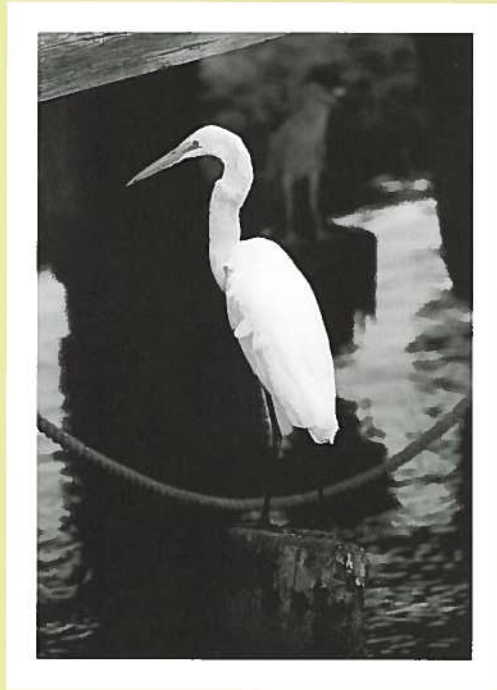


TEXAS SHORES



**Where
Does It Hurt?**

Sea Texas' Coast Through Texas Shores



We have a purpose at *Texas Shores* — helping our readers understand what's happening on the Texas marine scene.

To do this, we pioneered a newsletter, *The University and the Sea*, 25 years ago to keep people informed. Through the years, this has evolved into *Texas Shores*, an award-winning blend of clear, concise writing and sharp photography that is still the

only magazine in Texas devoted exclusively to the marine environment.

We base it on your priorities. Witness the timely themes of recent issues.

Oil spills, bycatch, coastal preserves, sea turtles, redfish, red tide, Galveston Bay, marine debris, oysters.

There were issues on erosion, the Flower Gardens, marine

mammals. And more recently, the crabbing industry, marine research and freshwater inflows.

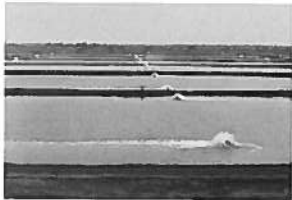
At Texas Sea Grant we are as committed to meeting your information needs as we are to the Texas coast and its effect on your life. And to ensure that we reach as many Texans as possible, we now offer free subscriptions to all residents. Subscribe today to *Texas Shores*.

Texas Shores

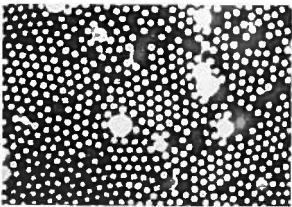
FALL 1995

TEXAS SHORES

VOLUME 28, NUMBER 3



PAGE 6



PAGE 14



PAGE 26

THE ISSUE: TAURA VIRUS

2

SEA NOTES

Highlights include an account of how menhaden were consistent losers in three fish kills along the Texas coast; one short course and two seminars announce meeting dates for 1996; NOAA installs the PORTS program in Galveston Bay; and Texas A&M researchers join with Baylor College of Medicine to find new ways to clean up hazardous wastes.

4

IT'S ALWAYS THE LITTLE THINGS

Just when it appeared the Texas shrimp aquaculture industry had finally established an economic foothold, a microscopic killer named Taura has decimated this year's anticipated 6-million-pound harvest.

24

ADVISOR

A quick tour of the coast with MAS' five county marine agents provides an overview of their most pressing concerns and projects.

FRONT AND BACK COVERS — © STEPHAN MYERS
INSIDE FRONT COVER — JAMEY TIDWELL

STAFF – Mike Hightower, *Interim Director*; Amy Broussard, *Associate Director*; *TEXAS SHORES Staff*—Jim Hiney, *Editor*; Jeff Guillory, *Marine Advisory Editor*; Amy Broussard, *Design*; Eric Graham, *Distribution Manager*; Anessa Heatherington, *Editorial Assistant*.

MISSION – *TEXAS SHORES* is published quarterly by the Sea Grant College Program at Texas A&M University in an effort to promote a better understanding of the Texas marine environment. Sea Grant is a partnership of university, government and industry focusing on marine research, education and advisory service. Nationally, Sea Grant began in 1966 with the passage of the Sea Grant Program and College Act. Patterned after the Land Grant Act of the 1860s, the Sea Grant concept is a broad-based scientific effort to better the world for all those living in and out of the sea.

HISTORY – In 1968, Texas A&M received the distinction of being named among the nation's first six institutional award recipients. Three years later the school was designated a Sea Grant College. The university has a rich heritage of oceanography research dating back to 1949 when the program began. In addition, there is an ongoing program to get marine information to the public.

SERVICE – The effort is aided by eight county marine extension agents serving the 10 coastal counties of Texas. These individuals are backed by a group of specialists in marine recreation, fisheries and business management, as well as seafood marketing and consumer education.

FUNDING – Sea Grant is a matching funds program. The Texas A&M Sea Grant College Program itself is made possible through an institutional award from the National Oceanic and Atmospheric Administration, U.S. Department of Commerce, and appropriations from the Texas Legislature and local governments.

Change of Address, Subscription Information or Other Questions: *TEXAS SHORES*, Sea Grant College Program, Texas A&M University, 1716 Briarcrest, Suite 603, Bryan, Texas 77802. Or call 409-862-3767. Please include old label when changing mailing address. *TEXAS SHORES* (ISSN 0747-0959), is published quarterly by the Sea Grant College Program, Texas A&M University, 1716 Briarcrest, Suite 603, Bryan, TX 77802. Subscriptions are free to Texas addresses. The cost is \$7.50 per year for out-of-state or foreign addresses. Second class postage is paid at Bryan, TX. **Postmaster:** Send address changes to the Sea Grant College Program, 1716 Briarcrest, Suite 603, Bryan, TX 77802.

SEA NOTES

TEXAS A&M UNIVERSITY
SEA GRANT COLLEGE PROGRAM

It was a bad summer for menhaden

Some days it just doesn't pay to be a filter feeder.

Since late August more than 50 million menhaden, a bait fish, have died in three kills along the Texas coast. In the first two cases the fish died from lack of oxygen. The Texas Parks and Wildlife Department (TPWD) blamed the most recent deaths on cold weather.

The first kill was spotted Aug. 25 on a two-mile stretch of the Colorado River that ended where the river empties into the Gulf of Mexico. An estimated 42 million fish, mainly menhaden, turned the river into a silver death procession to the Gulf.

Menhaden are filter feeders, meaning they take in water and filter out the nutrients they need — like phytoplankton and zooplankton — before expelling the water.

Experts say a combination of things depleted the oxygen in the river, killing the fish. There was an unusually high tide that lasted longer than normal, cutting down the water circulation and keeping oxygen from the Gulf out of the river.

The menhaden ate most of the phytoplankton, which add oxygen to the water, and overcast skies inhibited growth of more phytoplankton, said Jack Ralph, field response coordinator for the Texas Parks & Wildlife Department.

In fact, the lack of phytoplankton made the water so clear that fishermen found the kill at 6 a.m. when they noticed millions of dead fish on the river bottom.

"There was an absolute silver sheen that covered the river bottom," Ralph reported.

Lastly, there was little wind to whip up the river's surface and create natural aeration.

The second kill was on the Arroyo Colorado, between Harlingen and Rio Hondo, over the weekend of Sept. 16. Cameron County Marine Agent Tony Reisinger put the death toll there at



"several million," although he didn't venture a guess at a more specific number.

An article in the *Valley Morning Star* newspaper in Harlingen put the number of fish killed at more than 100,000 along the three-mile stretch of the Arroyo.

"The fish kill was probably related to nutrients from sewage treatment plants," Reisinger speculated.

The cities of Harlingen, San Benito and Rio Hondo all discharge treated sewage that is nutrient-rich into the Arroyo, leading to a heavy algal bloom. That bloom attracts the menhaden.

As with the Colorado River kill, there was little wind on the Arroyo to stir up the water and create aeration. The overabundant algae and huge numbers of fish used up all of the oxygen in the water.

This kind of fish kill on the Arroyo is almost an annual event, Reisinger added. The *Valley Morning Star* article quoted a game warden as saying it was the biggest fish kill in the river's history.

Some people tried to blame the deaths on nutrient-rich water discharges from two shrimp farms in Arroyo City. Reisinger said the kill happened upstream from the farms so their discharges weren't involved.

About 16 million menhaden died in the Laguna Madre near Port Isabel over the weekend of Sept. 23. First thought to be victims of a small and short-lived red tide, the fish were actually victims of a cold front that moved through the area on Sept. 22 according to Randy Blankinship, a conservation scientist with TPWD's coastal fisheries division.

A rapid temperature drop shocked the fish and killed them. Blankinship said it was coincidence that the kill and red tide happened at the same time.

The red tide led state health officials to close what little harvesting there is of clams, mussels and oysters in the Laguna from Port Mansfield Bay to the mouth of the Rio Grande.

—Jim Hiney

Short course, two seminars scheduled in 1996

Dates have been announced recently for various 1996 meetings.

- 25th Annual Dredging Engineering Short Course, Jan. 8-12, 1996, College Station. Contact: Dr. Robert Randall, Center for Dredging Studies, (409) 845-4568.
- 19th Annual Marine Safety Seminar, March

21-22, 1996, Galveston. Contact: Dewayne Hollin, Texas Sea Grant Program, (409) 845-3854.

- 29th Annual Dredging Seminar, June 12, 1996, New Orleans. Contact: Dr. Robert Randall, Center for Dredging Studies, Texas A&M, (409) 845-6156.

Mariners have new PORTS to call in Bay

Port activity has more than doubled in Galveston Bay since 1970, and increased activity inevitably means increased accidents. There have been more than 1,200 groundings in the Bay since 1986. Water current and wind conditions were factors in more than half of those accidents.

In an effort to fix the problem, the National Oceanic and Atmospheric Administration installed a Physical Oceanographic Real-Time System (PORTS) in the Bay in early September. The PORTS will provide reliable, real-time information on water levels and currents to harbor pilots, vessel captains, port authorities and other users. It will also provide other meteorological and oceanographic information.



The PORTS will increase safety for the 100,000 recreational boaters and nearly 5,000 commercial ships that cross the Bay each year by combining real-time measurements with an information system that uses an interactive telephone service, a computer modem dial up system, and Internet access.

The system includes measurements from two new permanent current meter installations, one at Morgan's Point and the other at Bolivar Roads; one new mobile current meter to be deployed at several locations for periods of six to 12 months; water level measurements from three state and two federal water level stations around the Bay; and wind and other meteorological and oceanographic sensors.

Texas A&M team studying Superfund sites

Texas A&M University scientists are looking at ways to clean up more than 31,000 uncontrolled hazardous waste sites in the United States. As part of the Hazardous Substances Basic Research Program, Texas A&M and Baylor College of Medicine researchers are trying to determine the effects of the chemical waste on animal life and humans near toxic waste sites designated as Superfund sites by the Environmental Protection Agency.

Dr. Stephen Safe, distinguished professor of toxicology in the College of Veterinary Medicine, said the research team is studying how active the chemical compounds are and their potential health risks. The results will help government agencies decide what to do with toxic waste sites.

"We're looking at methods to determine the toxicities of various chemical mixtures at Superfund sites, how good the cleanup is at various sites, and also ways to biodegrade these substances," Safe continued.

The program is part of a study funded by the National Institute of Environmental Health Sciences that seeks methods for detecting hazardous waste, ways of cleaning up waste sites, and information on the effects of toxic waste sites on human health.

"The question for NIEHS, EPA and for local



and regional authorities is how to deal with mixtures and how to do risk interactions for some toxicities. If these antagonistic interactions are important then, for example, we may be overestimating the toxicity of dioxins and related compounds."

Safe says scientists and policymakers are accustomed to studying one chemical at a time and using those findings in regulating the substance. But, he said, Superfund waste sites are often contaminated with hundreds of compounds. Any one of these chemicals could produce changes in other compounds, making them either more or less toxic.

"These are really complicated problems," he went on. "In order to understand them, we have to do a lot of basic research, but the outcome of this basic research will have an impact on regulations.

"We hope some of our methods can be used to facilitate site selection and then monitor the progress of the cleanup."

Ultimately, Safe said, government and industry will have to determine how to use their findings on the interactions of chemical mixtures in toxic waste dumps.

"We're trying to understand it, and once we do, regulatory agencies and industry will have to decide how it's used in risk assessment," he added.

— Texas A&M Office of University Relations

Those who live with it variously characterize it as a great white shark, a swarm of locusts, the plague, or even as a vicarious symbol for man because it is, “All consuming.” 🌿 It is just 31 nanometers in diameter. Laid side by side, 310 million of them stretch a little less than a half inch. And it has virtually wiped out Texas’ farm-raised shrimp crop for this year and has both shrimp farmers and shrimp fishermen worried about their futures. 🌿 Such is the nature of a virus.

What it lacks in size, it makes up in sheer numbers and destructive power. 🌿 It’s named “Taura” after the Ecuadorian river where it was first detected in 1992, although there are those who believe the disease may have come from Colombia before that. 🌿 In simple terms the virus attacks a shrimp’s epidermis, the clusters of cells that form the cuticle, and causes the cells to die quite rapidly. Not all of the epider-

It’s always the little things ...



**Microscopic
killer
decimates
state's
shrimp
farms**

mal cells are infected. The virus tends to attack clusters of cells. 🌿 No one is sure exactly how Taura kills. It could be a combination of things. But ultimately, if Taura kills enough cells then the shrimp dies. It stops eating, becomes lethargic and disoriented, has trouble swimming and then dies. 🌿 Those few who survive are marked with a pattern of black spots that has been compared to that left by a shotgun blast. 🌿 Taura is a prodigious killer that likes speed. It spreads as quickly as it kills, often running through hundreds of acres of ponds in less than a week.

B Y J I M H I N E Y



Taura leaves an unmistakable mark on its victims. They are covered by a pattern of black spots that has been compared to a shotgun blast.

PHOTO (ABOVE) DR. S. K. JOHNSON; INSET PHOTO JOSÉ VILLALON

Taura is so relatively new that much about it remains a mystery, like how it spread from Ecuador through Central America to Texas in three years and how it jumped 200 miles up the Texas coast, from the southern tip to the middle coast at Palacios in about a month.

There's a bigger question, though — how to keep it from coming back.

It's only been a year since American researchers discovered the disease is caused by a virus. Scientists even have a

shrimp *Penaeus vannamei*, the primary species grown in Central American shrimp farms and the only exotic species used on Texas farms.

"The boss said we tried to put all of our eggs in one basket with *vannamei* — and they broke," said Ya Sheng Juan, manager of Southern Star shrimp farm in Arroyo City.

Gone from the Texas farms is most of this year's *vannamei* crop, which was predicted to be about 6 million pounds

but usually only when they are very young and they don't seem to die in great numbers.

But the native whites are also apparently carriers of the disease. No one knows how long Taura can tag along on a *setiferus* host or if carrying Taura will make *setiferus* offspring resistant to the virus.

This year's wild *setiferus* larvae in the nursery of the Arroyo Colorado were past the critical age when shrimp farms there discharged water, perhaps laden with Taura, into the Arroyo.

Texas shrimpers fear the disease, which had been confined to the shrimp farms, may spread into the wild population on the bodies of the *setiferus* moving from the Arroyo into the Gulf of Mexico. While that poses little threat to older shrimp, no one knows what it means to the spawn of the carriers and, in turn, the rest of the Gulf's marine residents, next year.

Sitting in the office of his shrimp farm near Palacios, Harold Bowers talked of what could have been.

"If we have even had a mediocre crop, we were expecting more than 2 million pounds," he said of his predicted shrimp harvest before Taura hit. "Now we're hoping for 300,000 pounds.

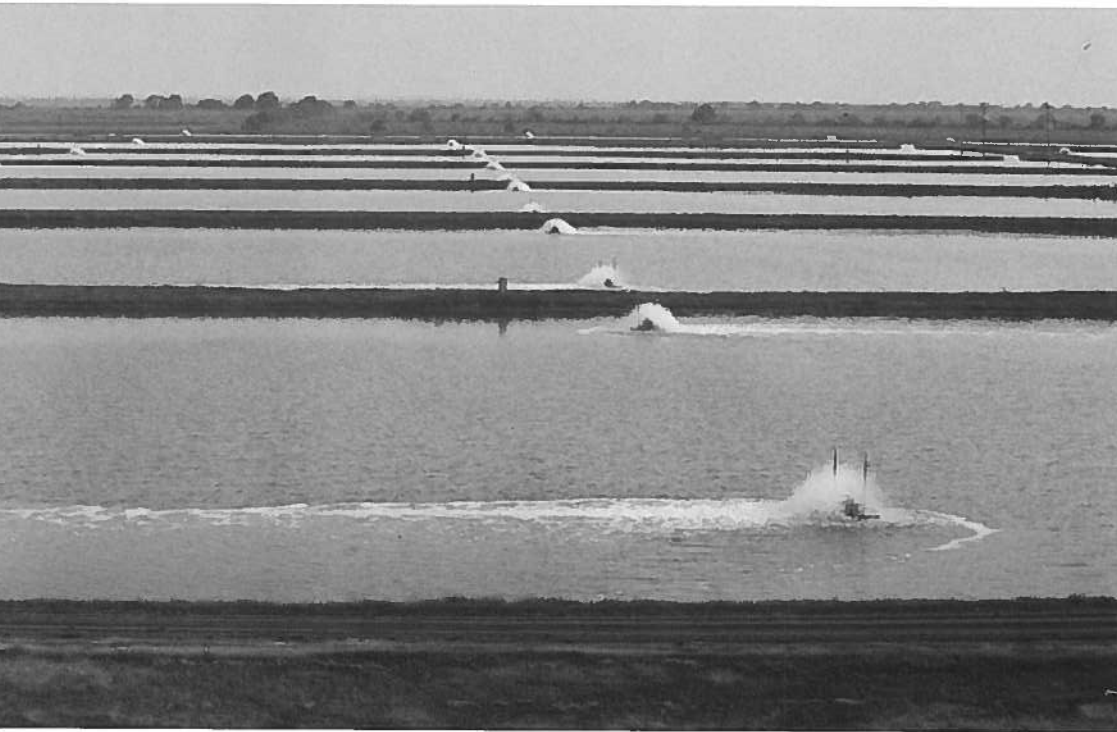
We think we lost \$1.7 million if we would have gotten all of the ponds stocked."

The stories are similar at shrimp farms all along the coast. Most of the *vannamei* are gone and the number of workers has been cut in half or more. Farm owners and managers will consider themselves lucky if they make a few dollars on the remaining *vannamei* and *setiferus* in the ponds.

Is this Armageddon? The end of the world?

As John Wayne said so often in the movie *Big Jake*, "Not hardly."

Not even from the shrimp farmers' point of view. As far as anyone can determine, Taura hasn't run anyone out of business yet. Taura is a major disaster to



Row upon row of aerating paddlewheels spin at Bowers Shrimp Farm in Palacios.

few pictures of Taura taken through electron microscopes.

The Ecuadorians say that what they call Taura was caused by fungicides used on the country's banana crops in 1992. According to them, what Americans call Taura is actually an intercellular bacteria that is now plaguing Ecuador after the Ecuadorians imported shrimp from Texas among other places.

The disease itself hasn't paused to consider its roots or identity. After spreading like a wildfire through Central America it swept through Texas coastal shrimp farms earlier this year. Taura boasts an average 80 percent to 90 percent mortality rate among its favorite prey, the Pacific white

weighed with heads on or about 3.6 million pounds of tails. Most of the shrimp that weren't killed by the disease were left to grow in the ponds while farmers restocked with native white shrimp (*Penaeus setiferus*) to salvage at least some kind of harvest this year.

There is a little bit of good news. The virus doesn't hurt humans or any other animals that eat shrimp, except, of course, other shrimp. But even there the news isn't all bad. *Vannamei* seem to be the only shrimp species with an extremely terminal aversion to Taura. The Pacific blue shrimp (*Penaeus stylirostris*) and native white shrimp have shown that they can get the disease in laboratory studies,

the shrimp and to the people who farm them, but in the relative scheme of things it's a minor crisis.

At best, the state's farm-raised shrimp crop amounts to about 10 percent of what shrimpers bring in from the Gulf of Mexico. Last year Gulf shrimpers landed about 48 million pounds of shrimp valued at \$197 million, compared to the 3.7 million pounds of shrimp valued at \$12.8 million that were raised on Texas farms.

Only 18 percent of the wild catch is *setiferus*, which is the only native species that appears susceptible to Taura. Native brown shrimp (*Penaeus aztecus*) comprises about 80 percent of the annual wild catch and the rest is the native pink shrimp (*Penaeus duorarum*) and other species.

The numbers of farm-raised shrimp really pale when you consider that Texans consume about 32 million pounds of shrimp per year and the entire nation consumes about 800 million pounds annually, 75 percent of which is imported from other countries.

But that's the big picture. The small picture is painted every day in the homes of the 100 or so people who would have been working had Taura not come to town.

"You really shouldn't rank crises because no matter the size of them people are still impacted," said Tony Reisinger, Cameron County marine agent. "Families are hurt no matter what size the disaster."

Those workers aren't buying some of the goods they might otherwise have bought. The shrimp farms are cutting back on the things they normally use, like feed and supplies.

Before this year, shrimp farming was the fifth largest industry in Cameron County, according to Reisinger. The county's shrimp crop was valued at about \$8 million in 1994 but the industry's impact there is more than that.

"You have an economic multiplier of

three associated with agriculture," Reisinger explained. "So if you have \$8 million worth of shrimp produced, the economic impact on Cameron County is going to be \$24 million. That means the money will be spent three times before it leaves the area."

In other words, a shrimp farm worker spends the money on, say, groceries. The grocery store uses part of the revenue from the groceries bought by the worker to buy products from a local vendor. The

for every 1 pound of shrimp produced. Shrimp farmers were expecting about 6 million pounds of shrimp this year but they'll be lucky if they get much more than 500,000 pounds.

That means they'll buy 5.5 million pounds less feed than expected. At about 22 cents per pound, the loss to the feed suppliers comes to about \$1.2 million.

You'd think that would put a crimp in the feed manufacturer's bank account but it didn't, at least as far as



Harold Bowers stands by equipment in his processing plant made idle by the Taura virus.

vendor then spends the money on something else. On average the dollars change hands three times within the county before they flow out of the county.

Part of the cash flow from the shrimp farms goes to the two leading feed providers in the state, Rangen and Nutrena. Bowers said that after Taura hit his farm he cut back from eight truckloads of feed per week, at about 42,000 pounds per truck, to about one truckload every other week.

The state's other affected shrimp farms report similar declines in the amount of feed they bought. A rule of thumb is that during a growing season the shrimp farms buy about 2 pounds of feed

Rangen is concerned.

"We produce a lot of feed for export," said Ed Brauer, manager of Rangen's Angleton feed plant, "and there are tremendous quantities of shrimp that are being produced in Mexico and in Central America. Basically, we've just shifted to those markets.

"We've moved our losses into those other markets," he continued. "Because of the suddenness at which the problem came on there was some disruption, but we've moved through that and we're operating at full capacity right now. We still believe the shrimp farming in Texas will work through this problem, at least that's our hope as a Texas producer of feeds."

Deyaun Boudreaux has an impish sparkle in her eyes when she talks about her beloved Gulf of Mexico and all of its inhabitants, especially the shrimp. 🌿 She talks of the fisherman's duty to preserve the Gulf's life and habitat, which extends to the state's bays and rivers. 🌿 "Stewards of the water," that's what the fishermen are, she said. 🌿 Taura has the stewards worried. 🌿 They fear the disease that was confined to shrimp farms will ravage the native

Next stop: The Gulf?

shrimp population. 🌿 Right now there is no law, no regulation that prevents shrimp farmers from discharging Taura-contaminated pond water into the nursery grounds of native shrimp. Farmers had voluntarily impounded their water at the request of the Texas Parks & Wildlife Department but the impoundment ended Sept. 1 and the farms began exchanging water again. 🌿



That the disease might kill a

lot of shrimp is only part of the problem. The fact that the disease is around at all may indicate that the water is in trouble, she says.

🌿 "The keystone of the whole food web of the Gulf of Mexico is shrimp," explained Boudreaux, environmental director for the Texas Shrimp Association. "If you were to pick a symbol for each body of water — and the Gulf is the ninth largest sea in the world — you'd pick the shrimp." 🌿 What Taura does if and when it spreads to the Gulf remains to be seen. If it thrives and kills large numbers of shrimp then the virus may signal a larger problem. 🌿 "Nasty viruses usually do better in a declining or a degraded area," Boudreaux went on.

**Presence
of disease
could
indicate
lack of
stewardship**



The shrimp farms exchange up to 90 million gallons of water daily at peak operation. The discharge is full of silt that causes buildups and full of organic material adding to algal blooms that can cause massive fish kills, she said.

"It's loss of habitat and that's our whole concern with wanting some type of regulation applied to the effluents of aquaculture. The disease came along after the original concern over the use of the water and putting it back without treating it," Boudreaux continued.

Boudreaux believes shrimpers might have been able to help keep Taura out of Texas had they put more pressure on the state to fund the shrimp quarantines and health certifications required by law but which she says happen infrequently.

"We wanted the animal health people to come in because these shrimp are livestock, so why doesn't the animal health group that takes care of deer and everything else, why couldn't they kick in?" Boudreaux asked. "Why couldn't all of the agencies approach it from wildlife protection, instead of looking at it as regulating aquaculture — particularly when they know shrimp are a protected species because they belong to the high seas?"

TPWD doesn't see it the same way.

"Right now our major involvement has to do with exotic species," said Mike Ray, deputy director of inland fisheries and the department's aquaculture coordinator. "This *vannamei*, this Pacific white shrimp, is the only approved legal exotic shrimp to be raised and we have complete jurisdiction over that.

"When it comes to native species, as we speak at least, we have very limited oversight there ... The Texas Department of Agriculture is really the lead agency and they basically have not done very much there. They don't enforce anything. They don't have enforcement capability yet they have some responsibility there so they're kind of in a pickle."

The Texas Natural Resources Conservation Commission is responsible for water quality on shrimp farms and the General Land Office has some jurisdiction but only where it applies to shrimp farms on public lands, Ray explained.

"There's a complicated maze of government bureaucracies dealing with this," he continued. "That's part of the concern right now—is there enough or isn't there enough. There's an interim Senate subcom-

mittee looking into aquaculture as we speak.

"That's a new thing that's in the mill right now. Basically people are trying to see if the industry is sufficiently regulated, is it under control, are they happy with where it's going? I don't know where that's going to go," Ray went on.

Part of the problem is a basic lack of respect for shrimp, according to Boudreaux. She believes shrimp farmers don't show much concern for shrimp because shrimp are invertebrates.

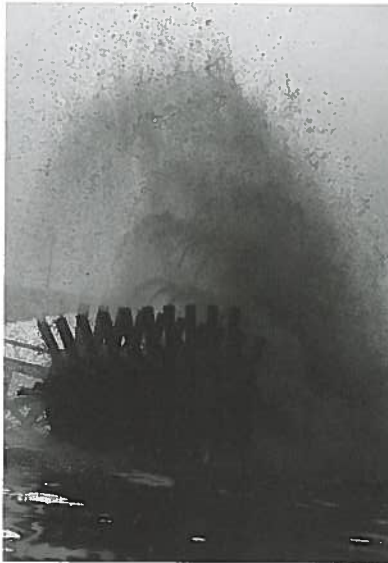
"The aquaculturalists look at them like a crop, like you would maize or corn," she said.

"We feel good about what we do. It makes us feel very good to provide shrimp to people who don't have the means to get their own. It goes back to it's a historical family-oriented type of business and we do care about these animals.

"We wouldn't spend at least half of our time trying to ensure that the animals have their nursery if we had no respect for the animal. That's where I feel we need to come together with the aquaculturists, so they can understand what it is to be a seafood producer."

Boudreaux's offer of help comes despite the popular belief that shrimpers are at odds with shrimp farmers because shrimpers view the farms as competition, a notion Boudreaux rejects.

"How in the world can an extrapolated



Shrimp farms began exchanging water again on Sept. 1. Two weeks later, the Arroyo Aquaculture Association farm in Arroyo City drained some of its ponds as workers began harvesting what remained of the farm's Pacific white shrimp crop.



\$36 million industry touch a \$600 million industry?" she asked, using the agricultural multiplier of three to arrive at the statewide economic impact of both industries.

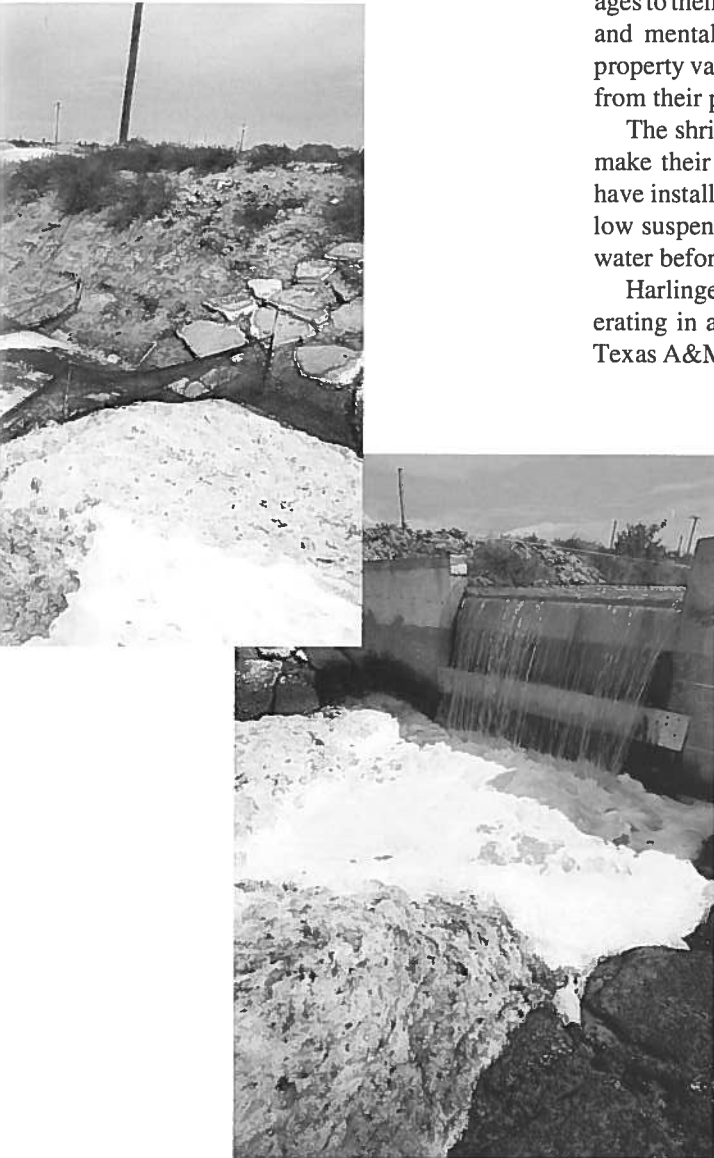
"One of the historical roles of the fishery has been that of a special population of mariners who have special knowledge," Boudreaux said. "We're a store of information. Come and ask us. We know all about how to be sustainable. The only reason that the oceans are still productive is because of the laws of the sea that make harvest of seafood a priority use of the oceans."

Taura didn't cause the rift over discharges from shrimp farms into the Arroyo Colorado, and ultimately the lower Laguna Madre, but it was the latest straw that broke the camel's back.

Shrimpers and landowners near the farms have long complained about the discharges — which, depending on the

size of the farm, can reach 90 million gallons per day — that flow from the farms. They claim the effluent contains fecal waste from the shrimp, high levels of ammonia, silt and now dead shrimp infected with the Taura virus

Some of the landowners, shrimpers and sport fishermen made those claims the basis of a class action lawsuit filed in Cameron County against the three local shrimp farms on Sept. 6, just five days after the farms ended their voluntary water impoundment and started exchanging



water for the first time in four months.

The lawsuit claims that the effluent creates a nutrient-rich environment that is causing a brown tide in the Laguna and that the dead shrimp are passing Taura to the native shrimp. Both conditions hurt those who fish and shrimp the Gulf for a living, the plaintiffs say.

The suspended solids in the effluent are causing silt buildups around the landowners' docks and making the Arroyo's waters unsuitable for water sport activities, the plaintiffs say.

They want farms to pay for the damages to their livelihoods, for physical pain and mental anguish, for their losses in property values and for loss of enjoyment from their properties.

The shrimp farms have taken steps to make their discharges clean. The farms have installed sedimentation ponds to allow suspended solids to settle out of the water before it is discharged.

Harlingen Shrimp Farm is now cooperating in an experiment, funded by the Texas A&M Sea Grant Program, to see if oysters can be used to filter pondwater before it is discharged.

The farms impounded their water at the request of TPWD, which, according to Ray, wanted to give the native white shrimp a chance to beat the disease.

"Through some of the laboratory work that was done this last year it looked like our native white shrimp were susceptible for a very brief period of time in the post larval state, PL 10," he said. "Our native shrimp were in the process of spawning during the summer months and they're beyond that post larvae level by this point in time and, therefore, would not be affected by any remaining Taura

problem that could be in their discharge."

Ray's contentions are backed up by work done by Jeff Lotz. Lotz is an associate research scientist at the Gulf Coast Research Laboratory in Ocean Springs, Miss.

"We found that you can infect *Penaeus*

setiferus, which is the local white shrimp," Lotz said. "The native brown and pink seem to be unaffected."

James Brock and Don Lightner, two of the leading Taura researchers in the U.S., discovered Taura was a virus by feeding the tissue of Taura victims to other *vannamei*, who then contracted the disease. Lotz and his group used the same method to find out if native shrimp species were susceptible to Taura. The browns and pinks weren't affected. The whites seemed only to be infected when they were very young — less than a month old.

But the native whites seem much more resistant than the Pacific whites.

"The *setiferus*, in general, seem to die less quickly than the *Penaeus vannamei*, so they are somewhat more resistant but are still susceptible to it," Lotz explained.

"You can get a situation where you have an aquarium study and all of the (*setiferus*) die in it but for the most part the disease either goes slower or you have a greater amount of survival. As the (*setiferus*) get older that discrepancy gets wider. In other words, fairly good sized *Penaeus vannamei* can be killed by the virus where that's not the case with *setiferus* once they get up to a reasonable size."

Just as Taura prefers Pacific white shrimp to other varieties of shrimp, it seems to have its favorite strains within the *P. vannamei* species. It appears that Mexican high-health *vannamei* are more susceptible than the Panamanian strain of *vannamei*.

There was some early excitement over the possibility that Gulf of Mexico *setiferus* were more resistant than other *setiferus* varieties, which stretch from the Atlantic coast of the U.S. though the Gulf of Mexico.

The excitement came from one of Lotz's infectivity studies, which first used *setiferus* from South Carolina. Those animals contracted Taura after eating the tissue of Taura victims. Lotz ran the study again using *setiferus* from Texas and those animals did not die.

But the excitement was short lived. Lotz re-ran the experiments using the same Texas shrimp, which were a bit older by then, and they, too, died. Lotz also discovered that the remaining *setiferus* carried the disease. He fed some of the survivors to some *vannamei* and they contracted the disease.

Taura played a pretty good game of hide and seek for the first two years after it hit Ecuador. Shrimp were dying by the ton, yet the farmers didn't know what they were fighting. 🌿 The Ecuadorians first blamed the deaths on two fungicides — Tilt made by Ciba-Geigy and Calixin made by BASF. 🌿 To the Ecuadorians' credit, there was a lot of circumstantial evidence pointing to the fungicides in the beginning, says Ken Hasson, a graduate research

Finding a killer

associate in Don Lightner's University of Arizona laboratory. 🌿 Lightner and James Brock, an aquaculture disease specialist in Hawaii's aquaculture development program, are among the leaders in research into Taura. Hasson is intimately involved in the research and is doing his doctoral dissertation on the disease. 🌿 "Some of the evidence (pointing to fungicides) was that the out-



**Taura's
hide-and-
seek is no
fun for
researchers**

break of the disease occurred when fungicides were being used in increased amounts on the banana plantations," Hasson said. "More Tilt and Calixin were being sprayed on the banana plantations to combat a fungal disease they had there called sigatoka negra (black leaf wilt)." 🌿 Shrimp that died were in the process of molting so researchers believed that whatever killed them inhibited the molt cycle, Hasson continued. As it turned out, the fungicides contained an agent thought to do the same in shrimp, although scientists later determined that wasn't the case. 🌿 Researchers thought the final break came in 1993 when an Ecuadorian research group claimed it reproduced the disease in shrimp by exposing them to the fungicides.



“We attempted to repeat (the Ecuadorians’) work based on limited information but we didn’t get any conclusive results,” Hasson went on. “We got hold of some Tilt and Calixin from Ecuador and conducted one bioassay here in Tucson, but were unable to induce the disease.”

“When we made this public, the (Ecuadorian group) was pretty upset about it and invited us to come down to their lab and

run it with them, which is what I did,” Hasson said. “The results were totally inconclusive.”

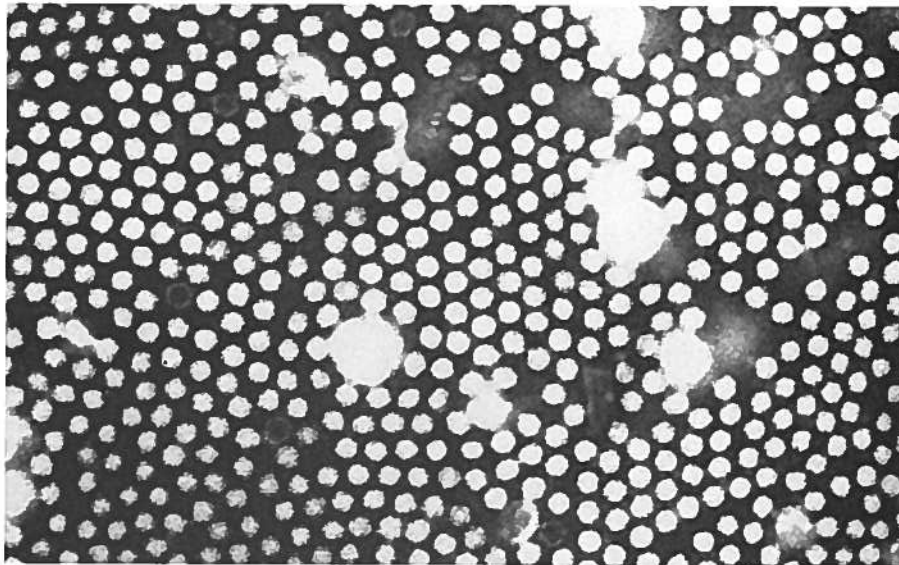
It seems that Hasson and the Ecuadorians used the exact same experimental design and setup as the Ecuadorians had used in their first experiment with one crucial difference.

In previous experiments the Ecuadorians performed a “pre-conditioning” step where they fed tissue from Taura victims to the test shrimp. Hasson didn’t perform that step because it wasn’t part of the procedure for the experiment given to him by the Ecuadorians.

Had the Ecuadorians just fed Taura victims to the test shrimp and then left the shrimp alone they would have seen that the deaths had nothing to do with the fungicides.

Within six months, about May 1994, Brock began experimenting with feeding Taura victims to test shrimp. The test shrimp began dying and Brock took tissue from the new victims and fed it to a whole new set of shrimp.

Each new group of test shrimp died at the same rate. Because of this, Brock was able to show that there was no toxic chemical involved. Had it been a chemical, it



Microscopic view of isolated virus from Taura-infected tissue collected in Ecuador.

would have become more and more diluted as it passed from one group of test shrimp to another, ultimately becoming too diluted to hurt the shrimp.

Instead, the shrimp died at the same rate, proving that there was a pathogen that was actively reproducing inside each new host.

Hasson and Lightner recreated Brock’s results but they took it a step further. They made a homogenate — a liquefied form of Taura-infected tissues — and then made a dilution series comprising the straight homogenate and homogenate diluted at ratios of one part homogenate to 100 parts saline and 1 part homogenate to 10,000 parts saline.

“Even when it was diluted 1 to 10,000 the animals became heavily infected and died in equivalent numbers in equivalent time periods to those which were injected with the undiluted inoculum,” Hasson said

Before diluting the inoculum, Hasson and Lightner ran it through a filter with pores that were 0.45 microns in diameter, the size of a small bacteria. When the shrimp began dying, Hasson and Lightner knew they were dealing with a pathogen smaller than a bacteria, possibly a virus.

Eventually Lightner, Hasson and Brock

isolated the virus and saw virus particles under electron microscopes.

In the year since the Taura virus was discovered, two other researchers in Lightner’s lab — J.R. Bonnamei and Joycelyn Mari — developed a gene probe that detects Taura. It is highly specific for Taura according to Hasson.

The Ecuadorians maintain that they lost shrimp in 1992 and 1993 to the ef-

fects of fungicides and that the more recent mortalities in 1994 were caused by an intracellular bacteria that entered Ecuador through shrimp larvae imported from Texas, Hawaii and Honduras.

“It has never been proven that what we have here is a virus,” contends Nancy Cely, executive director of Cámara Nacional de Acuicultura, or the National Chamber of Aquaculture, a trade organization.

“Maybe you are aware that there are two versions in the world about it. There is the toxic version and a new virus, which has regrettably taken the same name, which is confusing to the scientific world.

“Some scientists are calling this virus the ‘Taura syndrome virus’ and they are confusing it with what we are calling here ‘Taura syndrome,’ which is a mortality caused by toxic sediments mainly related to fungicides and pesticides.”

The Ecuadorians are now suing several parties, including Ciba-Geigy, maker of one of the fungicides, in federal court over the Ecuadorian shrimp deaths.

Hasson says there is no confusion about Taura syndrome among the scientific community.

“What the Ecuadorians didn’t know was

all of the isolated virus that I was using in the experiments that ... demonstrated a viral etiology for the disease was isolated from shrimp carcasses collected from Ecuador in 1993," Hasson continued.

Lightner and his people save all of the tissue samples that come into their lab in case they need the tissue for future work. Those saved tissues include shrimp killed during the original 1992 Taura outbreak in Ecuador.

"With the development of the gene probe we went back and probed the original samples that were coming out of Ecuador when the disease first broke in 1992. We tested samples from Ecuador, Colombia, Mexico, Hawaii ... and the probe lit up like a charm in the lesions in every one of those animals.

"So it's beyond a shadow of a doubt that the virus was in Ecuador in 1992 and it subsequently spread throughout the Americas from there," he said.

While devastating from the shrimps' standpoint, Taura isn't the end of shrimp aquaculture in Texas, according to Sea Grant's aquaculture specialist Granvil Treece.

In the relative scheme of things, Taura is more of an obstacle — a hurdle to overcome — than a brick wall.

"The industry is going to survive," Treece said. "The industry is going to find a way around it. If there is money to be made, the shrimp farmers are going to find a way to make it. If the demand is there, which it is, people are going to find a way to produce shrimp.

"They are going to find a way around Taura," he emphasized. "It is not going to devastate the industry."

At least not this year.

"We're all looking forward to 1996 and what we can do to have a better outcome at that point in time," said Fritz Jaenike, production manager at Harlingen Shrimp Farm. "It's been pretty rough but I don't

Gordon Lipscomb, a Harlingen Shrimp Farm pond manager, holds some of the surviving Pacific whites.

Shrimp farming will rise again



see that we're going under. Now, if it happens two years in a row that would be a different circumstance."

Well, maybe not too different of a circumstance, contended Louis Hamper, a pond manager for Harlingen Shrimp Farm and farm manager of the Arroyo Aquaculture Association farm in Arroyo City.

"I think we're smarter than to let two years of Taura knock us in the butt," he said. "I like to think we're smarter than that, anyway."

One major disadvantage for Texas shrimp farmers is that they face Taura in the midst of a drop in shrimp prices. The Ecuadorians and Hondurans say their shrimp farming industries would have been dealt more catastrophic blows had shrimp prices not been boosted because of shrimp shortages due to other diseases that struck the productive Asian farms.

"Well, we took advantage of those years also," Hamper went on. "We had good crops the last two years and took advantage of the high prices."

Like Jaenike, Harold Bowers said his Palacios shrimp farm won't go under this year, but the unknowns

make next year a bit scary.

"The future looks real, real dim because of a couple of things," he explained. "One of the things is we don't know what's going to happen for next year. We don't have enough research to tell us if we can come back with the same shrimp variety. Is Taura going to be here next year? Is it going to be worse?"

Texas shrimp farmers may receive some help from the federal government. Using loss figures put together by Cameron County marine agent Tony Reisinger, Gov. George W. Bush signed a request asking the U.S. Department of Agriculture to declare an agricultural emergency due to Taura. If the request, which is still pending before Secretary of Agriculture Daniel Glickman, is approved then the farmers will be eligible for various loan programs.

There is also some comfort in studying Ecuador's plight since Taura.

"Even with Taura they've produced more shrimp than all the rest of the Western Hemisphere put together. They're still producing shrimp, even with Taura," Treece said.

“Taura is a disease syndrome that has been recognized in cultured shrimp in the Western Hemisphere,” explained Brock, the state of Hawaii’s aquaculture disease specialist. 🌿 “The cause of Taura is controversial,” he continued. “There’s a lack of agreement about the etiological agent. Depending on who you talk to you can learn that it’s caused by exposure to a cocktail of fungicides that are used to control a fungus in bananas, or by a virus, or,

A bit of history

in some cases, that it’s a combination of an intracellular bacteria and a virus.

🌿 “When you talk to me, the data I’ve seen and the work I’m familiar with leads me to believe that it’s caused by a virus, that it’s a viral pathogen that induces lesions that cause the shrimp to get sick with what’s called the Taura syndrome,” Brock concluded.

🌿 Taura seems to like less salt in the water and tends



to prey more heavily on shrimp in lower salinity. That puts Texas shrimp farmers at a bit of a disadvantage because another shrimp disease — NHP or the so-called “Texas mortality syndrome” — hits harder in high salinity ponds. 🌿 Shrimp that survive Taura and have the “shotgun blast” markings eventually go through another molt. They lose the black spots and regain the look of a normal animal. 🌿 “We think those normal-looking animals that have recovered harbor the virus ... for an undefined but perhaps an extended period of time as an asymptomatic infection,” Brock said. 🌿 Ecuador’s Nancy Cely reported her country’s gross

**Few agree
on the
cause—all
agree on
the effect**



annual shrimp production of 105,000 metric tons fell by 16 percent in the first year of the disease and another 4 percent in the second year.

Taura hit the country's economy hard because, unlike Texas, farm-raised shrimp account for 94 percent of the country's total production. Shrimping is the country's second largest private business, behind bananas, and third largest industry overall behind oil and bananas, Cely said.

When Taura hit, the \$524 million industry lost \$200 million in revenues.

"The main effect was, of course, unemployment," Cely continued. "We give jobs to many people ... We closed down, we shut down 17,000 hectares (about 42,000 acres) due to the Taura syndrome.

"If you overfly them you'll see a cemetery of shrimp ponds," she went on.

"You can imagine all of the people who worked there had to leave. Also we had some small packers who had to close. Of course, there was the problem of the people who owned the farms. They could not afford the pending payments. It was a very difficult situation for them."

After moving through Ecuador the virus popped up in Honduras in early- to mid-1994. What had been the nation's third largest industry, behind bananas and coffee, producing about 25 million pounds of shrimp tails annually and generating \$75 million, saw an average production drop of 30 percent, according to Francisco Avalos, executive director of the National Association of Honduran Aquaculturers (NAHA.)

"There are about 12,800 hectares (31,630 acres) used in shrimp farming in the country, producing 1,800 pounds to 2,000 pounds per hectare during a normal period," Avalos reported, speaking through an interpreter. "When Taura hit, production levels dropped about 30 percent. These are all averages. There were cases where farmers lost 60 percent of their crop, but on the average 30 percent is the figure."

The Honduran and Ecuadorian shrimp industries might have been in a bit of trouble had 1994 not been a bad year for shrimp diseases around the world, decreasing the world supply.

"There was a compensation because prices did go up per pound of shrimp," Avalos explained. "So when the prices went up there was compensation, but for 1995 we'll have to wait and see. What we've done is given ourselves the goal of

producing the same amount as we did in 1994 so if the average price falls we'll still be all right.

"Up until now the problems haven't been all that significant," Avalos said. "There haven't been any farm closings, layoffs have been low, about 10 percent, and profits have been maintained by the shrimp price hike, so the profits were about the same.

"In the meantime, we're doing lots of research to try to fight off the Taura virus. About \$1 million has been invested solely in research."

Cely tells a similar story.

"In the last three years, especially the last year, if the price had gone down at least one-third of our producers would have gone out of business because the shrimp survival rates were not high. Only these abnor-

mally high prices (more than \$5 per pound for 41-50 count shrimp) permitted us to stay in the business and to recover, and administratively, technically, to go ahead. Still we are facing problems with cost productions versus survival rates now with the prices slowly going down.

"The country has regained little of the lost production, only about 1.4 percent. But things are looking up. I'd say we hit bottom so we will not go under these figures any longer. But I would expect no



impressive increases of production in our country for the next two to three years."

Cely is confident the country will eventually return to its former shrimp production levels, and then some. Ecuadorians are not intensive shrimp farmers, but Cely said the industry will most likely increase its stocking intensity a bit to "get a little more production and also take better care of our production."

But the country's shrimp farmers won't stock as intensely as those in Texas, she continued.

"I'm optimistic that banana farmers, with our understanding of what they were doing to the river flows, will be more careful and will have fewer problems with any toxic product and that we'll be able to reach some more investigation on the control of this intracellular bacteria," Cely added.



Harold Bowers and his son, Reed, look over new ponds they built before the start of this year's shrimp season. The ponds, meant to increase the farm's production, were never used. The Taura virus hit the farm before all the ponds were stocked.

Don't cry 'Wolf'

The evidence seems to show that *setiferus* can get Taura, but is it a big deal?

The same evidence seems to say "No."

All of the shrimp farmers who stocked *setiferus* in the same ponds that were infected with Taura report no unusual mortalities. Even if the bug gets out into the wild population, history indicates it won't have much impact.

"There are some examples in some other situations," Lotz said. "For example, IHHN virus, which is a shrimp virus that doesn't cause mortality in *Penaeus vannamei* but does in *Penaeus stylirostris*, was introduced into northern Mexico a few years back and wiped out nearly all that country's aquaculture of *Penaeus stylirostris*.

"At that time it also got into the wild stocks of *Penaeus stylirostris*. It was suggested that the fishery for the blue shrimp was declining. It's hard to get landings

data from Mexico but if you look at some of the overall landings, the decline started prior to the introduction of the IHHN virus and apparently the blue shrimp fishery is coming back. We do know that you can get (*stylirostris*) from the Gulf of California that are carrying the IHHN virus."

"So a virus that's probably more lethal to *Penaeus stylirostris* than Taura is to *P. setiferus* got into the wild *stylirostris* populations in Mexico and probably did affect the population. My guess is it probably didn't affect the overall numbers (of shrimp) but it might have affected the composition in that they are probably more resistant shrimp now."

There's also the philosophical angle of "competing risks."

It's generally agreed that less than 2 percent of all animals survive in wild shrimp populations.

The question is will Taura add to the

number of shrimp that die or simply kill shrimp that would have died from some other means?

The same holds true for shrimp farms, where the average mortality is about 25 percent. In theory, 25 percent of the shrimp would have died anyway, leaving Taura with just a 55 percent to 65 percent mortality rate.

"When you have animals that have a really high mortality level to begin with, it would be very difficult to predict an effect, I think," Lotz said.

Lotz and his group continue to study the possible risks of Taura loose in the wild shrimp population.

"What are the chances (Taura) could get established?" Lotz asked. "For any kind of disease ... animals and humans can take a certain dose and not get an infection. You can put a certain amount in a pond, and we don't know what that number is, but it's not just one virus particle in an epidemic. It has to do with the susceptibility of the shrimp, the density of the shrimp and how they're distributed."

No one is sure what the future holds for shrimp farmers, shrimpers or the shrimp themselves. Taura research is still young. On a human time line, Taura research is still in its infancy, according to Ken Hasson. 🌿 “Taura is partially characterized and there’s good evidence that there are reasonable management strategies that can be applied to help weather the storm should you get Taura on your farm. But it’s all in the testing phase right now

The future

and there’s nothing conclusive as far as that goes at this point,” Hasson said. 🌿

Lightner’s people are also researching development of Taura-resistant strains of *vannamei*. 🌿 “Every time we’ve run an experiment, and also under natural conditions in ponds, there are always survivors of Taura syndrome,” Hasson stated. You don’t see 100 percent mortality. It’s usually somewhere between 80 percent



Too many questions — not enough answers at this point

to 90 percent. In our laboratory experiments we usually see between 60 percent to 80 percent mortality survivals ranging from 20 percent to 40 percent. 🌿 “We did one experiment where we re-injected survivors ... well, we took a group of animals, we injected them with purified Taura syndrome virus, we saved the survivors, allowed them to recuperate for a month and then re-injected them using appropriate controls and none of the re-challenged shrimp died. None of them came down with the infection. 🌿 “The positive controls we ran at the same time



showed a 40 percent to 50 percent mortality. It was under 50 percent, it was lower than we expected, but still significant that animals that were exposed for a second time — the survivors — did not die.

“So we’re working on that and we’re going to repeat that work here very shortly with larger numbers of animals.”

Hasson says researchers will also turn their attention south of the border, to a Taura outbreak in Mexico.

“The outbreaks in Mexico present some interesting possibilities because some of the farms are experiencing lower mortalities than what’s normally seen,” Hasson said. “We’re gearing up to test in the next week or two, or begin testing, to find out if a different strain of Taura syndrome exists in Mexico. It’s going to be a long process.

“It’s possible that there are different environmental factors that are beneficial to the animals and help them somehow fight off the disease, resulting in lower mortalities.

“It’s also possible that there are different strains of *vannamei* that are in and of themselves more resistant to the disease.

“It could be due to the management practices used by the Mexicans. There may be a difference there than what’s being done elsewhere when the disease first hits.

“And they’re also using calcium hydroxide, or lime, in their ponds to help combat this. And they’re using medicated feed, so there’s a whole bunch of variables involved that have to be examined on why some of the farms are experiencing higher survivals than others.

“There’s still a tremendous amount of work to be done.”

In the short term, diversity seems to be the farmers’ best weapon against Taura.

“I think one of our best hopes is to switch to another variety of shrimp,”

Harold Bowers said. “I don’t think, with the experiments we’ve seen, that the native whites are going to work. I’m hoping we can maybe bring in *stylirostris*. I think that’s what most of our dreams are, anyway.”

Texas shrimp farmers will have to keep



on dreaming, at least for the time being. *Stylirostris* won’t be an option for next year, Mike Ray stated.

There have been inquiries, primarily from shrimp researchers at Texas A&M, about farmers using *stylirostris* next year but TPWD wants those researchers to answer a lot of questions before allowing farmers stock the Pacific blue shrimp again.

“I want to know what they’re temperature tolerances are, I want to know what their life histories are, I want to know what kind of disease problems they may or may not have,” Ray said. “There’s just a whole level of things that need to be done in a very controlled situation that can be answered.”

“I don’t think it’s in the short term by any means,” he went on. “It’s certainly not something that’s going to happen very quickly.”

Ironically, it was disease that led

shrimp farmers to stop using *stylirostris* and switch to *vannamei* in the first place. *Stylirostris* were the shrimp of choice from the mid-1960s to the early 1980s. IHHN hit the farms then and farmers switched to *vannamei* because they were more resistant to IHHN.

Even with Taura around, Ray believes there is still interest in shrimp farming in Texas.

“Even after Taura arose there have been lots of inquiries,” Ray said. “I was rather amazed at the interest in expansion, particularly by new entities, that are still in place right now.

“I thought with some of these problems some folks might reconsider, but at this point in time it appears everybody is continuing the process of trying to get Corps of Engineer permits and those required by other agencies through the mill so they can operate.

There are a few, mostly on the middle coast, who are trying to pursue farms still.”

The story is a bit different around Tres Palacios and Lavaca bays on the middle Texas coast, where shrimp farming was just starting to get a foothold when Taura hit. In fact, Bowers was on his way to a meeting of prospective shrimp farmers and some bankers when he got word that his farm had Taura.

“We had a lot of interest,” he said. “I would say shrimp farming would have been one of the biggest industries in this area in three years if this hadn’t bombed out.

People saw what I did with this operation and we had a lot of interest.

“I didn’t need for this industry to grow but I’m trying to promote it because I think it’s good for the country. It’s been good to me.

“I don’t know what’s going to happen now.” ■

A CHANGE OF COMMAND

Dear Readers:

I want to take this opportunity to introduce myself. My name is Jim Hiney and I'm the new editor of *Texas Shores* magazine.



I'm very pleased to be writing for the Sea Grant Program and Texas Shores. It's a bit of a change for me. After graduating from Texas A&M in 1985, I spent five years writing for weekly and twice-weekly papers in New Boston (Bowie County), Seven Points (Henderson County) and Navasota (Grimes County).

I spent the past five years as a staff writer for the Bryan-College Station *Eagle*, a daily newspaper here in Brazos County.

After 10 years in the newspaper business I was ready for a change of pace and a new challenge. I think *Texas Shores* is the perfect answer.

Much of our lives depend on our oceans and their inhabitants. We can't survive if they don't.

Texas Shores has a long and distinguished history of covering important marine issues that affect our lives, whether we live along the coast or are high and dry hundreds of miles from the surf. I plan to continue that tradition.

And hopefully, along the way, we'll have some fun together learning about that part of our heritage which laps daily at our Texas shores.

Sincerely,

Jim Hiney, Editor
Texas Shores

Dear Readers:

Let me introduce myself. My name is Jeff Guillory and I am the new Marine Advisory Editor for *Texas Shores*.

Both Jim Hiney, our new editor, and I are committed to providing the most comprehensive, objective news about the environment, sport and commercial fishing and related issues, as well as about the latest technology and research.



A long-time resident of south Louisiana, I was raised in the outdoors and began hunting, fishing and camping at a young age. Fortunately, a strong sense of responsibility and respect for the environment and its creatures was instilled in me by my father. I hope one day to pass the tradition on to my children.

I am a 1988 graduate from the Manship School of Journalism at Louisiana State University in Baton Rouge. Following my graduation, I was hired by Cable News Network in Washington, D.C., in 1989. There I served as research/bookings assistant for the program *Crossfire*. Later that same year I transferred to the Atlanta, Ga., newsroom where I worked in several capacities, including production assistant.

For the past five years I served in various capacities, including as editor, of my hometown newspaper, *The Ville Platte Gazette*, a biweekly publication. I also served as Acadiana Editor at *The Advertiser*, a daily newspaper in Lafayette, for one year.

Having been born in Dallas, I can comfortably say that I'm a Texan. I look forward to serving you. Please feel free to call me if you have any news items, questions, comments or suggestions. My phone number is (409)862-3773.

Thank you,

Jeff Guillory

MARINE ADVISOR

TEXAS MARINE ADVISORY SERVICE

Marine agent, a shrinking breed in Texas? That point is debatable, but it certainly hasn't been a good year. Hiring freezes, priority shifts and county downsizing has taken its toll on the state's agent population, reducing the number of agents from eight to five.

There is hope that some of the frozen or vacated positions will be filled, but in the meantime Galveston's Julie Massey, Brazoria's Charles Moss, Matagorda's Willie Younger, Aransas and San Patricio's Richard Tillman and Cameron's Tony Reisinger are the state's flagbearers.

It's a difficult tightrope these five walk every day — serving the needs of their county constituents while trying to accomplish both national and state-wide goals. At the same time, they are being approached by several different special interest groups: environmentalists, shrimpers, aquaculturists, industry representatives, political organizations, consumer groups, concerned citizens, recreational enthusiasts and Joe Public.

Sea Grant and the Texas Marine Advisory Service have been in the forefront in the areas of education, research, information gathering and problem solving. During a recent inaugural trip along the Texas Gulf Coast, this former Louisianian had the opportunity to view these five MAS agents and tour the communities that they serve.



Landscaping with native plants and grouping plants by their watering needs ultimately benefits the Bay.

Julie Massey, representing Galveston and parts of Harris County from her office in Dickinson, has poured her time and energy into educating the public about nonpoint source pollution and maritime sanitation.

Her project, "Yards and Neighbors," is proving to be a huge success. The program, designed to promote alternative home and lawn care in communities to help reduce runoff and nonpoint source pollution, has attracted the participation of three communities — two in Clear Lake and one in Dickinson.

"We just completed the educational programs: landscape design, plant selection, lawn care and maintenance, tree care and maintenance, and disease control," Massey explained. "The idea is to create bay-friendly landscaping that still looks nice."

Under the able direction of local landscaper Mark Fox, there are about 250 volunteer participants in the program. Fox donated all of the designs, MAS provided all the materi-

als and the volunteers offered "sweat equity" (hard work).

"Approximately 22,000 newsletters were mailed out informing the public about the program. In addition, 3,000 questionnaires were also mailed, with 1,000 being returned," Massey added.

The landscape projects, scheduled to be completed by mid-November, include two traffic medians and one park. The first planting was held Oct. 21.

"I think the project has been well received. The communities are really excited about it," Massey said.

Massey's other area of expertise is educating the boating population on the responsible discharge of waste. The Clear Lake community is already preparing to comply with federal zero discharge regulations. On Feb. 6, 1995, the Environmental Protection Agency designated Clear Lake as a no discharge lake.

Following a study conducted by the Texas Natural Resource Conservation Commission, the Galveston Bay

BY JEFF GULLORY

Natural Estuary Program reported that sewage discharge from boats had a local impact on the community's water quality. As a result, marinas with 10 slips or more were required to have pump-out stations. The state is now in the process of formalizing the rules. The first of several public hearings to add Clear Lake to the list of zero discharge waterbodies was held Sept. 20. Approximately 25 persons attended the meeting.

"We've been involved in the education end of this proposal. We conducted potty training for boat operators, full demonstrations, education and even free pump outs. The response from the boat owners has been great," Massey said.

There currently are eight pump-out stations in the Clear Lake area, and, according to Massey, the city has an opportunity to receive federal funding for up to four additional stations under the Clean Vessel Act.

Charles Moss of Brazoria County may be the oldest living MAS agent, but you'd never know it by looking at his schedule. The 22-year agent, who represents the state's largest county (geographically), just completed another successful beach cleanup.

The 10th Annual Beach Cleanup drew 1,200 volunteers who bagged garbage along 20 miles of beach — from San Luis Pass to Surfside City and from Quintana to the Brazos River.

"We gathered 2,000 sacks of garbage," Moss said. "Recyclables were separated and taken to the materials recycling facility. The remainder was taken to a nearby landfill."

As was the case in past years, Moss included school children in the annual goodwill/educational event.

"This year, Angleton Middle School West participated in the cleanup," Moss

added. "It all begins with a visit in which we make a presentation and recruit volunteers. Students are told about global warming, protecting the environment and being responsible for the quality of their own communities.

"The students were taken by bus to the beach sites. There, along with Dow Chemical beach buddies (trained volunteers who are experienced in environmental cleanup), the students cleaned up the beaches."

According to Moss, the involvement by the county's next generation is paramount to the success of the project.

These kids get to see the adults at work and learn a concept that they can focus on for the rest of their lives. After a kid participates in one cleanup I've never seen him (or her) throw something out of a car window again," Moss continued.

Wetlands enhancement is the focus of another Moss

project, this one with City of Freeport residents.

Last month, citizens met with representatives of the Army Corps of Engineers, U.S. Fish and Wildlife, Texas Natural Resource Conservation Commission and the City of Freeport to confirm the site for the project.

The project, which has been in the developmental stage for more than a year, is designed to turn an area of little ecological or economic value into a productive wetland.

"The goal is to turn the area into an eco-tourism attraction that will become a better place for plants and animals," Moss said.

The site is located on City of Freeport property. The city has passed the pre-application mode and is now in the permitting area. "It looks like all the hurdles are being cleared," Moss added.

Moss has been selected to receive the 1995 Superior Service Award in the county extension agent category. The Superior Service Award is the highest honor bestowed by the Texas Agricultural Extension Service to a limited number of faculty and staff who have excelled in job performance in their area of responsibility. The award will be presented on Nov. 1.



Local beach cleanups are a tradition started and nurtured by MAS' Charles Moss in Brazoria County.



Sargent Beach, littered with wooden debris, appears sandy at first glance (left), but in reality is quite muddy. A simple summer shower can result in huge chunks of beach washing away (right). Below, the drawbridge over the Gulf Intracoastal Waterway is a mere stone's throw from the Gulf of Mexico these days. In some areas the two bodies of water are less than 300 yards apart.

Matagorda County marine agent Willie Younger rarely lacks for activities to keep him busy during the day. Two in particular, however, are getting his attention now. The first, construction of an 8-mile seawall at Sargent Beach, is the result of an eight-year campaign in which Younger, along with community leaders, landowners and conservationists, convinced Congress to step in and save the Gulf Intracoastal Waterway. The waterway, which runs from Fort Myers, Fla., to Brownsville, Tex., accounts for billions of dollars a year in revenues for the state. The Gulf of Mexico, at one time nearly a half-mile from the GIWW, is now separated by less than 300 feet in some spots on Sargent Beach due to severe coastal erosion.

Back in 1988 when Younger and a small army of local landowners asked their local legislators and the U.S. Army Corps of Engineers to do something about the problem, he described the situation as a timebomb, ticking ever quicker.

"By 2003, if things go as they have in the past, we should not even have a beach isolating the canal. The locals shoot for the date around 1995," Younger testified then.

Fortunately, the locals were wrong. However, ironically, construction of a new seawall began in July of this year. According to Younger, most Corps projects are scheduled for 15 years. However, due to the magnitude of the problem, it has been put on the front burner, with a timetable of about eight years.

Is the response too little, too late? "No, but it's a shame it took so long to get some action," Younger said. "Hundreds of thousands of dollars in homes and property

were lost before it (Congress) finally acknowledged we had a crisis."

Workers with Luhr Bros., an Illinois-based construction company overseeing the project, have taken advantage of dry conditions the past two months to begin digging the ditch that will house the concrete seawall. The project, originally estimated at \$80 million, is now expected to cost about \$42 million.

Younger's second project is of a more ecological/economical nature.

Maintenance dredging of the GIWW has created an ongoing demand for environmentally acceptable, landowner/rancher acceptable and economically acceptable sites for materials removed from the entire Gulf coast.

The GIWW, a major regional transportation link, has produced about 150,000 jobs and is responsible for approximately 20 percent of the state's gross product. Required maintenance of the GIWW, however, has caused a shortage of disposal areas. It is expected that by the year 2000 the Texas Department of Highways and Public Transportation will need to provide more than 3,000 acres of upland disposal areas.

Added to the mixture of increased need and lack of sites is public disdain. Many public landowners view dredge materials as spoil.

A new Sea Grant project hopes to enhance coastal dredge disposal sites with vegetation for increased forage production and amended soil salinity to create agreeable agriculture benefits from the removed dredge materials.

The project site is on property adjacent to East Matagorda Bay on which silty dredged material was pumped by the Corps of Engineers

Galveston District. Younger, Texas Marine Advisory Service Environmental Quality Specialist Dr. Russell Miget and Dr. David Bade with Texas A&M's Department of Soil and Crop Sciences examined the site recently to monitor the development of forage and determine the nutritional value for livestock. The project will continue for two years.

Richard Tillman, MAS agent for Aransas and San Patricio counties, is one of the state's best jugglers. One day he may be on a shrimp boat helping shrimpers comply with Turtle Excluder Device (TED) regulations. The next day he may be in a school classroom teaching students about the importance of wildlife management. And still another day he may find himself working with concerned citizens, educating them about the devastating effects of nonpoint source pollution.

The 13-year agent currently has two major environmental projects in addition to his other activities. The Corpus Christi Bay National Estuary Program and the City of Ingleside recently received a \$40,000 grant to implement a demonstra-

tion project to help reduce nonpoint source pollution, specifically in storm runoff.

Tillman, a member the citizen's advisory committee for the program, recommended that some type of demonstration project be implemented, similar to Julie Massey's in Galveston County.

The demonstration project, scheduled for Cove Park, will involve several Best Management Practices (BMPs) to reduce pollutants in the runoff. BMPS are environmentally friendly landscaping and design practices that focus more on natural enhancement and less on toxic herbicides.

Tillman's second project involves water quality.

"We (Tillman working with the local Extension staff) have been collecting water samples from private water wells throughout Aransas County for the past month," Tillman said. "For the last two weeks we've been passing out water test kits. People with private water wells drew their samples and turned them in at eight locations throughout the county."

Once collected, samples are shipped to Corpus Christi for bacteriological analysis and the others are sent to Texas A&M for regular routine minerals analysis.

"We're not trying to find one specific thing. We're just trying to get a snapshot picture of what the groundwater looks like for private water well users. We also provided the service at a reduced cost," Tillman explained.

In addition to his current projects, Tillman is also following up on his very successful Great River Run, which marked its second anniversary earlier this year. He is applying for the Urban Rivers Restoration Award, which includes a cash award and participation in the Second Annual Urban River Symposium in Spring 1996. It is offered through the American Rivers Program, a consortium of non-profit river groups.

The Second Annual Great River Runs, week-long programs for high school teachers and students, were held on the Guadalupe and the Neches Rivers in June.

"We're applying for this award both to gain recognition and to get some money to expand the program," Tillman said. "What we eventually want to do is run one of these programs on every major river system in Texas.

"Not only does the week educate people on all the uses of fresh water in Texas, but it also demonstrates how important that freshwater inflow is to the bays and estuaries."

The program is open to high school teachers and students in coastal counties and along the designated watershed.



Rich Tillman in his outdoor classroom.

Cameron County MAS agent Tony Reisinger has had his share of crises during the past few months. Taura, the Central American-originated virus that has infected shrimp in aquaculture farms primarily in the Rio Grande Valley, has nearly wiped out the 1995 crop.

The projected crop of nearly six million pounds of shrimp (heads-on) coastwide may now be reduced to less than one million pounds. In Cameron County alone the original estimate of 3.24 million pounds may incur a 90 to 95 percent reduction. The Harlingen Hatchery and Lone Star Hatchery, as well as several shrimp farms in the the Valley, all Taiwanese owned, virtually ceased all

operations during the summer months.

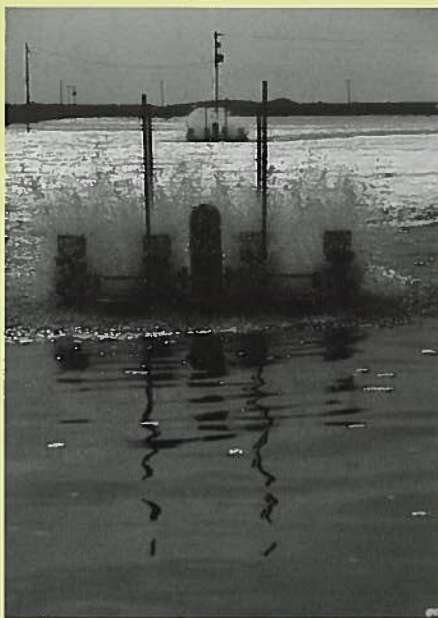
During a trip to the Harlingen Shrimp Farm in late August, this reporter saw only a skelton crew at work. "This farm has laid off about 70 percent of its workers," Reisinger said. "In all, about 100 employees have been impacted in Cameron County."

Reisinger's role, although a delicate one, was vital to the struggling industry in its darkest hour. With lots of snake oil salesmen and amateurs fueling the rumor mill, the local MAS agent was determined to gather and distribute the facts.

"My role was mainly providing information, working with and through Texas A&M, serving as a liaison on research at A&M, working with Dr. Ken Johnson, our disease specialist, and also providing economic data, gathering information and disseminating it to the right people," Reisinger said. "I also assessed the impact and briefed the county judge on what the actual impact on Cameron County would be so he could make a decision on whether to write to the Governor."

The county judge wrote the Governor, George W. Bush, who in turn drafted a petition for potential disaster relief. The petition is currently sitting on the U.S. Secretary of Agriculture's desk.

What did Taura do to Cameron County shrimp farming? "In plain and simple terms, it has devastated shrimp production, but not to the point of no return. I think that's going to remain a business decision for different farmers. Whether they have deep enough pockets to weather this setback is still unknown," Reisinger said. ■



Cameron County shrimp farms may face a 95 percent reduction in harvest.

PUBLICATIONS

TEXAS A&M UNIVERSITY
SEA GRANT COLLEGE PROGRAM

The following refereed journal articles and reports are representative of the published research findings by Texas Sea Grant project investigators.

Modeling Oyster Populations. IV: Rates of Mortality, Population Crashes, and Management. Eric Powell, John Klinck, Eileen E. Hofmann, and Sammy Ray. In *Fishery Bulletin* 92:347-373, 1994. TAMU-SG-95-801.

Lactic Acid/Melanosis Inhibitors to Improve Shelf Life of Brown Shrimp (*Penaeus aztecus*). R.A. Benner, R. Miget, G. Finne, and G.R. Acuff. In *Journal of Food Science* 59(2):242-245 & 250, 1994. TAMU-SG-95-802.

Partitioning of Cu, Pb, Ag, Zn, Fe, Al, and Mn Between Filter-retained Particles, Colloids, and Solutions in Six Texas Estuaries. G. Benoit, S.D. Oktay-Marshall, A. Cantu, E.M. Hood, C.H. Coleman, M.O. Corapcioglu, P.H. Santschi. In *Marine Chemistry* 45:307-336, 1994. TAMU-SG-95-803.

Modeling Oyster Populations II. Adult Size and Reproductive Effort. Eileen Hofmann, John Klinck, Eric Powell, Stephanie Boyles, and Matthew Ellis. In *Journal of Shellfish Research* 13(1):165-182, 1994. TAMU-SG-95-804.

Surface disinfection of red drum (*Sciaenops ocellatus* Linnaeus) eggs leading to bacteria-free larvae. P.A. Douillet, and G.J. Holt. In *Journal of Experimental Marine Biology and Ecology* 179:253-266, 1994. TAMU-SG-95-805.

Trace Metal Chemistry of Galveston Bay: Water, Sediments and Biota. John Morse, Bob Presley, Robert Taylor. In *Marine Environmental Research* 36:1-37, 1993. TAMU-SG-94-802.

Sex Ratio of Immature Green Turtles Inhabiting the Hawaiian Archipelago. Thane Wibbels, George H. Balazs, David Owens, and Max Amoss. In *Journal of Herpetology* 27(3):327-329, 1993. TAMU-SG-94-806.

Genetic Distinctness of Red Drum (*Sciaenops ocellatus*) from Mosquito Lagoon, East-Central Florida. John Gold and Linda Richardson. In *Fishery Bulletin* 92:58-66, 1994. TAMU-SG-94-808.

Interactions of Trace Metals with authigenic Sulfide Minerals: Implications for their Bioavailability. John Morse. In *Marine Chemistry* 46: 1-6, 1994. TAMU-SG-94-811.

Serum Gonadotropins and Gonadal Steroids Associated with Ovulation and Egg Production in Sea Turtles. Thane Wibbels, David Owens, Paul Licht, Colin Limpus, Philip Reed, and Max Amoss, Jr. In *General and Comparative Endocrinology* 87: 71-78, 1992.

Fishing Trip Satisfaction: A Typology of Anglers. Stephen Holland and Robert Ditton. *North American Journal of Fisheries Management* 12:28-33, 1992. TAMU-SG-93-802.

Initial Palatability and Growth Trials on Pelleted Diets for Cephalopods. Phillip Lee, John Forsythe, F. P. DiMarco, Randal DeRusha, and



Roger Hanlon. In *Bulletin of Marine Science* 49(1-2):362-372, 1991. TAMU-SG-93-805.

Isolation of Maturational Gonadotropin Subunits from Spotted Seatrout (*Cynoscion nebulosus*) and Development of a Beta-Subunit-Directed Radioimmunoassay for Gonadotropin Measurement in Sciaenid Fishes. Paul Copeland and Peter Thomas. In *General and Comparative Endocrinology* 88:100-110, 1992. TAMU-SG-93-808.

Adrenal-Kidney and Gonadal Steroidogenesis During Sexual Differentiation of a Reptile with Temperature-Dependent Sex Determination. Richard White and Peter Thomas. In *General and Comparative Endocrinology* 88:10-19, 1992. TAMU-SG-93-809.

Mechanisms and Rates of Decay of Marine Viruses in Seawater. Curtis Suttle and Feng Chen. In *Applied and Environmental Microbiology* 58(11):3721-3729, 1992. TAMU-SG-93-813.

Wide-spread Occurrence and Clonal Variation in Viruses Which Cause Lysis of a Cosmopolitan, Eukaryotic Marine Phytoplankter, *Micromonas pusilla*. Matthew Cottrell and Curtis Suttle. In *Marine Ecology Progress* 78:1-9, 1991. TAMU-SG-93-814.

Spatial and Temporal Distributions of Contaminant Body Burden and Disease in Gulf of Mexico Oyster Populations: The Role of Local and Large-scale climatic controls. E.A. Wilson, E.N. Powell, T.L. Wade, R.J. Taylor, B.J. Presley & J.M. Brooks. In *Helgolander Meeresunters* 46:201-235, 1992. TAMU-SG-93-815.

Oyster Disease and Climate Change. Are

Yearly Changes in *Perkinsus marinus* Parasitism in Oysters (*Crassostrea virginica*) Controlled by Climatic Cycles in the Gulf of Mexico? Eric Powell, Julie Gauthier, Elizabeth Wilson, Alanna Nelson, Roger Fay, and James Brooks. In *Marine Ecology* 13(3):243-270, 1992. TAMU-SG-93-816.

Modeling Oyster Populations I. A Commentary on Filtration Rate. Is Faster Always Better? E.N. Powell, E. E. Hofmann, J.M. Klinck, and S.M. Ray. In *Journal of Shellfish Research* 11(2):387-398. TAMU-SG-93-818.

Modeling Oyster Populations III. Critical Feeding Periods, Growth and Reproduction. Eileen Hofmann, Eric Powell, John Klinck, and Elizabeth Wilson. In *Journal of Shellfish Research* 11(2):399-416, 1992. TAMU-SG-93-819.

A Restriction Enzyme Map of the Mitochondrial DNA of Red Drum, *Sciaenops ocellatus*. Timothy Schmidt and John Gold. In *Northeast Gulf Science* 12:2. TAMU-SG-93-822.

Characteristics of the Anion Transport system in Sea Turtle Erythrocytes. Erich Stabenau, Acrios Vanoye, and Thomas Heming. In *Pulmonary Research Laboratories* 261:1218-1225, 1992. TAMU-SG-93-823.

Swimming Performance of Captive-reared Kemp's Ridley Sea Turtles *Lepidochelys Kempii* (Garman). Erich Stavenau, André Landry Jr., and Charles Caillouet, Jr. In *Journal Experimental Marine Biological and Ecology* 161:213-222, 1992. TAMU-SG-93-824.

Field Studies Using the Oyster *Crassostrea virginica* To Determine Mercury Accumulation and Depuration Rates. Sally Palmer, Bobby Presley, Robert Taylor, Eric Powell. In *Environmental Contamination and Toxicology* 51:464-470, 1993. TAMU-SG-93-825.

A Polyclonal Antibody Developed from *Perkinsus marinus* Hypnospores Fails to Cross React with Other Life Stages of *P. marinus* in Oyster (*Crassostrea virginica*) Tissues. Kwang-Sik Choi, Donald Lewis, Eric Powell, Paul Frelier, and Sammy Ray. In *Journal of Shellfish Research* 10(2):411-415, 1991. TAMU-SG-92-814.

Homogeneity Across MAil Survey Waves: A Replicated Study. Seungkam Choi, Robert Ditton, Gary Matlock. In *Journal of Leisure Research* 24(1):79-85. TAMU-SG-92-815.

Ovarian Development in the South American White Shrimp, *Penaeus vannamei*. Susan Rankin, James Bradfield, and Larry Keeley. In *NOAA Technical Report NMFS* p.27-33. TAMU-SG-92-817.

Female-biased Sex Ratio fo Immature Loggerhead Sea Turtles Inhabiting the Atlantic Coastal Waters of Florida. Thane Wibbels, R.Erik Martin, David Owens, and Max Amoss. In *Canadian Journal of Zoology* 69:2973-2977. TAMU-SG-92-818.

The Evolution of Recreational Fisheries Management in Texas. Robert Ditton, Anthony Fedler,

and Richard Christian. In *Ocean & Coastal Management* 17:169-181, 1992. TAMU-SG-92-819.

Serum Gonadotropins and Gonadal Steroids Associated with Ovation and Egg Production in Sea Turtles. Thane Wibbels, David W. Owens, Paul Licht, Colin Limpus, Philip C. Reed and Max S. Amoss, Jr. In *General and Comparative Endocrinology* 87: 71-78, 1992. TAMU-SG-93-801.

Fishing Trip Satisfaction: A Typology of Anglers. Stephen M. Holland and Robert B. Ditton. In *North American J. of Fisheries Management* 12:28-33, 1992. TAMU-SG-93-802.

Nutrient Enhanced Coastal Ocean Productivity: NECOP Workshop Proceedings, October 1991, NOAA Coastal Ocean Program. 154p. TAMU-SG-92-109.

Gulf of Mexico Oyster Bibliography. Thomas Soniat, James Simons, and Eric Powell. 59p. TAMU-SG-92-602. \$5.00.

Effects of Group Size on the Responsiveness of Zebrafish, *Brachydanio rerio* (Hamilton Buchanan), to Alanine, a Chemical Attractant. C.W. Steele, A.D. Scarfe, and D.W. Owens. In *Journal of Fish Biology* 38: 553-564, 1991. TAMU-SG-92-801.

Soft Plastra of Adult Male Sea Turtles: An Apparent Secondary Sexual Characteristic. M. Brent Charland. In *Herp. Review* 22(2): 47-49, 1991. TAMU-SG-92-803.

Use of Ultrafiltration to Isolate Viruses from Seawater which are Pathogens of Marine Phytoplankton. Curtis A. Suttle, Amy M. Chan, and Matthew T. Cottrell. In *Applied & Environmental Microbiology* 57(3): 721-726, March 1991. TAMU-SG-92-804.

Reproduction, Age and Growth, and Movements of the Gulf Butterfish *Peprilus burti*. Michael D. Murphy and Mark E. Chittenden Jr. In *Fishery Bulletin, U.S.* 89: 101-116, 1991. TAMU-SG-92-808.

Extensive Polymorphism at Adenosine Deaminase in the Marine Fish *Sciaenops ocellatus* (L.). D.A. Bohlmeier and J.R. Gold. In *Animal Genetics* 21: 211-213, 1990. TAMU-SG-92-810.

Genetics Studies in Marine Fishes: II. A Protein Electrophoretic Analysis of Population Structure in the Red Drum *Sciaenops ocellatus*. D.A. Bohlmeier and J.R. Gold. In *Marine Biology* 108: 197-206, 1991. TAMU-SG-92-812.

Genetic Studies in Marine Fishes: IV. An Analysis of Population Structure in the Red Drum (*Sciaenops ocellatus*) Using Mitochondrial DNA. John R. Gold and Linda R. Richardson. In *Fisheries Research* 12: 213-241, 1991. TAMU-SG-92-813.

A Polyclonal Antibody Developed from *Perkinsus marinus* Hypnospores Fails to Cross React with Other Life Stages of *P. marinus* in Oyster (*Crassostrea virginica*) Tissues. Kwang-sik Choi, Donald H. Lewis, Eric N. Powell, Paul F.



Frelieir, and Sammy M. Ray. In *Journal of Shellfish Research* 10(2): 411-415, 1991. TAMU-SG-92-814.

Homogeneity across Mail Survey Waves: A Replicated Study. Seungdam Choi, Robert B. Ditton, and Gary C. Matlock. In *Journal of Leisure Research* 24(1): 79-85, 1992. TAMU-SG-92-815.

Recreation Specialization: Reconceptualization from a Social Worlds Perspective. Robert B. Ditton, David K. Loomis, and Seungdam Choi. In *Journal of Leisure Research* 24(1): 33-51, 1992.

Ovarian Development in the South American White Shrimp, *Penaeus vannamei*. Susan M. Rankin, James Y. Bradfield, and Larry L. Keeley. In *NOAA Technical Report NMFS* 106, 27-33. TAMU-SG-92-817.

Female-biased Sex Ratio of Immature Loggerhead Sea Turtles Inhabiting the Atlantic Coastal Waters of Florida. Thane Wibbels, R. Erik Martin, David W. Owens, and Max S. Amoss, Jr. In *Can. J. Zoology* 69: 2973-2977, 1991. TAMU-SG-92-818.

The Evolution of Recreational Fisheries Management in Texas. Robert B. Ditton, Anthony J. Fedler, and Richard T. Christian. In *Ocean & Coastal Management* 17: 169-181, 1992. TAMU-SG-92-819.

Baculovirus-Impregnated Filter Paper Method for Assessing Disinfection Protocols in Shrimp Mariculture Facilities. D.H. Lewis, W.M. Charanza, and M.T. Omran. In *Journal of Aquatic Animal Health* 4: 69-72, 1992. TAMU-SG-92-820.

Tidal Stream Transport of Larval Fishes

into Non-stratified Estuaries. Scott A. Holt, G. Joan Holt, and Connie R. Arnold. In *Rapp. P.-v. Reun. Cons. int. Explor. Mer.*, 191: 100-104. 1989. TAMU-SG-91-801.

Reproduction, Movements, and Apparent Population Dynamics of the Atlantic Threadfin, *Polydactylus octonemus*, in the Gulf of Mexico. Michael W. Dentzau, and Mark W. Chittenden Jr. In *Fishery Bulletin* 88(3), 1990. TAMU-SG-91-802.

Attraction of Zebrafish, *Brachydanio rerio*, to Alanine and its Suppression by Copper. C.W. Steele, D.W. Owens, and A.D. Scarfe. In *Journal of Fish Biol.* 36: 341-352, 1990. TAMU-SG-91-803.

A Quantitative Analysis of Courtship Behavior in Captive Green Sea Turtles (*Chelonia mydas*). Diana K. Crowell Comuzzie and David Wm. Owens. In *Herpetologica* 46(2): 195-202, 1990. TAMU-SG-91-804.

Isolation and Identification of a New Cembranoid Diterpene from the Tunicate *Styela plicata*. John M. Wasylyk and Maktoob Alam. In *Journal of Natural Products*, 52(6): 1360-1362, Nov-Dec 1989. TAMU-SG-91-805.

Isolation, Synthesis, and Evaluation of a Series of Indencarbazates as Hypotensive Agents. Thomas L. Lemke, Radhika Sanduja, Mohamad M. Mroue, Shridhar Iyer, Maktoob Alam, M.B. Hossain, and Dick van der Helm. In *Journal of Pharmaceutical Sciences* 79(9): 840-844, 1990. TAMU-SG-91-806.

Demographics, Participation, Attitudes, Expenditures, and Management Preferences of Texas Saltwater Anglers, 1986. Robert B. Ditton, David K. Loomis, Alan D. Risenhoover, Seungdam Choi, Maury F. Osborn, Jerry Clark, Robin Riechers, and Gary C. Matlock. In *Texas Parks & Wildlife Dept. Management Data Series*, No. 18, 1990. TAMU-SG-91-807

Salts, Seeps, and Symbiosis in the Gulf of Mexico: A Preliminary Report of Deepwater Discoveries Using DSV ALVIN. James M. Brooks, Denis A. Wiesenburg, Harry Roberts, Robert S. Carney, Ian R. MacDonald, Charles R. Fisher, Norman L. Guinasso, Jr., William W. Sager, Susanne J. McDonald, Roger A. Burke, Jr., Paul Aharon, and Thomas J. Bright. In *EOS Transactions, American Geophysical Union*, 71(45):1772-1773, 1990. TAMU-SG-91-808.

Infection of Phytoplankton by Viruses and Reduction of Primary Productivity. Curtis A. Suttle, Amy M. Chan, and Matthew T. Cottrell. In *Nature* 347(6292): 467-469, 1990. TAMU-SG-91-809.

Ultrasound Imaging of Reproductive Organs and Eggs in Galapagos Tortoises, *Geochelone elephantopus* spp. Todd R. Robeck, David C. Rosenthal, Patrick M. Burchfield, David W. Owens, and Duane C. Kraemer. In *Zoo Biology* 9: 349-359, 1990. TAMU-SG-91-810.

F A L L
1 9 9 5

