New Waves
The Research Newsletter of the Texas Water Resources Institute
Volume 7, Number 3, October 1994

TWRI to Fund 6 Projects at Texas A&M, North Texas, UT

The Texas Water Resources Institute (TWRI) will fund six research and technology transfer projects at three universities in its 1994-95 research program.

TWRI Director Wayne Jordan announced that the Institute will fund two new projects:

- Ann Kenimer of the Agricultural Engineering Department at Texas A&M University will be investigating the use of constructed wetlands for agricultural waste treatment .
- David Maidment of the Civil Engineering Department at the University of Texas at Austin will be developing a spatial water balance for the State , with special emphasis on the Lavaca-Navidad watershed.

In addition, TWRI will continue to support three other research projects:

- Clyde Munster of the Agricultural Engineering Department of Texas A&M University is evaluating the non-point source pollution potential of using agricultural chemicals in floodplains.
- Richard Loeppert and Klaus Raven of the Texas A&M University Soil and Crop Sciences Department are determining the hazards associated with heavy metals in streambeds.
- Tom Waller and Miguel Acevado of the Institute for Applied Sciences at the University of North Texas are investigating if toxicity in river systems can be assessed by using living organisms.

Continuation of the *New Waves* newsletter and other public information efforts are being funded in a technology transfer project led by Ric Jensen of TWRI.

UNT Researchers Study if Clams Can be Pollution Monitors

One of TWRI's more interesting and unusual studies is being conducted by scientists with the Institute for Applied Sciences (IAS) at the University of North Texas (UNT). The lead investigator is Tom Waller of UNT's Biology Department. Others participating in the project include IAS scientists Ken Dickson and Miguel Acevado, James Kennedy of the UNT Biology Department, and Larry Ammann of the Mathematics Department at the University of Texas at Dallas.

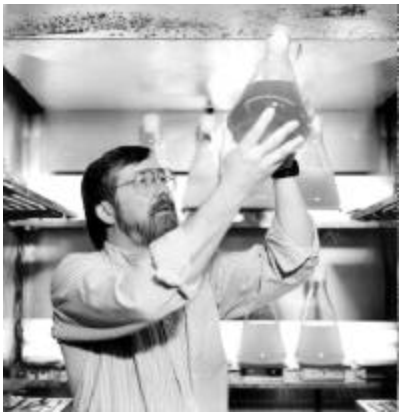
The researchers are investigating if toxicity in river systems can be assessed by evaluating the impact of pollutants on living organisms. In the project, which is in its second year, Waller is developing a prototype of a system that will measure the heart rates and gape measurements (the degree that a shell is open or closed) of Asiatic clams (*Corbicula fluminea*). This type of system could be used to monitor clams or other organisms that could be placed in the Trinity River of other water bodies. The researchers believe that slight changes in the gape and bioelectric signals can be detected, processed, and continuously recorded. If the data showed that the organisms are stressed, it could reflect that pollutants or poor water quality are in the river.

In the first year of the project, the scientists developed and tested a prototype system in the lab. The research involves developing a method to monitor the clam gape at sites throughout a watershed, and relaying information about the status of each clam to a central receiving site. The system would rapidly alert water managers when the behavior of the clams was outside a range of normal values for the gape or the heartbeat. Finally, the system should be able to allow scientists to collect polluted water quality samples when the clams are under stress so that analyses could be performed.

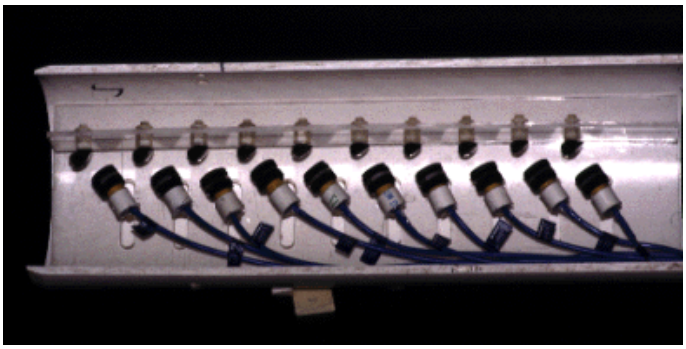
The scientists say the system holds a great deal of promise. A major advantage is that the signals from the clams are rather simple to store and analyze, when compared to gathering data on the heartbeat of a trout. Once the engineering and environmental design issues are stabilized, Ammann will work to develop the statistical tools necessary to differentiate between clam responses to pollutants and natural stresses.

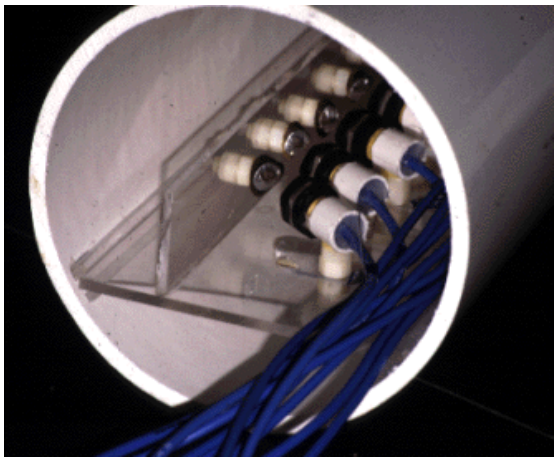
If all goes well, the researchers hope to test the system in actual field conditions later this year. The researchers believe the system may make it easier for water management agencies to investigate chronic toxic events and to identify pollutants that stress aquatic organisms.

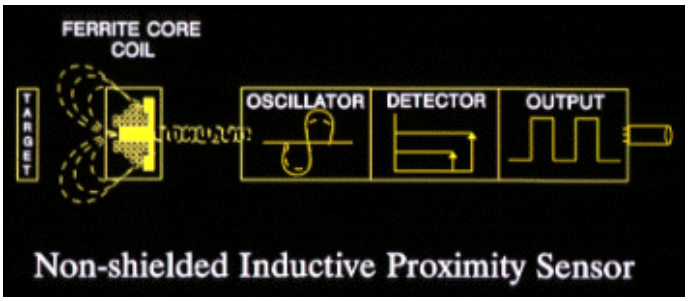
For details, call Waller at (817) 565-2982. His e-mail address is Twaller@gab.unt.edu"> Twaller@gab.unt.edu.

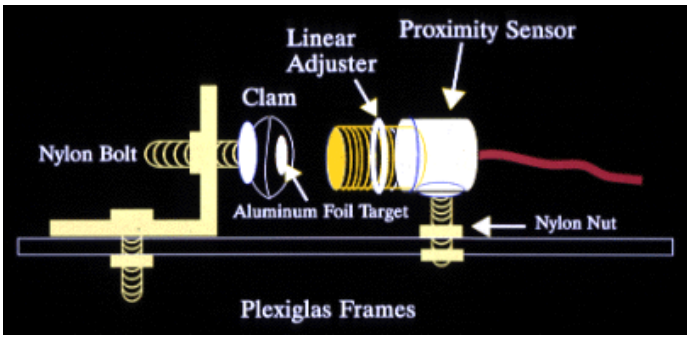


UNT researcher Tom Waller prrepares a sample that will be simliar to water in the Trinity River. Asiatic clams will be put in the water in lab studies.

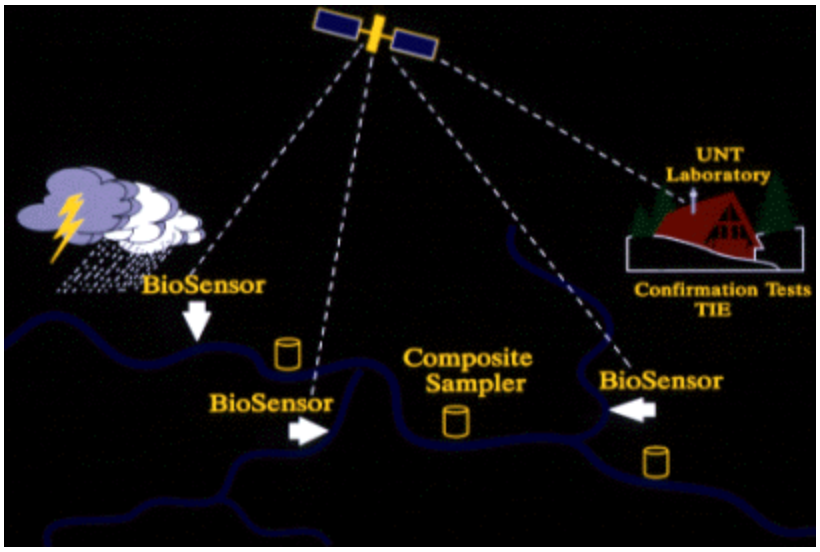








Tom Waller and Ken Dickson of the University of North Texas are leading a team research project that uses Asiatic clams to monitor water quality. In this system, the clams are mounted on a plexiglas frame (see photos and drawings, above).



A proximity sensor detects the degree that clam shells are open or closed (the gape). This information is then relayed instantly to a central computer monitor (see drawing). If a large number of clams are changing their behavior (closing their shells) at any site, this may indicate there is a water quality problem. Then, water managers can take additional samples or perform water quality tests.

TWRI "Water for Texas Conference" Set for Jan. 26-27 in Austin

One of the best ways to learn about any issue is to bring people together and talk about major concerns with colleagues. With that in mind, TWRI has been busy hosting and planning three conferences this year.

On July 7-8, TWRI hosted a meeting at Texas A&M University titled "Environmental Issues of the U.S.-Mexico Border Region." This workshop focused on identifying major research programs and opportunities. Speakers included representatives from Texas A&M University, the University of Texas at El Paso, the Texas Agricultural Experiment Station, the Houston Area Research Consortium and state and federal agencies. On the final day of the workshop, participants discussed and prioritized research needs. TWRI is now assembling a report that will contain abstracts of speakers' talks, research needs that were identified, and a list of contacts.

On July 27-28, TWRI co-sponsored a conference titled "Constructed Wetlands: Linking Industrial Wastewater Treatment and Environmental Protection." Other sponsors included DuPont, the Texas Agricultural Experiment Station, the Texas Agricultural Extension Service, the Tennessee Valley Authority, and K.W. Brown and Associates. This workshop featured talks on the use of man-made wetlands for wastewater treatment, wetlands flora and fauna, the use of constructed wetlands for industrial wastewater treatment, and the relationship between wetlands and groundwater pollution.

TWRI is now organizing its major "Water for Texas" conference that will be January 26-27, 1995 at the Driskill Hotel in Austin. Sponsors include the Texas Water Development Board, and the Texas Water Conservation Association. The theme of the conference is "Research Leads the Way." Scientists and water resources professionals are invited to present papers at the meeting. Sessions will focus on such topics as water supply and management; water conservation and reuse; groundwater; aquatic biology; coastal studies; water quality; socioeconomics and policy and watershed management. **Individuals that wish to present a paper at the conference must contact TWRI by Nov. 10 with a title of their proposed talk and a brief abstract.**

For more details on any of these conferences, please call TWRI at (409) 845-1851.

Denitrification and Oxygen Consumption in the Nueces and Guadalupe Estuaries

Researchers: Won Bae Yoon and Ron Benner, University of Texas Marine Science Institute (UT MSI), Port Aransas, TX.

Problem: Estuaries are ecologically important sites because they process and produce nutrients that many species need to survive and flourish. Nitrogen is of primary importance for maintaining the high productivity in Texas' coastal estuaries. Few studies have addressed the process that affects how nitrogen is removed from Texas estuaries and how this affects biological productivity. Nitrogen can be removed from estuaries by these processes: 1) flows to coastal waters, 2) commercial or recreational fisheries, 3) sediment deposition, and 4) atmospheric losses of nitrogen gas due to denitrification. The Guadalupe and Nueces estuaries are roughly the same size, but the Guadalupe Estuary typically receives greater freshwater inflows.

Objectives: To develop data on the spatial and temporal rates of denitrification in the Guadalupe and Nueces estuaries.

Methodology: Sediment cores were collected from each site using a hand-operated coring device or by scuba divers. Sampling sites included three locations in the Guadalupe Estuary and San Antonio Bay, two sites in the Nueces Estuary, and two sites in Corpus Christi Bay. Sampling was performed from August 1988 through May 1989. Sediment cores were sent to the UT MSI lab at Port Aransas and were placed in glass incubation chambers. The chambers were sampled at 1 to 3 day intervals for nitrogen production, oxygen consumption, and nutrient concentrations. Distilled water and sea water was poisoned and added to the chambers until the volume of the gas phase was equal to the volume in chambers with sediment. This was done to make sure that nitrogen contamination had not occurred. Gas samples were analyzed for nitrogen and oxygen levels by gas chromatography.

Results: During the study period, salinity levels ranged from 32 to 44% in the Nueces Estuary, and from 11 to 29% in the Guadalupe Estuary. This reflects the varying volumes of freshwater inflow to these estuaries. Salinity appeared to have little effect on denitrification. Spatial differences in denitrification and oxygen consumption rates were

evident in both areas. The highest rates occurred in the upper estuaries where the porosity and organic matter contents of sediments were typically highest. Rates of both processes were 2 to 6 times higher in Spring and Summer than in Winter. Denitrification typically accounted for more than half of the total inorganic nitrogen flux from sediments. In the Guadalupe Estuary, denitrification removed 57% of the inorganic nitrogen entering the estuary from riverine inflow and precipitation. In the Nueces Estuary, denitrification exported more nitrogen than the amount that was produced by riverine inflow and precipitation. The study suggests that man-made inputs may be important sources of nitrogen to that estuary.

Reference: Yoo, Bae Yoon, and Ron Benner, "Denitrification and Oxygen Consumption Rates in Sediments of Two South Texas Estuaries," *Marine Ecological Progress*, December 1992.

Strategies to Manage Methane Emissions from Rice Fields

Researchers: Ron Sass, Frank Fisher, and Y.B. Wang, Ecology and Evolutionary Biology Dept., Rice University, Houston, TX; and Fred Turner and M.F. Jund, Texas Agricultural Experiment Station (TAES), Beaumont, TX.

Problem: Increasing world populations are expected to create a demand for significant added rice production by the year 2020. Flood irrigation of rice fields creates conditions for anaerobic bacteria to generate methane and methane gas. Draining floodwater from rice fields decreases methane emissions because it increases soil aeration. Conventional methods of growing rice that are now used along the Texas coast generate as much as 190 pounds of methane emissions per acre per day (a total of 28,000 tons per day). Many experts believe that methane emissions from flooded rice fields and other sources may lead to global warming and climate change.

Objectives: To quantify methane emissions generated by conventional rice production strategies now used along the Texas Gulf Coast, and to investigate the effect of alternative floodwater management strategies on methane emissions, rice yields, and water use.

Methodology: Studies were conducted at the TAES research farm near Beaumont using "Jasmine 85" rice. Four rice production techniques were evaluated. The conventional strategy involves brief flush irrigations after planting to help establish young plants. After the rice plants are about 6" tall (about 7 weeks after planting) a 4" flood is applied and maintained until two weeks before harvest. Alternative strategies that were evaluated include mid-season drainage and aeration; multiple drainage and aeration; and late season flooding. Methane samples were obtained twice each week by placing open-bottom chambers over the vegetation for 30 minutes. The chambers were mounted on airtight aluminum flux collars, and the bottom of the chambers was below the water surface. Methane levels were determined with a gas chromatograph. Dissolved methane levels in soil pore water were determined by analyzing sediment samples. Measurements of water use and plant growth were also made.

Result: No significant methane emissions were observed in any field before flooding or after fields were drained. In all fields, methane emissions did not reach significant levels until at least one week after flooding. Soil analyses show that 80 to 90% of the methane was produced in the top 4" of the soil surface. Significantly, irrigation strategies that used three short-term (2 to 3 days) draining of rice fields reduced methane emissions by 88%, but did not adversely affect rice yields, but increased water use by 400%. Mid-season aeration allowed methane levels to peak before fields were drained, but doubled water use. Late-season floodwater treatment suppressed methane production, but methane levels peaked at 250% of normal values after floodwater was applied. Late-season flooding produced the lowest yield of any method that was evaluated, but did not increase water use. Researchers are now developing methods to apply only the amount of water needed for evapotranspiration. This could reduce methane emissions and maintain yields while not increasing water needs.

Reference: Sass, R.L., F.M. Fisher, Y.B. Yang, Fred Turner, and M.F. Jund, "Methane Emission from Rice Fields: The Effect of Floodwater Management," *Global Biogeochemical Cycles*, Vol. 6, No. 3, 1992.

Incorporating Return Flows and Instream Flows into Water Allocation Policies

Researchers: Ronald C. Griffin and Shih-Hsun Hsu, Agricultural Economics Dept., Texas A&M University, College Station, TX.

Problem: Policies now being used to allocate surface waters within watersheds focus on the amount of water that is diverted. Developing an efficient policy that includes instream flows and return flows is difficult at best. Protecting and augmenting instream flows for non-consumptive uses such as recreation and protection of aquatic species and habitats is now a major environmental issue.

Objective: To develop a framework for a simulation model that would efficiently allocate water, and to develop a property rights system that can serve as an interface between water diverters and instream flow users.

Model Development: To deal with instream flows, a new economic depiction of water interrelationships is required. The model should recognize that the withdrawal of water from a given site on a stream impacts downstream users who derive value from those instream flows, even if the entire diversion is returned at some downstream point. The model incorporates the following concepts: water is a multi-dimensional good in that people derive value from many properties of water; each water use has substitution opportunities (this implies that the amount of water diverted, used, and returned to the stream can be controlled); and each water use can have a unique character with respect to when and where return flows will re-enter the stream. The model assumes that people care about the amount of water they divert, the amount of water they consume, and the amount of water in the stream. The model divides water users into diverters (farmers, cities and industries) and instream users. Instream users are located continuously at intervals that are separated by neighboring diverters. The model also includes a regional

welfare equation to determine the optimal consumption of water. The ability to develop an "idealized" water market that recognizes return flows and instream flows was also investigated.

Results: Assuming that the objective of any water allocation policy is to maximize regional welfare, the location of diversion points and return flows relative to streamflow is pertinent. Centralized or decentralized water allocation policies can be employed as long as the spatial character of water use is addressed. Transferrable water right systems or water markets can be redesigned to simultaneously manage water diversions and instream flows, but attention to instream flows introduces new complexities for marketing. Efficient water marketing requires transferrable rights for water diversions and water consumption. The goal of economic efficiency requires market participation or representation by instream beneficiaries. If the non-rival character of instream water use could be avoided, market participation by instream water districts would be satisfactory. In the absence of this idealistic case, the research results recommend a basin-wide system of economic motivations where incentives capture the value of streamflow along different reaches of the waterway. Diverters could then trade rights for water diversion and consumption with the economic incentives offering inducements for streamflow impacts. Mathematical formulations for such a system are developed by the research.

Reference: Griffin, Ronald C., and Shih-Hsun Hsu, "Potential for Water Market Efficiency When Instream Flows Have Value," *American Journal of Agricultural Economics*, May 1993.

Determining Baseline Water Quality Levels in Oso Creek in Corpus Christi

Researchers: Joan Koenning and Andrew Ernest, Environmental Engineering Department, Texas A&M University-Kingsville, Kingsville, TX.

Problem: Many creeks in urban areas are affected by point and non-point source pollution. To understand water quality problems in a creek, potential sources of pollution need to be identified within different sections of a watershed.

Objective: To determine summer baseline water quality parameters along Oso Creek in Corpus Christi, TX.

Methodology: A 3.6 mile segment of the creek was sampled in October and November, 1993. Six sites were used for on-site testing of the following water quality parameters: dissolved oxygen, temperature, pH, turbidity, salinity and conductivity. Those sites included the outfall of the Corpus Christi wastewater treatment plant and the confluence of Oso Creek and LaVollo Creek. Other sampling locations included sites before, at and after the intersection of Oso Creek and state highway (SH) 286, and the intersection of Oso Creek and farm to market (FM) road 43. A landfill is near the wastewater treatment plant, while the Cabiness Navy base is far downstream. In addition, three of these sites were also used to gather samples for laboratory tests for parameters including 5- and 20-day biochemical oxygen demand, total organic carbon, total Kjeldahl Nitrogen, ammonia

nitrogen, nitrate, total phosphorous, orthophosphorous, and chlorophyll. Those locations were the wastewater treatment plant, the intersection of the creek and SH 286, and the intersection of the creek and FM road 43.

Results: Storm drains located along Oso Creek probably influenced the water quality. For example, many of the parameters including BOD and organic carbon peaked at the site that was immediately downstream of the storm drain. Runoff from nearby agricultural operations and the landfill probably affected levels of BOD, total phosphorous, organic carbon, ammonia nitrogen, Kjeldahl nitrogen, nitrates and nitrates. Turbidity levels were lowest at the site nearest the wastewater treatment plant and increased significantly downstream. Nitrate concentrations decreased and nitrite levels increased at each consecutive downstream site. This suggests that nitrates were being converted into nitrites.

Reference: Koenning, Joan, M.S. Thesis, *Determination of Summer Baseline Water Quality Parameters in Oso Creek, Corpus Christi, TX*, Texas A&M University-Kingsville, Kingsville, TX, 1993.

Using Preozonation to Remove Turbidity from Drinking Water

Researchers: Syed R. Qasim and Muhammad I. Hossain, Civil Engineering Dept., Univ. of Texas at Arlington, Arlington, TX.

Problem: Interest in preozonation (treating drinking water with ozone before coagulation and flococulation) has increased in recent years. Much of the increased interest is due to growing public health concerns about the formation of trihalomethanes (THM) that may result from disinfecting drinking water with chlorine. In addition, preozonation is also being used to remove foul tastes, odors, and colors; to treat iron and manganese; and to oxidate and volatilize organics.

Objective: To evaluate the effect of preozonation on: 1) the settling velocity of floc, and turbidity removal, 2) reduction in coagulant doses, 3) length of filter runs and head losses, and (4) removal of Total Organic Carbon (TOC) and chlorine demand.

Methodology: Bench- scale and pilot- plant studies were conducted. In the bench- scale studies, the impact of preozonation on the settling velocity of the floc and turbidity removal was evaluated. The optimal doses of preozonation and coagulating chemicals were identified. In the pilot plant experiments, some of the drinking waters were treated with ozone while others (the control group) were not. Levels of pH, turbidity, TOC and chlorine demand were measured in raw, aerated, settled and filtered water. Filter head losses and filtered water turbidity were monitored until turbidity breakthrough occurred.

Results: Preozonation improved the settling velocity of the floc, and less coagulant dose was required to achieve the same amount of turbidity in the settled water. Pilot plant studies were conducted with various doses of ozone and coagulants. When coagulant doses and the length of the filter runs were increased, the turbidity of settled water was reduced. Preozonation seems to have a negligible effect on the TOC removal, which may

more be due to the fragmentation of organic matter than oxidation. There was a slight reduction in the 7-day chlorine demand due to preozonation.

Reference: Qasim, Syed R., and Muhammad I. Hossain, *The Effect of Preozonation on Turbidity Removal* , Department of Civil Engineering, The University of Texas at Arlington, 1992 (a project completion report was submitted to the City of Fort Worth).

Researchers from TAES, TAMU-K, TAMU-CC Work to Improve Wastewater Quality from Shrimp Farms

A team of researchers from the Texas Agricultural Experiment Station (TAES), Texas A&M University-Kingsville, and Texas A&M University-Corpus Christi is cooperating on a study to identify methods to improve water quality from South Texas shrimp farms. Lead investigators on the project are Tsaghi Samocha and Addison Lawrence of the TAES Shrimp Mariculture Laboratory in Corpus Christi. Andrew Ernest of the Environmental Engineering Department at Texas A&M University-Kingsville and Virender Sharma of the Texas A&M University-Corpus Christi College of Science and Technology.

This truck transports feed for shrimp ponds at a site in Arroyo City.

The project will assess methods to treat wastewater streams from two large commercial shrimp farms in Arroyo City. Taiwan Shrimp Village contains about 85 1-acre ponds, while Hung's Shrimp Farm operates 94 5-acre ponds. The studies are needed because there are concerns that the shrimp farms are discharging large amounts of total suspended solids (TSS) and other pollutants into the Arroyo Colorado River and the Laguna Madre. Roughly 100 million gallons per day flow into the shrimp farms. Typically, incoming waters have TSS values of roughly 20 parts per million (ppm), but those levels have jumped to more than 300 ppm in shrimp farm wastewaters. There are also concerns that biochemical oxygen demand (BOD) in the wastewater may be excessive.

Initially, the project will involve inventorying the mariculture operations, and defining site-specific operations, effluent volume and inflow and discharge points. Later, water quality samples will be collected for TSS and BOD. Ernest will explore the feasibility of

treatment technologies such as sedimentation basins, constructed wetlands, filtration, and gravity thickening that may best treat the wastes. Lawrence and Samocha will review the operations of both plants and assess if aquaculture management strategies can cut pollutant loadings. They will investigate such factors as fish diets, stocking fewer shrimp per pond, increasing aeration, and water recirculation. Lawrence, Samocha, Ernest, and Sharma will be involved with water quality testing and analyses.

The project is important because there is a potential to develop aquaculture operations along the Texas coast. If water quality problems cannot be solved, it may be much more difficult to operate existing facilities and recruit and develop new plants.

For details, call Lawrence at (512) 749-4625, Samocha at (512) 937-2268, Ernest at (512) 595-3041, or Sharma at (512) 994-2349.

Scientists at SFA, Texas Tech Track Movement, Preferences, of Fish with Radio Transmitters

When people today want to keep in touch with business associates, friends, and loved ones, they use beepers and pagers. Aquatic biologists also often want to keep track of fish and other species in lakes and rivers. The question is, how can you do that?

Researchers at Stephen F. Austin State University insert a transmittor into this crass carp so they can follow its movements in an East Texas lake.

For the past few years, scientists at Stephen F. Austin State University (SFA) and Texas Tech University have been following and documenting the movement of fish in lakes and reservoirs using small, lightweight, transmitters that are implanted in the body of a fish in independent studies. The transmitters provide useful data about where the fish travel within lakes and nearby rivers and streams and can yield clues about preferences that fish have for different habitats, water temperatures, salinity and other variables.

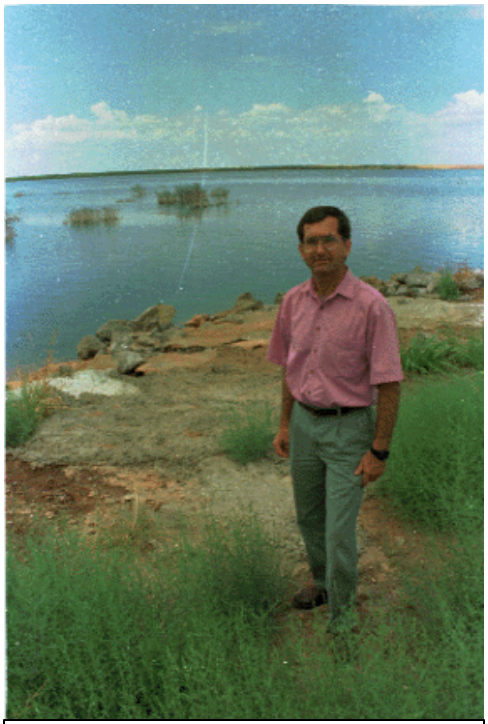
At SFA, radio transmitters were implanted into 26 triploid grass carp in Martin Creek Reservoir near Tatum. The carp were stocked in the lake to control hydrilla. Researcher Jack McCullough and graduate student John Hanks used the transmitters to find out if the grass carp would stay in a problem area that was plagued by waterweeds, and if power

plant effluents with high temperatures would influence the migration patterns within the lake. The study is still ongoing, but preliminary results suggest that the grass carp did not stay in the area that was targeted for hydrilla control. For more information on this project, call McCullough at (409) 568-3601.

In a separate study, Robert Weller and Jimmy Winter of the Range and Wildlife Management Department at Texas Tech University implanted small transmitters into 20 flathead catfish in Buffalo Springs Lake. The study involves evaluating changes in seasonal home range, habitat use, temperature preferences, and activity of sportfish in West Texas lakes. The researchers hope that the transmitters will provide information about the water temperature, dissolved oxygen levels, depth of water, substrate type, and the distance from the shore. In addition, data will be gathered on the peak movement of the fish as it relates to the time of the day and weather conditions. The goal is to improve overall sportfish management. For more information on this study, call Weller or Winter at (806) 742-1983.

TAES Scientists Seek Out Plants That Thrive on Salty Brines, Consume A Lot of Water

During much of his scientific career, Jerry Cox of the Texas Agricultural Experiment Station has been investigating plants and crops that use water efficiently. Now, as part of a study sponsored by the U.S. Army Corps of Engineers, he's seeking out species that consume as much salty water as possible.



TAES researcher Jerry Cox is helping the Corps of Engineers find plants that could help control water levels in brine diversion lakes.

Cox is based at the Texas A&M University Agricultural Research and Extension Center at Vernon. The Corps approached him to see if he could identify plants that could be planted in and around lakes where salty waters and brine are diverted from tributaries of the Red River. The Corps hopes that these plants could lower the water levels in the brine lakes, which are now filling up too quickly.

In the research, Cox and co-worker Jim Ansley will evaluate plants and crops that consume a lot of water, can live when they are partially or totally submerged, and can tolerate high Texas temperatures. After reviewing previous studies, Cox and Ansley will visit sites with similar conditions to look for candidate plants. Later, field research will be conducted at the Truscott Brine Lake where plant growth and water use will be evaluated under varying levels of salinity. If all goes well, these species could ultimately be planted near many brine diversion lakes and could lessen the need to construct additional sites to

store salty water from the river.

For details, call Cox or Ansley at (817) 552-9941.

UH Researchers Evaluate Methods to Remove Uranium, Radium from Groundwater

As many as 1,500 communities nationally suffer from the presence of naturally high levels of uranium, radium, and other radioactive chemicals in their groundwater supplies. Now, University of Houston (UH) researchers are assessing the best methods to treat and remove these potentially life-threatening elements.

Dennis Clifford of the UH Civil and Environmental Engineering Department focused much of his research on drinking water treatment methods. In the past year, Clifford and Zhihe Zhang investigated the use of ion exchange with mixed beds of cation and anion resins to remove uranium and radium from groundwater supplies in northwest Houston. The goal was to assess the ability of anion resins to remove uranium, to determine how pH and salt levels influenced the treatment process, and to identify the best way to regenerate resins that were partially exhausted from uranium removal.

Many of the studies and chemical tests were conducted over a 16-month period in UH's Mobile Drinking Water Laboratory. Raw waters contained up to 125 micrograms per liter (u/l) of uranium and up to 25 picocuries per liter (pci/l) of radium. A mixture of strong acid cations and strong base anions was used in the treatment beds. Fixed-bed tests were run in glass column experiments. After the beds were exhausted, the resin was regenerated with ordinary salt. The study showed that this system removed more than 95% of the uranium in the raw water. Surprisingly, pH levels as low as 5.8 did not reduce the system's performance. Lowering pH levels to 4.3 caused uranium leakage through the columns and prematurely exhausted a resin bed. Salts and sodium-based compounds reduced the ability of the beds to remove uranium. Sulfates influenced exchange resin capacity, and lessened the time before regeneration was needed.

Two articles on this research were featured in the April 1994 *American Water Works Association Journal.* For details, call Clifford at (713) 743-4266.

Texas A&M Corpus Christi Teams Up With Nueces RA to Manage Data Needs

For many river authorities in Texas, complying with the data gathering and analyses requirements of the Clean Rivers Act (Texas Senate Bill 818) is a daunting task. The program requires that river authorities compile huge amounts of information on many water quality issues. Recently, the Nueces River Authority (NRA) decided to team up with researchers at Texas A&M University-Corpus Christi (TAMU-CC) to help manage the data needed to comply with the Act.

The research will be performed by Patrick Michaud and Rocky Freund of TAMU-CC's Conrad Blucher Institute for Surveying and Science. The bulk of the effort involves

developing and implementing a computerized system to collect, transfer, maintain and use data sets that contain natural resources information for the region. Individual components of the project involve establishing procedures for quality assurance and quality control, customizing software to meet the needs of the NRA and the Texas Natural Resource Conservation Commission, training NRA personnel and others on how to use the system, and formatting data so that it can be easily imported and exported into other programs and platforms.

The project also includes creating a base map of the Nueces River and its coastal bays that can be used as part of a geographic information system (GIS). Later, the TAMU-CC researchers hope to work with the NRA to add additional data layers to the GIS for such factors as stormwater outlets, water rights, terrestrial and aquatic vegetation, aquatic species, and brine discharges.

For more information, contact Michaud at (512) 994-2376. His e-mail address is PMichaud@cbi.tamucc.edu.

Texas A&M Ag Engineering Departnemt Offers Graduate Fellowship

The Agricultural Engineering Department at Texas A&M University, has a USDA Fellowship for Environmental Water Quality Research and Educational Opportunities in: groundwater, surface water, wetlands, irrigation and drainage. The fellowship is available at $17,000 per year for three years. Out-of-state tuition fees are waived and the Department supplements the fellowship at $1,200 per year. Applicants must be a citizen or native resident of the U.S. and should have completed requirements for the M.S. degree in Agricultural Engineering, Civil Engineering or other related environmental engineering discipline. The Fellowship must be filled by November 30, 1994, and applicants must enroll by August, 1995.

To apply, send a resume and a statement of research interest to: Clyde Munster, Agricultural Engineering Dept., Texas A&M University, College Station, TX 77843-2117. His phone number is (409) 847-8793.

Texas Tech Publishes Playa Lake Proceedings

A proceedings that focuses on issues related to the many playa lakes that are scattered throughout the Texas High Plains has been published by the Water Resources Center at Texas Tech University.

The proceedings was edited by Center Director Lloyd Urban and A. Wayne Wyatt, the General Manager of the High Plains Underground Water Conservation District No. 1 in Lubbock.

The proceedings feature 31 technical papers that were presented by researchers at Texas Tech University, Texas A&M University, and many other organizations. Sections of the proceedings deal with such topics as the significance, origin, and history of playa lakes; recharge from the playa lakes to the Ogallala Aquifer; water quality and environmental

concerns; use of playa lakes for animal waste management; economic and environmental challenges; and regulations that treat playa lakes as wetlands.

The proceedings can be purchased from the Center by calling Urban at (806) 742-3597. His e-mail address is LUrban@coe2.coe.ttu.edu.

SW Texas "Web" Site Lets Users Learn About Edwards Aquifer from Their Computers

Individuals who are interested in learning more about the Edwards Aquifer can now access text and graphics about the Aquifer and related issues from their computer. The Edwards Research and Data Center at Southwest Texas State University (SWTSU) recently established a site about the Aquifer on the "world wide web." The site can be accessed by computer users with internet connections or high speed modems by using Mosaic or Gopher software. The software supports both Macintosh and IBM-compatible personal computers.

The web site includes a variety of text and graphics about the Aquifer, the Center, and research at SWTSU. For example, users can access and download regional hydrologic and hydrogeological conditions, as well as data on recharge, water use, pumping, daily flows at San Marcos Springs, and U.S. Geological Survey streamflows. Users can also request a password from the Center so that they can run an Edwards Aquifer simulation model.

Center Director Glenn Longley says that establishing a web site has a number of advantages. It bypasses the need for many printed publications and allows users direct access. Users with Mosaic software can access the Edwards Center Web at the following address: http://eardc.swt.edu/ . For more details, you can call the Center at (512) 245-2329.

Texas Tech Video Explains Benefits of LEPA Irrigation

A videotape on low energy precision application (LEPA) irrigation systems is now available from Texas Tech University.

The 30-minute videotape, *LEPA: Saving Water for Future Producers*, was produced by Pam Alspaugh of the Texas Tech University Video Services Department. The project was a joint effort of the Texas Tech University News and Information Office and the Texas Agricultural Extension Service (TAEX). Funding was provided by the Texas Tech Water Resources Center, the Texas Corn, Grain Sorghum, the Peanut and Wheat Producers Boards, LaMesa Cotton Ginners, and the Mesa Underground Water Conservation District.

LEPA irrigation systems apply low volumes of water near the plant canopy under low pressure. This decreases losses to evaporation and wind. LEPA also requires careful management of irrigation and tillage operations. The video features interviews with 18

farmers and experts from Texas Tech University and the Texas A&M University System about their experiences with LEPA.

County extension agents, soil conservation service offices, irrigation dealers and the commodity groups listed above can borrow the videotape. Copies of the videotape can be purchased for $10 by contacting: Texas Tech University, Video Services, Box 42022, Lubbock, TX 79409-2022 or at the TAEX Centers at Lubbock or Amarillo.

Tarleton State U. Reports Examine Ways to Reduce Non-Point Source Pollution in Central Texas

Researchers at Tarleton State University have recently published two comprehensive studies that deal with reducing water pollution from confined dairies and other agricultural operations in Central Texas. The reports were published by the Texas Institute for Applied Environmental Research (TIAER).

Livestock and the Environment: Watershed Solutions was written by TIAER researchers Larry Frarey, Larry Hauck, Ron Jones and Nancy Easterling. The report contains detailed information on the sources of agricultural pollution in the region, and TIAER research that responds to those problems. For example, the report summarizes results of water quality sampling in the Upper North Bosque watershed, investigates the cost of regulations to dairy operators, and explores voluntary policy alternatives that could be implemented and still control pollution.

Dimensions of Planned Intervention was written by Larry Frarey and Ron Jones. This report analyzes the merits of strategies that rely on voluntary adoption of agricultural best management practices (BMPs) as well as traditional command and control techniques to lessen agricultural pollution. The report stresses that voluntary techniques may be very successful at reducing pollution from confined dairies, if they are supplemented with enforcement actions directed at those who do not want to adopt BMPs.

To order either report, call TIAER at (817) 968-9567.

Texas A&M Study Examines Potential for Water Marketing

A new study by Texas A&M University researchers sheds new light on the opportunity for increased water marketing in the State.

The report, *An Analysis of the Legal and Institutional Parameters for Water Marketing in Texas*, was written by Ronald Kaiser of the Recreation, Parks, and Tourism Sciences Department and Fred Boadu of the Agricultural Economics Department. Research conducted to produce the report was funded by the Texas Water Development Board. James Mertes of the Texas Tech University Landscape Architecture Department assisted with the research.

The overall theme of the report is that water marketing and reallocation will likely be needed in Texas by the year 2020, even if aggressive water conservation and efficiency

programs are implemented. With that in mind, the researchers investigated Texas water laws and policies that encourage or restrict water marketing. Goals of the study were to review Texas water law, regulations, and institutions that affect water marketing; to evaluate laws and policies used in other Western states to promote water marketing, and to recommend changes in Texas water laws, rules, and policies that would facilitate water reallocation and markets.

The research suggests that water marketing is a viable water management strategy for Texas because it can provide water to growing cities, promotes water use efficiency and conservation, and provides water for non-consumptive uses. The researchers found that Texas groundwater law permits the sale of water but does not encourage water marketing. On the other hand, Texas surface water law permits the reallocation of water within a river basin, but may restrict the transfer of water from one basin to another. Interbasin transfers, the researchers say, could also cause economic, political, socioeconomic, cultural, and environmental damage to "third parties." The report suggests that as much as 2.4 million acre feet (AF) of treated wastewater is returned to streams and rivers. This water could be widely marketed, if the issue of who owns return flows would be made more clear in Texas water laws and rules. For more details, call Kaiser at (409) 845-5303 or Boadu at (409) 845-4410.

"State of the Bay Report" Describes Galveston Bay Issues

A comprehensive, easy to read, and well-illustrated report that outlines problems facing Galveston Bay has recently been published by the Galveston Bay National Estuary Program (GBNEP).

The 232-page report, *The State of the Bay: A Characterization of the Galveston Bay Ecosystem*, was edited by GBNEP Director Frank Shipley and Russell Kiesling.

The report contains general information about the Bay and sections dealing with specific issues such as ecological modeling, the physical form of the Bay and processes that affect it, water and sediment quality, aquatic species, wetlands and reefs, and public health issues. The report also outlines 17 specific conclusions about the state of the Bay that resulted from GBNEP research. For example, the report states that vital habitats such as wetlands and submerged beds of aquatic vegetation have been lost; that contaminated runoff from nonpoint sources degrades the quality of water and sediments in the Bay; and that raw or partially treated sewage and industrial wastes enter the Bay during runoff.

More information about the report can be obtained by calling the GBNEP office at (713) 332-9937.

Measuring Changes in Soil Wetness Levels is Goal of Prairie View, Texas A&M Studies

A research project by scientists at Prairie View A&M University (PVAMU) and Texas A&M University (TAMU) recently studied if color patterns and physical properties of soils can yield clues into soil wetness conditions.

The study was conducted by Richard Griffin of the PVAMU Cooperative Agricultural Research Center and Larry Wilding of the TAMU Soil and Crop Sciences Department and is a component of a long-term project called the National Wetlands Study. The overall goal of the National Wetland Study is to develop methods to more accurately identify wetlands soils.

Understanding soil moisture is important along the Texas Gulf Coast Prairie where many soils drain poorly and shallow water tables (1 to 7 feet deep) often occur. Griffin and Wilding wanted to determine if soil saturation and wetness levels could be estimated by examining changes in soil color, structure, and texture. The goal of the study was to gather data from many sites so that soil color, structure, and textures could be calibrated for more widespread use.

Richard Griffin explains how variations in soil colors and patterns can be used to identify wetlands soils.

The project consisted of studying clay and loamy soils near Beaumont, Houston, and Victoria. The sites included irrigated and non-irrigated plots that were planted with crops, as well as native meadows and wetlands. Soils were monitored for changes in moisture levels and water logging every other week for more than 60 months. Piezometers were used to determine the presence of shallow and deep perched water tables and the reduction-oxidation potential. The amount of soluble iron in the soils (which indicates reducing conditions) was estimated by using a chemical that turns pink or red when ferrous materials are present.

Shallow and perched groundwater tables were found at the sites. The open borehole method, which is now widely used to determine water table levels, often overestimated the height of the water table and the amount of saturation. The depth to groundwater, recharge features, and soil wetness conditions vary remarkably over short horizontal distances in coastal areas. Previous studies demonstrated that soil color patterns may not reflect current wetland conditions, but may indicate "relic" or historical wetness.

The research may help establish conditions where color patterns, soil structure and soil textures may be used to identify hydric and wetlands soils. Research is now underway to model the probability of water table fluctuations. If the method is successful, it may provide land use planners and soil scientists with a way to inexpensively assess soil wetness and saturation based on field data. Still, more field monitoring and data

collection will have to be performed before this method can consistently be used to detect soil moisture levels.

For details, call Griffin at (409) 857-4012 or Wilding at (409) 845-3604.

West Texas A&M Forms Dryland Agriculture Institute

A research center has been formed at West Texas A&M University to investigate issues relating to dryland agriculture.

The Dryland Agriculture Institute, which was formed in 1993, is headed by Bobby Stewart, who was formerly the Director of the U.S. Department of Agriculture Conservation and Production Research Laboratory at Bushland.

The goals of the Institute are to promote research; to train graduate students; and to provide international training opportunities. Specific research interests of the Institute include efficient water use; erosion; soil fertility; the development of drought-resistant crops; reduced irrigation strategies; pest management; and grassland management.

The Institute has already been able to recruit six graduate students and has accepted two scientists from Ethiopia for five months of training. Roughly 26 participants from Asia, South America, the Middle East, and Africa took part in a four-week training workshop in June.

To learn more about the Institute, call (806) 656-2299.

UNT Geographers Study Lower Rio Grande Water Markets

Geographers at the University of North Texas (UNT) are examining water marketing trends in the Lower Rio Grande Valley to determine changes in diversion points and the amount of water use.

F. Andrew Schoolmaster conducted the study, which focused on water marketing by the cities of Brownsville, Harlingen, and McAllen, and Hidalgo and Cameron counties. In the study, Schoolmaster developed data from 1974 to 1987 on population trends, specific types and amounts of water use, and the amount and price of water traded in market transactions.

Schoolmaster found that municipal rights and options for Class A irrigation rights were the most expensive, because they constitute the most dependable supply of water. Water marketing may be more successful in the Lower Valley than in other parts of Texas and the Southwest because instream flow protection is not a major issue. Instream flows from the Rio Grande empty directly into the Gulf of Mexico just downstream of Brownsville. Finally, the Texas Natural Resource Conservation Commission Watermaster Program facilitates active water markets and may be a model other regions want to follow.

The research was featured Vol. 43, No. 3 (1992) of *The Professional Geographer*. Schoolmaster can be reached at (817) 565-2452.

Texas Tech Researchers Convert Raw Cotton into Pollution Cleanup Tool

Texas Tech University researchers have discovered an innovative way to separate oil from cotton pads that may be used to clean up oil spills in aquatic environments.

Texas Tech researchers Caryl Heintz and Harry Parker examine raw cotton that may be used to clean up oil spills.

The researchers, chemical engineer Harry Parker and biologists Caryl Heintz and Deborah Carr discovered the biological process during their studies of potential uses of low-grade raw cotton. Low-grade or raw cotton results from drought or early frost. It may be an ideal material for use in oil spills because it does not absorb water.

The study was sponsored by the Texas General Land Office.

In the research, Parker placed the cotton pads in a wave tank that contained chemicals representing a typical oil spill from a tanker or barge. Heintz then placed the oil- soaked cotton in a bioreactor and studied how to degrade the oil and the cotton into non-hazardous end products. The researchers discovered a biological process that separates the cotton and oil. They now are working to further develop the process so that the end products can be disposed without harming the environment. The goal is to develop a fast-responding cleanup system that collects more oil from the water and eliminates the disposal of oil-drenched sorbents.

The project could benefit the environment and the West Texas economy. The process could allow coastal waters to be cleaned more completely and quickly, reducing potential pollution. The process could also create a new market for Texas cotton producers. For details, call Parker at (806) 742-3553 or Heintz at (806) 742-2714.

UT Geologists Study Impact of Lignite Coal Mining on Groundwater

Mining for lignite coal is common throughout much of East Texas. However, whenever mining occurs it disrupts geological formations that often contain groundwater. Evaluating the impact of mining and mine restoration on groundwater supplies was the focus of a recent research project by scientists at the University of Texas at Austin.

The project was conducted by John Sharp of the Geological Sciences Department, and Frederick Holzmer of Intera, Inc.

Strip mining typically disrupts the hydrogeologic structure because overburden (areas above coal deposits) is removed by drag lines and scrapers. After an area has been mined, the spoil material (soils and rocks that were excavated to reach the lignite) is used to create new "reclaimed" lands.

In this study, the researchers studied a lignite mine near Fairfield that is part of the Wilcox Aquifer group. The goal was to characterize the water quality of a redeveloping groundwater system that was forming under lands reclaimed in 1985. That information was compared to natural groundwater conditions before mining began.

In general, the research found that there were distinct differences in groundwater quality before and after mining. For example, dissolved solids increased from a maximum of 1,700 parts per million before mining to a high of 4,000 parts per million afterwards. Sulfate levels in the reclaimed groundwater system were higher than normal because of pyrite oxidation. They also found that a new groundwater mound was forming in the area that had been reclaimed and investigated how water flowed in that system.

For details, call Sharp at (512) 471-5172 or Holzmer at (512) 346-2000.

Reduced Tillage Can Increase Soil Moisture, Yields, A&M-Kingsville, TAES Study Shows

Throughout much of the Texas Coastal Plains, farmers till their cotton crops as often as 12 times a year. Now, scientists with the Texas A&M University-Kingsville (TAMU-K) are working with researchers with the Texas Agricultural Experiment Station (TAES) at Corpus Christi to determine if tilling the soil less frequently may keep moisture on the field.

Lead investigators on the project include Armando Garcia and Duane Gardiner from TAMU-K and TAES researchers Juan Landivar and Daniel Lawlor.

Reducing the number of tillage operations leaves more crop residues on the field. The researchers wanted to study if reduced tillage increases the soil-water content, the amount of water that can be taken up by plants, infiltration, and yields, while reducing soil temperatures and water losses to evaporation.

The study was conducted near the TAES Corpus Christi Center. The reduced tillage field was plowed 13 times to a depth of 3 inches, while the conventional tillage plot was treated 16 times at a depth of 6 inches. The research shows that, in most cases, soil water content and plant extractable water was significantly greater in fields treated by reduced tillage. Soil temperatures in the reduced tillage fields were about 4deg. F lower than in areas that received conventional tillage treatments.

For details, call Gardiner at (512) 595-3719 or Landivar at (512) 265-9201.

TCU Biologist Patents System that Uses Algae-Eating Fish to Remove Nutrients

A Texas Christian University (TCU) biologist and his research team have patented a filtration system that uses a series of screens, algae, and herbivorous fish to remove phosphorus, nitrogen, and toxic chemicals from water supplies. The system may provide communities with a method to filter and reuse wastewater at a cost that is less expensive

than current methods now used to remove such substances. The system may be 3 to 10 times more efficient than constructed wetlands at removing nutrients.

Ray Drenner of the TCU Biology Department is the lead scientist on the project. Others who are participating include Durward Smith of the Biology Department and graduate students Stacy Basham, Don Day and Regina Steinkamp. The project is in its third year and the research is being funded by the Tarrant County Water Control and Improvement District #1.

TCU biologists Durward Smith (left) and Ray Drenner monitor the performance of algae-eating fish in an innovative wastewater treatment system.

Much of the research is being performed at the Eagle Mountain Fish Hatchery near Fort Worth. In the process, water with high levels of nitrogen and phosphorus flows into a network of 24 100-gallon tanks. Algae, exposed to the excess nutrients and the sun, rapidly grow on plastic screens placed in the tanks. Between 15 and 30 herbivorous stone-roller minnows and tilapia swim around in each tank, eating algae that grows on the screens. Later, the fish discharge the nutrients in feces, which settle at the bottom of the tank. The feces are flushed, thus removing the nutrients from the system.

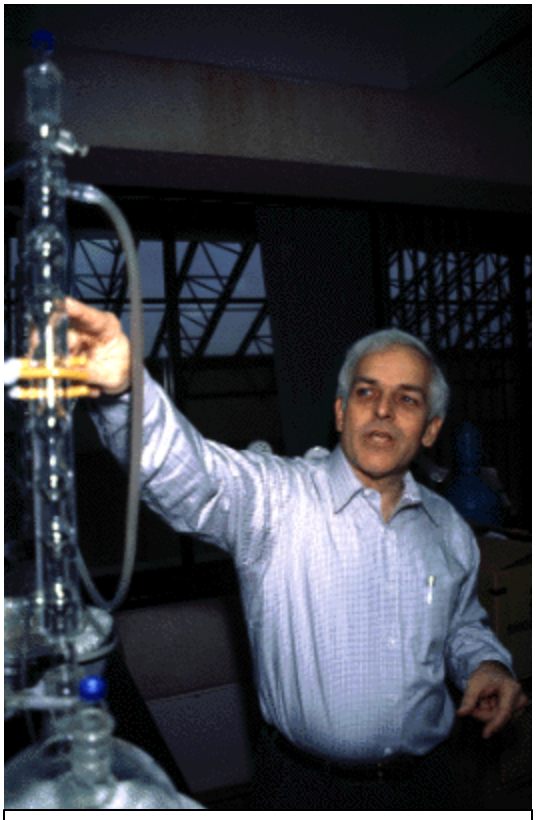
In developing the system, the biologists worked with more than a few variations. Basham thought insects in the system might carry off a large amount of phosphorus when they grow, emerge and fly off. In fact, they carry off less than 1% of the phosphorus. Day thought that most of the phosphorus removed by fish was ejected in their feces. Only about half is actually eliminated while the other half is incorporated into fish tissue during growth. Problems that still have to be addressed include the amount of screens needed to support the algae, the type and number of fish needed to eat the algae, and a way to remove fecal pellets without disturbing the system.

A final hurdle that has to be overcome is to determine if this laboratory-scale project can be enlarged into one that will handle 30 million gallons of water a day. Drenner said the water district is now considering whether to build a large pilot system.

For details, call Drenner at (817) 921-7165.

Texas A&M Studies Effect of Heavy Metals on Ecosystems

In much of Texas and elsewhere, there is concern that toxic heavy metals are polluting soils, lakes, rivers and streams. Researchers at Texas A&M University are studying methods that may provide improved assessments of the short- and long-term effects of heavy metals in sediments and water supplies to better reflect the impact of heavy metals in waters and streambeds on aquatic ecosystems.



Richard Loeppert adjusts the flow of oxygen for incubation studies to investigate the absorption and release of arsenic in reduced (flooded) versus oxidized sediments.

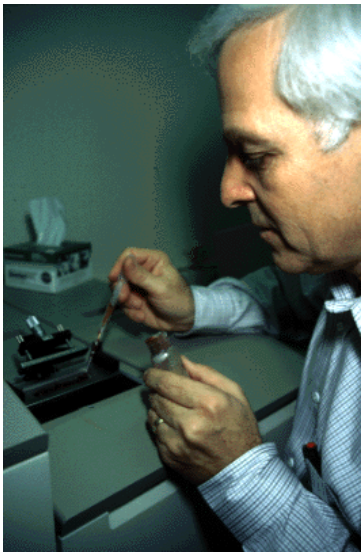
The project is being conducted by Richard Loeppert, Jianlin Wang, and Klaus Raven of the Soil and Crop Sciences Department in cooperation with Ralph Zingaro and Mysore Mohan of the Chemistry Department. In some cases, heavy metals like arsenic can build up to levels that are dangerous for fish, other aquatic life, and even humans. For example, aquatic plants and animals are able to absorb soluble arsenic from water and sediments. Current methods to quantify the levels of arsenic and other heavy metals in rivers and streams often do not provide an accurate estimate of the amount of heavy metals that may be taken up by fish, algae, and other species. The goal of this study is to more thoroughly understand the factors of sediment chemistry that influence how arsenic is released and taken up by aquatic organisms.

So far, work has focused on characterizing the levels and chemical forms of arsenic and factors that influence how it is retained and released. Specifically, the researchers hope to learn the role of oxidation and reduction processes that occur in sediments, and of biologically induced processes that may affect how sediment-bound arsenic is mobilized. Several contaminated lakes in Bryan, Texas are the primary study sites. Initial studies indicate that short- and long-term oxidation and reduction processes may play a very important role in arsenic release.

The work involves detailed chemical analyses and chemical speciation of the pore water; mineralogical analyses of sediments by x-ray diffraction and electron microscopy; and evaluation of arsenic retention and release by x-ray absorption, x-ray photoelectron spectroscopy, Fourier transform infrared spectroscopy, and extraction procedures. The extraction procedures will be compared to procedures now used by federal and state agencies for assessment of arsenic contamination. Future studies will involve evaluation of arsenic uptake by several plant species.

For details, call Loeppert at (409) 845-3814.

Richard Loeppert measures the concentration of dissolved iron in a soil solution by atomic absorption spectrophotometry. The atomic absorption spectrophotometer is used for the analysis of most metals, including arsenic, in the soil solution.



Richard Loeppert prepares a sediment sample for Fourier transform infrared analysis. By this procedure, information is obtained regarding the mechanism of bonding of arsenic to soil colloids.

Research Associate Amita Jain prepares the Fourier transform infrared spectrometer for analysis of arsenic contaminated sediment samples. The infrared spectrometer is used in studies of arsenic binding to sediment colloids.

Texas A&M Study Will Use Wetlands to Treat Pollutants

Determining how well man-made wetlands remove agricultural pollutants is the goal of a study by Ann Kenimer of the Texas A&M University Agricultural Engineering Department and Joe McFarland of the Texas Agricultural Experiment Station in Stephenville.

The goal is to evaluate the effectiveness of constructed wetlands as a best management practice (BMP) under controlled conditions. Kenimer says that although many BMPs like wetlands are concepts that may work, their performance in the field is not often thoroughly evaluated. The study will focus on a section of Smith's Spring Creek near Stephenville. The creek receives runoff from a 2,000-acre watershed that includes dairies, a cheese factory, and peanut production. All these sources create pollution. The cheese factory creates as much as 150,000 gallons of whey and wastewater daily, and now disposes of those wastes by surface irrigation. The site contains three ponds. The first pond receives water directly from the creek and has suffered from fish kills and heavy nutrient loadings. The water quality improves in the bottom two ponds.

The project involves constructing six wetland cells near two of the three ponds. The system is designed so water can be pumped into the cells from either of the two ponds to create different pollutant loadings. Kenimer hopes to test the performance of the system under various hydraulic loading rates and pollutant levels. Water samples will be collected and analyzed for standard parameters.

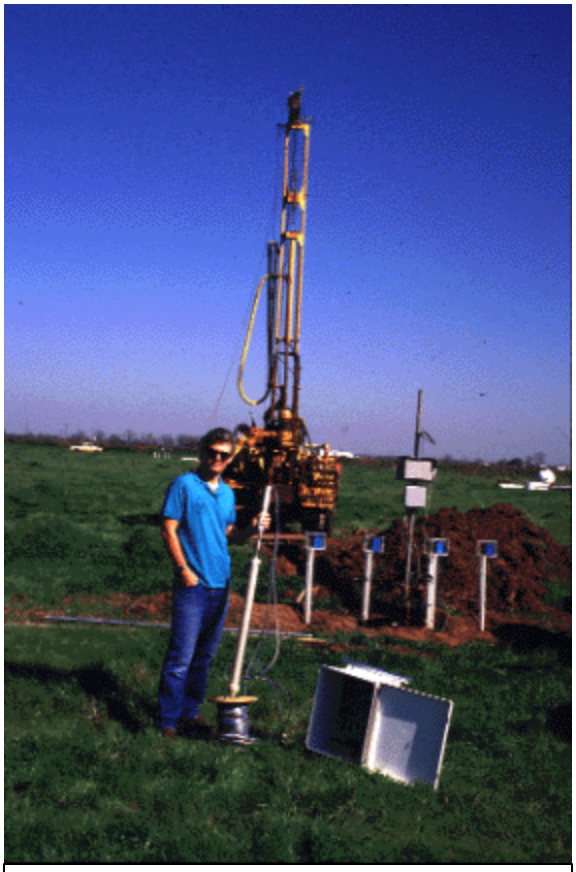
The project should develop more information on how man-made wetlands function in real-world situations, and will create a research site that can be used for future studies. You can call Kenimer at (409) 845-3931.

Kenimer presented a paper on this research project at the 1995 TWRI "Water for Texas" Conference. A more comprehensive report is now on-line.

Some of the dragonfly larvae identified in Ann Kenimer's research include this Libellula *(above), and* anax junius *(below).* Libellula *occur in waters of ponds and streams and wetlands. They are beneficial because they eat aquatic insects and mosquito larvae.* Anax junius *("green darners") are also thought to be beneficial for many of the same reasons.*

Texas A&M Assesses Water Quality in Brazos River Floodplain

Evaluating potential non-point source pollution problems from agricultural activities is the focus of on-going research by Clyde Munster of the Agricultural Engineering Department at Texas A&M University. The study is its second year and is being conducted on a 10-acre site in the Brazos River floodplain along the Brazos-Burleson county border. The goal is to determine the fate of atrazine and nitrogen that is applied to river floodplains and to study the hydrologic interaction between the alluvial aquifer and the Brazos River.



Sandy Ballard used this sensor to trace aquifer flow patterns in the Brazos River floodplain.

Munster has subdivided the site into two watersheds. Each watershed is instrumented with H-flumes and ISCO samplers to quantify and sample surface water runoff. So far, 40 monitoring wells and a pumping well have been installed. To assess water quality and groundwater interactions with surface water, nine well nests (each with four wells) have been installed in a 3 x 3 grid that runs parallel and perpendicular to the river. Each monitoring well is equipped with a wellhead device that continuously monitors groundwater levels. Atrazine, nitrogen and a tracer (bromide) were applied in April to a newly planted cornfield. Groundwater and soil samples have been collected and analyzed monthly for nitrate, ammonium, atrazine and bromide. Data on the depth to groundwater has been collected automatically and plotted daily. Munster also used an experimental in-situ permeable flow sensor to measure 3-dimensional groundwater flow and direction. The device heats the area immediately surrounding the sensor. The sensor was developed by Sandy Ballard of the Sandia National Laboratory in New Mexico. Temperature data the sensor collects can then be used to deduce groundwater velocity and direction.

Munster says that a few generalizations can be made about the results so far. There appears to be a direct correlation between the water levels in the river and the nearby alluvial aquifer. Initial test results suggest that the sensor accurately predicts 3-dimensional groundwater flows.

Next year, Munster will plant a second corn crop, apply nutrients and herbicides, and collect and analyze soil, groundwater and surface runoff samples. Several pump tests are

also planned to determine aquifer properties, groundwater interactions with the river, and the accuracy of the 3-dimensional flow sensor. The project will provide more information about the risks of water pollution from farming activities in floodplains.

For more details, call Munster at (409) 847-8793.

Texas A&M graduate students mix chemical tracers that will be used to follow the flow of pollutants through groundwater in field experiments at the Texas A&M University research site on the Brazos River in Brazos County.

Tractors apply the tracers to crops grown on the site.

Texas A&M students install sensors in the ground that will automatically collect information on water levels and water quality.

Part of the project involves using a device that sends heat impulses into the ground so that 3-dimensional groundwater flow patterns can be traced.

This control box is where groundwater data will be recorded so it can be downloaded.

Clyde Munster, the lead investigator on this project, tests the equipment to see that it is working properly and takes notes on the results.

Part of the project involves using a device that sends heat impulses into the ground so that 3-dimensional groundwater flow patterns can be traced.

UT Engineers to Develop Grid Based Water Balance for Texas

A researcher at the University of Texas at Austin is developing a system that will display site specific information about evaporation, runoff, groundwater recharge, and other hydrologic events over a three-dimensional grid of Texas. The project will be led by David Maidment of the UT Civil Engineering Department. The ultimate goal is to develop a spatial water balance for Texas.

Maidment says the project is needed for many reasons. Evaporation rates from land surfaces have not been accurately quantified throughout Texas. Although recharge rates have been calculated for individual aquifers, Maidment says that no consistent method has been used to produce a detailed statewide map and database. Detailed information on local hydrologic systems will make it easier to predict and understand how pollution occurs and how to stop it.

The first component of the project involves building an annual spatial water balance for Texas on a 20-mile grid. Maidment will develop the grid by using vector- and raster-based geographic information systems. Later, a more detailed (4-mile scale) monthly spatial water balance will be constructed for the Lavaca Navidad watershed north of Corpus Christi. This watershed was chosen because it's small; it overlies part of a major aquifer; and it supplies water to Lavaca Bay. The project should be useful to state and regional planning agencies and will generate an automated method to develop needed information for water planning.

For details, call Maidment at (512) 471-3131.