources through Groundwater Conservation Districts* (B-1612) was developed by Guy Fipps of TAEX, in cooperation with staff members from the Texas Natural Conservation Commission and the Texas Water Development Board. According to Fipps, the fact sheet is designed for community

leaders, policy makers and others needing detailed information on the creation, organization, and responsibilities of groundwater conservation districts. The publication also contains a summary of the priority groundwater management area (PGMA) process. A shorter version of this publication, *Groundwater Conservation Districts* (L-5240), was also written by Fipps and colleagues and recently published by TAEX.

To order a copy of either brochure, contact TAEX at (409) 845-6571, or Fipps at g-fipps@tamu.edu or (409) 845-7454.

Isaac's Storm *Details Galveston, Hurricane Flood of 1900*

A powerful, spellbinding account of the great Galveston flood of 1900 has recently been published. The book, *Isaac's Storm -- A Man, a Time, and the Deadliest Hurricane in History*, was written by Erik Larson.

The book looks at the events that led up to the disaster through the perspective of Isaac Cline, who was the chief weatherman for Texas at the time and, Larson says, the "one man who could have saved Galveston." A key theme of the book centers on what Larson calls the arrogance and hubris of Cline and other scientists and policy makers who largely disregarded the notion that a severe storm could destroy Galveston. The book also includes personal accounts of storm survivors, how Galveston coped with the aftermath of the storm, as well as how the storm changed weather prediction and disaster preparation.

The book is published by Crown Publishers. You can learn about the book on the World Wide Web at http://www.isaacsstorm.com.

Tarleton State, A&M-Kingsville, LCC, Research Suggests Padre Island Ecology May Be Rebounding

Vegetation on the Padre Island National Seashore (PINS) appears to be on the rebound from overgrazing and oilfield activity, according to a study recently conducted by Allan Nelson of Tarleton State University, Cynthia Galloway of Texas A&M University-Kingsville, and Jim Goetze of Laredo Community College (LCC). Many students from Tarleton, A&M-Kingsville, and LCC participated in the investigation.

This study examined 83 species of flowering plants spread throughout four biological communities of the Big Ball Hill region of the Padre Island National Seashore (PINS). The researchers then compared the results with similar research done in the 1970s to determine how the island's vegetational ecology had changed. Vegetation is important because it allows dunes to form on the beach by providing anchors for moving sand. These dunes stabilize the beach against erosion and allow grassland areas called barrier flats to form on the western edge of the island. The barrier flats provide critical protection for the South Texas mainland.

Results of this project indicate that the native Seacoast bluestem (*Schizachyrium scoparium*) and Gulfdune paspalum (*Paspalum monostachyum*) grasses are now the dominant grasses in the barrier flat region. In comparison, the weedy Red lovegrass (*Eragrostis secundiflora*) was the dominant species in the 1970s. The barrier flat region is now in good ecological health and is nearing a natural climax stage due to the end of overgrazing in the region.

Even the areas formerly used as oil fields are recovering. Natural Resource Conservation Manager Paul Eubank of PINS has developed a method to reseed areas previously used for oilfields. It consists of removing the oil pad, baling native grasses, and then spreading the hay over the area.

Despite the good news, problems remain. The research revealed a high population of Beach evening primrose (*Oenothera drummondii*) in the small dune region of the seashore. Typically, this indicates disturbances and erosion in the dunes because that species is adapted to areas of moving sand. The researchers also noted the almost complete elimination of beach vegetation in the Big Ball Hill region due to heavy recreational use (less trafficked regions had more dense plant populations).

Studies on island mammals conducted by researchers from TSU and LCC, and in cooperation with Eubank and PINS staff member Darryl Eckels, show that mammal diversity in the region may have declined since the 1970s.

Texas A&M Researchers Work with TWDB to Model Socioeconomic Effects of Water Planning Scenarios

A team of Texas A&M University scientists is now working with the Texas Water Development Board to refine and verify tools to predict the social and economic impacts of alternative water planning strategies.

The lead researchers in this effort are Steve Murdock of the Rural Sociology Department and Lonnie Jones of the Agricultural Economics Department. Butch Bloodworth and Mickey Wright are the project leaders at the Board. In this project, Jones is developing economic assessments about the effect of water planning. Murdock then takes this information to interpret how it may affect the demographics of a region or county.

According to Murdock, the thrust of the project is to develop and refine computer simulation models which can be used for regional water planning in Texas. The models predict the effects of various water planning and use choices on specific services and industries and can be used to assess how water planning efforts may affect population and economic trends and income levels. In the short-term, these models could be very useful because comprehensive water planning efforts are being undertaken in many regions of Texas. The water planning work is being coordinated by the Board and is mandated by Senate Bill 1.

According to Murdock, the significance of this project is that it marks one of the first times that models have been developed to examine the social and economic impact of water development at a regional and county-by-county scale.

One of the major goals of this work is to make sure that the economic and demographic variables which are used in these models accurately reflect what really is likely to occur when various water planning strategies are considered, Murdock says. In addition, he hopes the model developed in this effort can provide individuals participating in regional water planning efforts with a "big picture" of how their actions may affect a region. "Ideally, we hope to develop a modeling framework in which regional leaders can compare and play out different water planning scenarios and get an idea of how individual strategies may affect the region as a whole. We hope to give them a realistic idea of the true cost of water as well as the degree to which various industries and activities use water resources."

The project is scheduled to be completed by the fall of 2000. At the conclusion of this study, the researchers also hope to work with TWDB staff to develop additional planning models. For details, contact Murdock at (409) 845-5332 or smurdock@rsocsun.tamu.edu, or Jones at lljones@tamu.edu or (409) 845-2336.

Better Understanding Why, How, River Channels Change May Improve Design of Highways, Bridges, TTU Study Says

Texas Tech University (TTU) researchers have recently completed a comprehensive study to learn more about how the naturally occurring changes in the shape of Texas rivers may affect the design of highways and bridges which cross these streams. The project was led by TTU Civil Engineering Department researchers David Thompson, Heyward Ramsey, Thomas Lehman and Tony Mollhagen. It was funded by the Texas Department of Transportation (TxDOT).

TxDOT often needs to modify or relocate stream channels as part of roadway construction projects, and such modification can have a negative impact on the natural environment and appearance of an area as well as wildlife habitat. Due to heightened concerns about the environmental impacts of stream modification, more environmentally sound methods need to be developed. Existing TxDOT design guidelines give qualitative suggestions for environmentally and aesthetically sound stream modification, but specific and quantitative recommendations are needed.

In this three-year project, Thompson and Ramsey focused on engineering issues, Lehman investigated the geological aspects, and Mollhagen explored environmental and biological problems. The focus was on developing specific recommendations for channel modification. The study included an assessment of common problems which were present at 10 sites where channels were modified, including drainage control, bank erosion, restricted channel access, and channel bed degradation.

According to Thompson, findings from this project suggest that engineers need to examine the dynamics of the whole drainage basin when considering whether to modify a stream channel, rather than viewing the river as a static entity. As a result, they need to take into account such factors as natural stream migration and erosion. By thinking in terms of the entire drainage basin over the long term and examining how a river has meandered over time, engineers may be able to choose an area to place a channel crossing that will work with, rather than against, the natural tendencies of the river and will protect the riverbanks and protect vegetation.

The investigation resulted in a number of recommendations for how to better plan channel modification projects. For example, structural, aesthetic, and environmental issues associated with stream channel crossings and modifications need to be well thought-out and defined. Dynamic processes which affect stream channels, including natural, geological, and biological processes, as well as human interactions, need to be better understood. Guidelines need to be developed which minimize structural, environmental, and aesthetic problems before they occur. There is also a need to better coordinate efforts among federal, state, and local agencies, as well as to implement better processes for data collection and documentation. At the academic level, increased education and training needs to be provided in areas such as fluvial morphology, landscape architecture, and wildlife management.

TAMU Researcher Participates in NIWR Study to Evaluate Water Management Options

Evaluating economic and institutional alternatives which could help meet interstate instream flow requirements is the objective of a multi-state research project now being carried out by a researcher with the Texas Agricultural Experiment Station (TAES) in El Paso. Ari Michelsen, a TAES researcher, is a lead scientist in this project, along with colleagues from Washington State University (WSU), Colorado State University, and the University of Idaho. The project was originally funded through the National Institutes of Water Research Program (which the Texas Water Resources Institute participates in) while Michelsen was a researcher at WSU.

In theoretical terms, the project focuses on methods to assess and prioritize economic and policy measures which can be utilized to provide sufficient water to meet the provisions of the Endangered Species Act. Specifically, this project centers on identifying measures which could free up additional water resources in Wyoming, Nebraska, and Colorado to support habitat needed for endangered whooping cranes. Although this project examines a critical problem facing these three states, Michelsen says the methods explored in this effort may also benefit Texas and states facing similar problems.

To solve this problem, the research team proposes that a systematic approach can be taken to identify the best policy solutions. First, an initial list of alternatives is developed and alternatives with related themes are grouped together. Second, the feasibility of each alternative is assessed, based in large part on whether specific objectives are met. For example, some of the key indicators that measure the likely success of an alternative include whether proposed actions are legally, hydrologically, and economically feasible, how much water could result from this strategy, the cost, and third party impacts. Finally, the results are incorporated into a matrix which can be easily communicated to policy makers and the public.

"We hope this project may identify a process which can be utilized in water planning efforts in Texas and elsewhere," Michelsen says. "Before a water management strategy is selected, it makes sense to carefully evaluate whether the best management choice is being made as well as take a serious look at how easily that measure can be implemented."

For more information, contact Michelsen at (915) 859-9111 or a-michelsen@tamu.edu.

TNRCC Publishes New Easy-to-Read Guide About Development of Total Maximum Daily Loads

A new easy-to-read handbook designed to assist water managers through the process of developing total maximum daily loads (TMDL) has recently been published by the Texas Natural Resource Conservation Commission (TNRCC). The document was developed by the TNRCC's TMDL team in cooperation with faculty and staff members from the Texas Institute for Applied Environmental Research (TIAER) at Tarleton State University, Texas A&M University (TAMU), and the Texas Water Resources Institute (TWRI).

The project was led by Adrienne Boer, Mel Vargas, and Daren Harmel of the TNRCC TMDL team, Jan McNitt, Chris Rottler, Erinn Wilcznski, and Richard Kiesling of TIAER, Marty Matlock of TAMU, and Ric Jensen of TWRI.

The 122-page report, *Developing Total Maximum Daily Load Projects in Texas--A Guide for Lead Organizations (GI 250*), was published by TNRCC in June 1999. The report introduces readers to TMDLs and presents a broad overview of the guiding principles behind TMDL development. Much of the report educates readers about how to develop and implement steps in the TMDL process, including identifying water quality targets, assessing water quality conditions, determining the capacity of a water body to absorb pollutant loads, analyzing pollutant sources, and allocating pollutant loads. Other sections of the book explain to readers how to implement TMDLs, ways to increase public participation, and how to develop a quality assurance and quality control plan. The handbook also presents information on how mathematical models can be used within the TMDL framework. An example TMDL work plan and guidance documents developed by the U.S. Environmental Protection Agency are included.

The report can be downloaded from the World Wide Web at http://www.tnrcc.state.tx.us/water/quality/tmdl. You can also obtain a printed copy by contacting Boer at aboer@tnrcc.state.tx.us or (512) 239-0846 . McNitt can be contacted at (254) 968-9578 or mcnitt@tiaer.tarleton.edu.

Rice WWW Site Provides Real Time Flood Alerts for Texas Medical Center Complex

Rice University's Department of Environmental Science and Engineering has developed a World Wide Web (WWW) site for the Texas Medical Center in Houston to monitor the water level of Brays Bayou and the consequent probability of flooding in the Medical Center area. This web site was created by Rice researchers Philip Bedient and Baxter Vieux, and graduate students Dawn Gladwell, Brian Hoblit, Stephanie Piepho, and Anthony Holder.

The site features "BayouCam," which provides regularly updated images from a videocamera pointed at the confluence of Brays Bayou and Harris Gully, which flows below Rice and the Medical Center. It also displays continuously updated NEXRAD (Next Generation Weather Radar) images of the Houston area with color-coordinated indicators of rainfall levels. This radar image keeps data for the previous 24 hours, and can be animated by the user in intervals of 1, 3, 6, 12, and 24 hours. Up-to-date graphs of cumulative rainfall for the entire watershed and for East and West Brays Bayou are also available. Rainfall data from rain gages from East and West Brays Bayou and the entire watershed are also available in tables which display the amount of precipitation within the last 1, 3, 6, 12, and 24 hours. An especially useful tool for flood prediction is a nomograph, which is a chart that relates the rainfall over the last several hours to the expected peak flow in Brays Bayou at Main Street.

This site also features similar information for Harris and surrounding counties as well as much of Southeast Texas. The WWW site address is http://www.floodalert.org.

Texas PIN WWW Site Features Pesticide Use Data

Do you know how pesticides are used in Texas and how they affect human health and the environment? The Texas Pesticide Information Network (PIN) was formed in 1998 to inform the public about these issues. Texas PIN seeks to inform Texans about when and where various types of pesticides are used in Texas. It also discusses why Texas may need a system to track both agricultural and non-agricultural pesticide use.

Pesticide users are not required to report amounts used to environmental agencies. According to a statement on the Texas PIN World Wide Web site (which was developed by the Texas Center for Policy Studies), the "lack of information on pesticide use impairs

the effective and efficient implementation of existing laws for the protection of drinking water quality, human health, food safety and fish and wildlife habitat from pesticide contamination."

The WWW site also advocates that "Texas needs a pesticide use reporting system, such as those available in other states, to provide the type of information essential for full and effective implementation of laws designed to protect human health and the environment from pesticide contamination."

An overview of Texas PIN is available on the WWW at http://www.texascenter.org, then selecting PIN. The WWW site details Texas PIN policy statements and goals. It provides information on upcoming meetings and conferences as well as links to related web sites of regulatory agencies and non-governmental organizations. The WWW site also can be used to view current and past pesticide-related legislation. Some of the Texas PIN publications which are available at this WWW site focus on such issues as pesticide use in Texas, pesticides and Texas water quality, atrazine contamination of Texas drinking water, and pesticide levels in recreational fish species caught in Texas.

For details, please contact Mary Kelly at the Texas Center for

Policy Studies at (512) 474-0811 or tcps@econet.org.

WWW Site Describes Texas Marine Mammal Stranding Network

The Texas Marine Mammal Stranding Network has developed a World Wide Web (WWW) site which provides information about the rescue, rehabilitation, and release of dolphins, whales, and mammals along the Texas coast.

The Network, which was founded in 1980, is headquartered at Texas A&M University-Galveston. It is a cooperative effort of many universities, including A&M-Galveston, Texas A&M University-Corpus Christi, the University of Texas Marine Science Institute at Port Aransas, the University of Texas-Pan American, and the University of Texas Medical Branch in Galveston. In addition, many agencies and a network of more than 2,000 volunteers participate in this effort.

`Some of the information contained on this WWW site includes statistics on the numbers and types of mammals which have been stranded, pathological reports based on necropsies which have been performed, and feature stories about some of the mammals which are currently being rehabilitated. In addition, the site also provides information on how interested individuals can be involved, as well as museum exhibits and other educational resources the Network can provide.

The Network is coordinated by Graham Worthy who is the Director of the A&M-Galveston Physiological Ecology and Bioenergetics Lab. He can be contacted at worthyg@tamug.tamu.edu or (409) 740-4721. The WWW site address is http://www.tammsn.org.