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Texas A&M University Sea Grant College Program

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Introduction

This is a catalog of publications currently available from the Texas A&M University Sea Grant College Program. The citations are listed by topics in chronological order, so more recent works are found toward the end of each section. A brief abstract describes each publication.

Topics

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The Sea Grant College Program at Texas A&M University publishes two periodicals. The flagship publication, *Texas Shores*, is a quarterly magazine that addresses marine-related issues of importance to Texas and reports on the research, advisory services and educational efforts that are underway to address those issues. Subscriptions are $7.50 per year.

Texas Shoreline is a free, quarterly newsletter, for anyone living or working along the coast. It contains material about current events and happenings in the marine industry.

Aquaculture

1971–72

Effect of Fish Removal on the Growth and Condition of White Shrimp, *Penaeus setiferus* (Linnaeus), in Brackish Ponds. Jack C. Parker, Hoyt W. Holcomb, Jr., Wallace G. Klussman and James C. McNeill, IV. June 1972. 12 pages. $1. TAMU–SG–72–701. NTIS-COM–72–11134.

The effect of fish removal on growth and condition of juvenile white shrimp was studied in two brackish ponds near West Galveston Bay, Texas. In the pond in which fish were removed prior to stocking with shrimp, the shrimp grew more rapidly and were in better condition. Survival of shrimp was also higher in the pond without fish.

1974–75

Growth and Mortality of Two Groups of Oysters, (*Crassostrea virginica* Gmelin), Maintained in Cooling Water at an Estuarine Electric Power Generating Station. Gill H. Gilmore, Sammy M. Ray and David V. Aldrich. January 1975. 67 pages. $3. TAMU–SG–75–207. NTIS–COM–75–10722.

Growth and mortality of oysters with high and low levels of *Labryinthomyxa marina* infection were measured during 1972 in (1) 0.1 ha ponds receiving a continuous flow of heated water from an electric power plant, (2) the power plant intake canal, and (3) the power plant discharge canal. Pond oysters had less cumulative mortality than intake or discharge canal oysters, regardless of *Labryinthomyxa* infection, and had gained in biomass by the end of the study.

Salinity Preference of Postlarval Brown and White Shrimp (*Penaeus aztecus* and *P. setiferus*) in Gradient Tanks. Richard K. Keiser, Jr. and David V. Aldrich. May 1976. 260 pages. $5. TAMU–SG–75–208. NTIS–PB–259–697/AS.

Brown and white shrimp were studied in tanks containing salinity gradients that ranged from 0 to 50 ppt, 0 to 70 ppt, and in control tanks of uniform salinity. Factors investigated to determine their influence on salinity preferences include: season, time (temporal, day-night, tidal), age, acclimation salinity, illumination and interactions among the above. Over 100 figures and 29 tables.

1975-76

Thermal Resistance and Acclimation Rate in Young White and Brown Shrimp, *Penaeus setiferus* Linn. and *Penaeus aztecus* Ives. Larry M. Wiesepape. November 1975. 196 pages. $4. TAMU–SG–76–202. NTIS–PB–250–064/AS.

A study of the thermal tolerance, acclimation rate, and effects and salinity on thermal resistance in postlarval brown and white shrimp. *Penaeus aztecus* post-larvae acclimated at three temperatures (24, 29, and 34°C) were tested for thermal resistance at five lethal temperatures for each acclimation temperature (34-38°C; 35-39°C). *Penaeus setiferus* postlarvae acclimated at two temperatures (29 and 34°C) were tested for thermal resistance at six lethal temperatures for each acclimation temperature (35-40°C; 36-41°C). Temperatures which caused 50 percent mortality at 10,000 were determined.

1976–77

Crawfish and Freshwater Shrimp Diseases. S.K. Johnson. August 1977. 20 pages. TAMU–SG–77–605. NTIS–PB–275–958/AS.

This handbook is designed as an information source and field guide for crustacean culturists, commercial fishermen, and others interested in parasites or abnormal conditions of freshwater crustaceans. Detailed descriptions, photographs and illustrations of the common parasites and commensals are given along with information on their life cycles and general biological characteristics. Several diseases of unknown cause are also described. A list giving definitions of terms is included.

1979–80

Bio-Engineering Economic Model for Shrimp Mariculture Systems. C.M. Adams, W.L. Griffin, J.P. Nichols and R.W. Brick. May 1980. 125 pages, 7 figures, 4 tables. $4. TAMU–SG–80–203. NTIS–PB–80–223–308.

A bio-engineering-economic computer model was developed to produce average annual budgets, monthly and annual cash flows and sensitivity analysis for a penaeid shrimp commercial grow-out system design located on the Texas Gulf Coast. Given the production data available, growth equations were simulated for various stocking densities. Sensitivity analyses also were performed on selected production variables and prices. A documentation of the program is presented in the Appendix along with a summary on how to run the program.

1980–81

Aquaculture in Texas: A Status Report and Development Plan. Robert R. Stickney and James T. Davis. August 1981. 103 pages, 2 tables, 6 figures. $8. TAMU–SG–81–119. NTIS–PB–82–148–321.

Texas has been a leader for aquaculture research and development because of its climate and extensive marine and freshwater resources. Overfishing and decreased environmental quality threaten the fisheries industry, and aquaculture offers economic opportunity and a new source of protein. This report is a guide for user and provider groups, state agencies and political bodies involved in aquaculture in Texas. Using groundwater, temperature, precipitation and soils data, it evaluates the state's potential for aquaculture. It discusses legal constraints on the development of the industry and recommends laws and regulations that would promote it. The report discusses marketing strategies for aquaculture products, inland sources of salt water and use of heated industrial effluent for temperature control of aquaculture facilities. It also recommends future research in disease prevention and control, diets and new species suitable for aquaculture. Status and research needs are presented for the channel catfish, crawfish, tilapia, largemouth bass, bait minnows, red drum, freshwater shrimp, penaeid shrimp, oysters and marine finfish.

Summary of Shrimp Mariculture Data at Texas A&M University, 1969-1978. M.A. Johns, H.W. Holcomb, D.L. Hutchins and W.L. Griffin. May 1981. 130 pages, 202 tables. $5. TAMU–SG–81–603. NTIS–PB–81–243–974.

Since it began, shrimp mariculture research in Texas has been supported by the Texas A&M University System and the Texas A&M Sea Grant Program. This report summarizes the development of shrimp mariculture in Texas and the research objectives of shrimp mariculture in Texas and the research objectives of shrimp culture facilities at Angleton and Corpus Christi, Texas. In addition, it presents weekly growth and

water quality data from research at the facilities between 1969 and 1978.

Mixed Infection in Columnaris Disease in Fish. J.E. Marks, D.H. Lewis and G.S. Trevino. In *Journal of the American Veterinary Medical Association*, Vol. 177, No. 9, November 1980. pp. 811-814, 1 table, 6 figures. **$1. TAMU–SG–81–811. NTIS–PB–81–199–861.**

Flexibacter columnaris and *Corynebacterium* sp were recovered from lesions associated with columnaris disease in catfish. Catfish exposed to pure cultures of the *Corynebacterium* sp developed circumscribed lesions, which regressed without further adverse effects. Disease signs were not demonstrable in catfish exposed to pure cultures of *F. columnaris*; however, when catfish were exposed to mixed cultures of *Corynebacterium* sp and *F. columnaris*, signs of columnaris appeared and the fish died.

Ultrastructural Localization of Peroxidase Activity in Nuetrophil Leukocytes of *Ictalurus punctatus*. M. Samuel Cannon, Hilton H. Mssollenhauer, Anita M. Cannon, Thomas E. Eurell and Donald H. Lewis. In *Canadian Journal of Zoology*, Vol. 58, No. 6, 1980. pp. 1139-1143, 2 figures. **$1. TAMU–SG–81–812. NTIS–PB–81–182–628.**

The cytoplasmic granules of the blood neutrophil leukocyte of the teleost, *Ictalurus punctatus*, have been shown to exhibit peroxidase activity at the light and electron microscopic levels when exposed to the 3.3'-diaminobenzidine tetrahydrochloride peroxidase procedure. Erythrocytes also show activity. Addition of cyanide to the incubation medium has no apparent effect on peroxidase reactivity in neutrophils, but inhibits pseudoperoxidase reactivity in erythrocytes. The presence of peroxidase-positive granules in the neutrophil serve as a marker for identification of this cell and strongly indicate antibacterial and phagocytic functions for the neutrophil.

A Comparison of the Capabilities of Juvenile and Adult *Penaeus setiferus* and *Penaeus stylirostris* to Regulate the Osmotic, Sodium and Chloride Concentrations in the Hemolymph. Frank L. Castille, Jr. and Addison L. Lawrence. In *Comparative Biochemical Physiology*, Vol. 68A, 1981, pp. 677-680. **$1. TAMU–SG–81–818.**

The capabilities of juvenile and mature adult *Penaeus setiferus* and *P. stylirostris* to regulate the osmotic, sodium and chloride concentrations in the hemolymph are compared. In *P. setiferus* and *P. stylirostris* acclimated to salinities of 9.8 and 10.8 ppt, respectively, juvenile shrimp are stronger hyperosmotic and hyperionic regulators than adults. However, the reduced regulatory capabilities of adult shrimp are not sufficient to require migration to offshore waters for survival. At 40.4 ppt juvenile *P. setiferus* are more effective hypoosmotic and hypoionic regulators than adults. However, there is no difference between the regulatory capabilities of juvenile and adult *P. stylirostris* at 36.2 ppt. Differences in hemolymph concentration between juvenile and adult *P. setiferus* at 23.5 ppt indicate that the isosmotic and isoionic crossover concentrations are elevated with maturation.

An Ultrastructural Study of the Leukocytes of the Channel Catfish, *Ictalurus punctatus*. M. Samuel Cannon, et. al. In *Journal of Morphology*, 161:1-23 (1980). **$1. TAMU–SG–81–820.**

Ultrastructure studies of leukocytes of the channel catfish, *Ictalurus punctatus*, revealed heterophils (neutrophils), small lymphocytes, monocytes and thrombocytes. Eosinophils and basophils were not seen. Thrombocytes and small lymphocytes were the most abundant types of leukocytes; monocytes were the least abundant. Monocytes and large lymphocytes were often indistinguishable. Cells that resembled macrophages or transitional forms between them and monocytes were seen occasionally. Glycogen, present in all leukocytes, was least abundant in monocytes and most abundant in heterophils. Monocytes and heterophils were similar in size and shape, but monocytes contained more rough endoplasmic reticulum (ER), more free ribosomes and fewer granules than did heterophils. In heterophils, granules were oval or elongate and often contained a crystalline or striated structure. Small tubules, similar to smooth ER, and cristae that cross the long axes of mitochondria were often seen. Small lymphocytes possessed pseudopodia, many free ribosomes, many large mitochondria and dictyosomes (Golgi), and long profiles of rough ER. Dictyosomes were often associated with a large zone of exclusion. Bundles of microtubules were seen near the elongated ends of thrombocytes. Deep indentations seen in the plasmalemma of thrombocytes gave the appearance of vacuoles.

Winter Culture of *Penaeus vannamei* in Ponds Receiving Thermal Effluent at Different Rates. G.W. Chamberlain et al. In *Proceedings of the World Mariculture Society*, 11:30-43 (1980). **$1. TAMU–SG–81–822.**

The marine shrimp *Penaeus vannemei* was cultured from 3 November 1978 to 10 April 1979 in eight 0.1-ha ponds whose water temperature could be increased with cooling water effluent from the adjacent electrical power plant near Corpus Christi, Texas. Four treatments were used, including different flow rates and feeding rates. The flow rate were: high (3,000 l/m), medium (1,500 l/m) and low (35 l/m). Feeding rates were three and four percent of body weight. Survival, growth and distribution of shrimp were monitored by cast-net sampling. In low-flow ponds, mortality was 94 percent after temperatures dropped to 5.2°C. Survival was much greater in ponds with higher flow rates. Maximum survival, 33.7-82.3 percent, was seen in the high-flow ponds. Low-temperature death occurred below 8°C regardless of acclimation and at temperatures as high as 12°C, depending on degree on acclimation. Growth rates among treatments ranged from -0.03 to 0.06 g/day. Highest growth rates occurred in high-flow ponds with a four percent feeding rate. The four percent feeding rate yielded greater survival, growth, food conversion efficiency, digestive gland index and spermatophore production than the three percent rate. At temperatures less than 21°C shrimp burrowed and cast-net catches declined. Shrimp inhabited deeper water during the day and were more evenly distributed at night.

Estimation of Shrimp Populations in Experimental Ponds Using Mark-Recapture and Stratified Random Sampling Methods. David L. Hutchins, George W. Chamberlain and Jack C. Parker. In *Proceedings of the World Mariculture Society*, 11:142-150 (1980). **$1. TAMU-SG–81–825.**

Reliable estimates of populations of organisms in mariculture ponds are essential for efficient management fo feeding programs and harvesting schedules. However, accurate estimates are seldom obtained in routine sampling programs because of the complexities of most sampling procedures. Two techniques for estimating *Penaeus vannamei* populations in ponds were investigated during Summer and Fall 1978. The Peterson mark-recapture procedure resulted in an estimate that was only 5.9 percent greater than the actual population. However, molting and mortality quickly reduced the number of marked animals, and estimates based on their recapture were not feasible. The second technique involved stratified random sampling by cast netting. A significant (r^2 = 0.64) relationship was found between the mean catch per cast

and the actual population at harvest in the 13 ponds tested. This relationship was then used to predict populations in seven ponds. The average deviation of the estimates was 11.6 percent greater than the actual populations.

1981–82

Sea Grant Aquaculture Plan 1983-1987. Feenan D. Jennings, Alfred M. Beeton, Jack R. Davidson, William S. Gaither and Malvern Gilmartin. July 1982. vii + 47 pages, 2 figures, 14 tables. **$5. TAMU–SG–82–114.**

The National Aquaculture Act of 1980 called for a coordinated national aquaculture program. The responsibility for aquacultural research and development on saltwater and Great Lakes species was later assumed by the Department of Commerce, primarily by the National Sea Grant College Program. This document presents Sea Grant's strategy for aquaculture research, education and advisory services for the next five years. Written by 21 working groups, the plan discusses its coordination with the national aquaculture plan, accomplishments of Sea Grant's aquacultural research, areas of effort for future research, and status and problems on a species basis. Areas of interest include aquacultural systems, genetics, nutrition, public policy, economics and marketing and advisory services. Species plans are given for 17 species or groups, including the most important molluscs, crustaceans, fishes, bait organisms and seaweeds.

Sea Grant Aquaculture Plan 1983-1987 - Executive Summary. July 1982. 4 pages, 2 figures, 1 table. **TAMU–SG–82–115.**

This is a summary of the above-listed publication, which describes Sea Grant's policy, goals and objectives as they relate to aquacultural development in the United States. It discusses the economic importance of aquaculture, assesses present aquacultural technology and projects funding for the next five years based on research needs and changing emphasis. Finally, it places the Sea Grant aquacultural effort in the context of the national effort.

Aquaculture: Public Health, Regulatory and Management Aspects - Proceedings of the 6th U.S. Food and Drug Administration Science Symposium on Aquaculture. July 1982. 226 pages, many tables and illustrations. **$5. TAMU–SG–82–119. NTIS–PB–83–120–303.**

The FDA's 6th Science Symposium on Aquaculture was held February 12-13, 1980 in New Orleans. This publication is the proceedings of that symposium and includes 81 of the papers that were presented. Topics include paralytic shellfish poisoning, immunology, environmental microbiology and virology, business and policy.

The Effect of Salinity on the Osmotic, Sodium and Chloride Concentrations in the Hemolymph of Euryhaline Shrimp of the Genus *Penaeus*. Frank L. Castille, Jr. and Addison L. Lawrence. In *Comparative Biochemical Physiology*, 68A:75-80 (1981). **$1. TAMU–SG–82–801.**

The hemolymph is isosmotic to seawater at 745 mOs/kg in *Penaeus aztecus*, 768 mOs/kg in *P. duorarum*, 680 mOs/kg in *P. setiferus*, 699 mOs/kg in *P. stylirostris*, and 718 mOs/kg in *P. vannamei*. The hemolymph is hyperosmotic to seawater at salinities below the isosmotic concentrations and hypoosmotic to those above. With respect to sodium and chloride, the hemolymph is hyperionic to seawater at low salinities and hypoionic to seawater at high salinities. *P. aztecus* and *P. duorarum* are weaker osmotic and ionic regulators at low salinities than *P. setiferus*, *P. stylirostris*, and *P. vannamei*. There are no significant differences in the osmotic and ionic regulatory capabilities of all five species at high salinities.

The Effect of Salinity on the Osmotic, Sodium and Chloride Concentrations in the Hemolymph of the Freshwater Shrimps, *Macrobrachium ohione* Smith and *Macrobrachium rosenbergii* de Man. Frank L. Castille, Jr. and Addison Lawrence. In *Comparative Biochemical Physiology*, 70A: 47-52 (1982). **$1. TAMU–SG–82–802.**

Adult *Macrobrachium ohione* are capable of weak hypoosmotic regulation and hypoionic regulation with respect to sodium and chloride regulation at an external osmolality of 822 mOsm/kg, and very strong hyperosmotic and hyperionic regulation in fresh water. The isosmotic crossover osmolality is 643 mOsm/kg and the isoionic concentration is 236 mM/l for sodium and 224 mM/l for chloride. Juvenile *M. rosenbergii* are also strong hyperosmotic and hyperionic regulators in fresh water, but at high salinities they are slightly hyperosmotic to the media, isoionic with respect to sodium and hypoionic with respect to chloride. The isoionic crossover concentration for chloride is 189 mM/l. Although both species are able to maintain a relatively constant hemolymph concentration in tapwater diluted with deionized water, *M. rosenbergii* is a more effective hyperosmotic and hyperionic regulator than *M. ohione* at very dilute concentrations (<14 mOsm/kg). The percentage of the osmotic concentration due to sodium and chloride suggests that protein in the hemolymph may be osmotically significant.

A Comparison of the Osmotic, Sodium and Chloride Concentrations between the Urine and Hemolymph of *Penaeus setiferus* (L.) and *Penaeus stylirostris* (Stimpson). Frank L. Castille and Addison L. Lawrence. In *Comparative Biochemical Physiology*, 70A:525-528 (1981). **$1. TAMU–SG–82–803.**

The osmotic, sodium, and chloride concentrations in the urine and hemolymph are compared in *Penaeus setiferus* and *P. stylirostris* at salinities ranging from 10 to 40 ‰. Isosmoticity of the urine and hemolymph indicate that the antennal glands are not important in osmotic regulation. At all experimental salinities, the urine was hypoionic to the hemolymph with respect to sodium and isoionic to the hemolymph with respect to chloride.

Enhancement of Chill Tolerance in Larval *Artemia salina*: Cooling Regimens and Multiple Type Cryoprotectant Exposure. J.G. Baust and A.L. Lawrence. In *Proceedings of World Mariculture Society*, 10:421-428 (1979). **$1. TAMU–SG–82–805.**

The enhancement of chill tolerance of *Artemia salina* larvae to single-component (glycerol, glucose or sucrose) and double-component (glucose/sucrose) cryoprotectant solutions was determined. Larvae, aged 0, 3, 6, 12 and 24 hours, were immersed in -1 °C cryoprotectant solutions for periods as long as 90 minutes. Survival of the different larval stages was compared between larvae exposed to instantaneous cooling from 28 °C to -1 °C and those exposed to a gradual (1 °C/hr) cooling from 28 °C to 18 °C followed by instantaneous cooling to -1 °C. In most cases, survival was enhanced to a greater extent when multiple-component cryoprotectants were used than in single component systems. Survival was two to five times greater than when no cryoprotectant was used. The significance of these results to the development of cryogenic larval banking is discussed.

Length-Weight Relations for Several Species of Penaeid Shrimp Cultured in Ponds near Corpus Christi, Texas. D.L. Hutchins, G.W. Chamberlain and J.C. Parker. In *Proceedings of World Mariculture Society*, 10:565-570 (1979). **$1. TAMU–SG–82–806.**

Length of shrimp is more easily measured than weight,

and length-weight relationships allow estimation of weight from length measurements. Using the model $W = aL^b$, linear regressions were calculated from paired length and weight measurements of aquacultured *Penaeus duorarum, P. occidentalis, P. setiferus, P. stylirostris* and *P. vannamei*, measured during 1972-1979. Length frequency distributions and regression formulas for predicting weights from lengths are presented for each species.

Maturation of Penaeid Shrimp: Dietary Fatty Acids. B.S. Middleditch, S.R. Missler, D.G. Ward, J.B.McVey, A. Brown and A.L. Lawrence. In *Proceedings of the World Mariculture Society*, 10:472-476 (1979). $1. **TAMU–SG–82–807.**

Comparisons were made between fatty acid profiles of gonad, digestive gland and tail muscle tissue samples from immature and mature male and female penaeid shrimp collected at sea. The major fatty acids of the lipids from mature ovaries were C_{20} and C_{22} polyunsaturated fatty acids. The polychaete *Glycera dibranchiata*, rich in lipids containing these acids, was used as a dietary supplement for shrimp grown in the laboratory, and spawning was achieved with *Penaeus setiferus*. The possible role of polyunsaturated fatty acids in ovarian maturation is discussed.

Fatty Acid Changes During Larval Development of *Penaeus setiferus*. D.G. Ward, B.S. Middleditch, S.R. Missler and A.L. Lawrence. In *Proceedings of the World Mariculture Society*, 10: 464-471 (1979). $1. **TAMU-SG-82-808.**

Fatty acid compositions of the egg, nauplius, protozea, mysis and one-to-two-day postlarva of Penaeus setiferus were determined. Of 12 fatty acids identified, the four major ones in the egg were 16:1, 16:0, 18:1, 20:4. Those of the one-to-two-day postlarva were 16:0, 18:1, 20:4 and 22:6. Per unit weight, the 16:1, 16:0, 18:1 and 20:4 fatty acids decreased between the egg and the one-to-two-day postlarval stages by 83, 47, 44 and 18 percent, respectively. However, the 22:6 fatty acid increased by 66 percent per unit dry weight during that time. Per animal, the largest increases were obtained for the 16:0, 18:0, 18:1, 20:4 and 22:6 fatty acids between the protozoeal and the one-to-two-day postlarval stages. The largest per-animal decreases were seen for the 16:1, 16:0, 18:1 and 18:0 fatty acids between the egg and nauplius stages. The significance of these results to understanding shrimp larval nutrition is discussed.

Maturation of Penaeid Shrimp: Lipids in the Marine Food Web. B.S.Middleditch, S.R. Missler, H.L. Hines, E.S. Chang, J.P. McVey, A. Brown and A.L. Lawrence. In *Proceedings of the World Mariculture Society* 11:463-470 (1980).$1. **TAMU–SG–82–809.**

Certain lipids are required in the diets of penaeid shrimp to promote ovarian maturation. To identify appropriate feedstock supplements that contain these lipids, several invertebrate species were examined from West Bay, Galveston, Texas, and from the Gulf of Mexico 50 kilometers off Galveston. With a few notable exceptions, the lipid profiles for the various species were very similar at each location. This implies that many lipids pass unaltered through the food web and that the suitability of a particular invertebrate food item for inducing ovarian maturation may depend on the diet of that invertebrate.

Maturation of White Shrimp (*Penaeus setiferus*) in Captivity. A. Brown, Jr., J. McVey, B.A. Middleditch and A.L. Lawrence. In *Proceedings of the World Mariculture Society*, 10:435-444, (1979). $1. **TAMU–SG–82–810.**

Penaeus setiferus matured and spawned in captivity at ambient temperature with controlled photoperiod and diet. The experiments were performed at the lagoon and seawater laboratories of the National Marine Fisheries Service in Galveston, Texas. One-half of the animals at each site were unilaterally eyestalk-ablated. The photoperiod was initially set at 15 hours and was increased to 16 hours when spawning began. Temperature ranged from 22°C to 29°C, salinity was 22-30 ‰ and pH was 7.5-8.0. The diet consisted of worms, squid, oysters and mussels. Egg production varied between the sites: 534,000 were produced at the lagoon facility and 3.8 million at the seawater laboratory. Spermatophore transfer did not occur, possibly because of a bacterial infection (*Vibrio* sp.) of the terminal ampoules and the compound spermatophore.

Organ Indices and Biochemical Levels of Ova from Penaeid Shrimp Maintained in Captivity Versus Those Captured in the Wild. A.L. Lawrence, D. Ward, S.Missler, A. Brown, J. McVey and B.S. Middleditch. In *Proceedings of the World Mariculture Society* 10:453-463 (1979). $1. **TAMU–SG–82–811.**

This paper further characterizes reproduction of penaeid shrimp by reporting (1) gonad, hepatopancreas, tail and eyestalk indices for unablated and unilaterally eyestalk-ablated *Penaeus setiferus* maintained in captivity and captured in the wild; and (2) the biochemical content of spawned ova from *P. setiferus, P. stylirostris* and *P. vannamei* obtained from the wild and from *P. setiferus* that matured and spawned in captivity. The data indicate that (1) the dietary and environmental regime used in this study was not optimal for reproduction of *P. setiferus* in captivity; (2) the hepatopancreas is directly involved in penaeid reproduction, but the tail muscle is not; (3) the population of *P. setiferus* sampled on June 2 and July 22, 1978 in the northwestern Gulf of Mexico was not at its reproductive peak; (4) the percentages of protein, lipids and carbohydrates in unhatched eggs of all three species are very similar; and (5) biochemical analysis of the unhatched eggs and determination of organ indices during reproduction are necessary for the evaluation of penaeid reproduction, both in the wild and in captivity.

The Maturation and Spawning of *Penaeus stylirostris* Under Controlled Laboratory Conditions. A. Brown, Jr., J.P. McVey, B.M. Scott, T.D. Williams, B.D. Middleditch and A.L. Lawrence. In *Proceedings of the World Mariculture Society*, 11: 488-489 (1980). $1. **TAMU–SG–82–812.**

About 35 female *Penaeus stylirostris* from Costa Rica and Mexico mated and spawned at least 247 times within 190 days, producing more than 98 million eggs. Each spawned 9-10 times, producing an average of 397,000 eggs. Hatching rates were 0-85 percent and averaged about 50 percent. Experiments were done at the National Marine Fisheries Service laboratory in Galveston, Texas. Females were unilaterally eyestalk-ablated and placed in 3-m-diameter tanks. The sex ratio was 1-1. Salinity was 20-30 ‰; water temperature was 29-30°C. The diet consisted of polychaetes, squid, and sometimes a pellet feed, at a 1-2-1 ratio. The photoperiod was 14h; only fluorescent light was used. Mating began at 1400-1500 h and continued until 2200-2230 h and later. Females with a spermatophore were placed in spawning tanks containing water treated with EDTA, Maracyn I and Maracyn II. Egg production and hatching rates were calculated for each tank. Nauplii were transferred to the hatchery, and viability was determined for selected spawns. Survival to postlarvae varied. More than 746,000 postlarvae were produced.

The Nutritional Response of Two Penaeid Species to Various Levels of Squid Meal in a Prepared Food. Jorge L. Fenucci, Zoula P. Zein-Eldin and Addison L. Lawrence. In

Proceedings of the World Mariculture Society, 11: 403-409 (1980). $1. TAMU–SG–82–813.

Several pellet feeds containing 30-35 percent protein were tested on *Penaeus stylirostris* and *P. setiferus*. Alginate-bound test diets varied in protein composition, but all diets contained about 30 percent sun-dried squid meal. Initial tests used diets containing as much as 13 percent squid meal. In later tests, squid meal content varied between 0 and 12.7 percent, and alpha-soy flour content varied between 0 and 12.4 percent. In one test diet, these components were replaced with 12.5 percent brewer's yeast. Conversion rates, survival and growth were determined during a three-week period for the two species and for two sizes of *P. stylirostris*. The presence of five to six percent squid meal is advantageous in feeds containing 30-35 percent protein.

The Effect of Salinity on the Osmotic, Sodium and Chloride Concentration in the Hemolymph of the Rock Shrimps, *Sicyonia brevirostris* and *Sicyonia dorsalis*. Frank L. Castille Jr. and Addison L. Lawrence. In *Comparative Biochemical Physiology* 70A: 519-523 (1981). $1. TAMU–SG–82–814.

When *S. brevirostris* and *S. dorsalis* are exposed to diluted seawater, the osmotic, sodium and chloride concentrations of the hemolymph decrease with the concentration of seawater. The hemolymph of both species i slightly hyperosmotic and hyperionic with respect to sodium and chloride in diluted seawater. In undiluted seawater (37-38 ‰), the hemolymph is slightly hypoosmotic and hypoionic with respect to sodium and chloride. In their responses to dilution, *S. brevirostris* and *S. dorsalis* more closely resemble poikilosmotic crustaceans than euryhaline penaeidean shrimp.

Aggregation of Penaeid Shrimp Larvae Due to Microbial Epibonts. D.H. Lewis, J.K. Leong, and C. Mock. In *Aquaculture* 27:149-155 (1982). $1. TAMU–SG–82–818.

Pseudomonas piscicida, *Aeromonas formicans* and *Flavobacteria* sp. were involved in aggregation of hatchery-reared larvae of *Penaeus stylirostris*. Aggregation was reproduced experimentally with pure cultures of these bacteria at densities of 10^4 cells per milliliter. Addition of at least 3 µg/ml gentamycin, 10 µg/ml nalidixic acid, 0.1 µg/ml acridine or Cutrine Plus into test suspensions prevented aggregation of the shrimp larvae.

1982–83

Bioeconomic Modeling with Stochastic Elements in Shrimp Culture. W.L. Griffin, J.S. Hanson, R.W. Brick and M.A. Johns. In *Journal of the World Mariculture Society* 12(1): 94-103 (1981). $1. TAMU–SG–83-802.

This study incorporates water quality parameters and a growth function into a bioeconomic model of shrimp mariculture. Certain parameters, such as weather and low oxygen concentrations, are unpredictable, so randomization of such parameters is introduced into the model. The results consist of means and standard deviations of profits determined from 25 replications of the model. The baseline model indicates that a mean profit of $679/hectare would be achieved with only a five percent chance of loss. Sensitivity tests of profit in the model, consisting primarily of changes in biological and environmental parameters, illustrate the usefulness of the model in directing future research.

Mono- and Polyculture of *Penaeus vannamei* and *P. stylirostris* in Ponds. G.W. Chamberlain, D.L. Hutchins and A.L. Lawrence. In *Journal of the World Mariculture Society* 12 (1):251-270 (1981). $1. TAMU–SG–83–803.

Fish polyculture is more productive than fish monoculture, but the effect of polyculture on shrimp production has received little attention. This study investigated production of *Penaeus vannamei* ("v") and *P. stylirostris* ("s") in monoculture and in polyculture at various species ratios (75v:25s, 50v:50s, and 25v:75s), at a constant population density of 0.18 million shrimp per hectare, in 0.1-ha ponds. *P. vannamei* has a greater mean survival rate (73 vs. 22 percent), but a smaller mean growth rate (0.09 vs 0.14 g/day) than *P. stylirostris*. Survival rates did not differ significantly among treatments. Final weight decreased significantly for both species with increasing density of the same species, but it significantly increased with increasing density of the other species. Best growth for both species occurred in the 75v:25s treatment. Interspecific differences in distribution and diel activity may partially explain the compatibility of the species in polyculture. Production rates (590-2,180 kg/ha) and value ($2,720-$5,740/ha) generally increased with increasing percentage of *P. vannamei*, but no significant difference in mean value was detected between the 110v and the 75v:25s treatments. Performance of shrimp (25v:75s) in a single-phase pond system was compared to that in a three-phase (nursery, intermediate and grow-out) system. Survival, growth, production and value were similar in both systems.

Decreased Toxicity of Copper and Manganese Ions to Shrimp Nauplii (*Penaeus stylirostris* Stimpson) in the Presence of EDTA. A.L. Lawrence, J. Fox and F.L. Castille, Jr. In *Journal of the World Mariculture Society* 12(1): 271-280 (1981). $1. TAMU–SG–83–804.

Ethylenediaminetetraacetic acid (EDTA) is used routinely in intensive culture of penaeid shrimp larvae to increase hatching and larval survival rates. However, its mode of action is unknown. This study evaluated the effect of EDTA (10 mg/l) on the toxicities of Cu^{++} and Mn^{++}, in terms of the percentage of *Penaeus stylirostris* nauplii surviving after 12 and 24 hours of exposure and in terms of percentage of nauplii metamorphosing into protozoea. In the absence of EDTA, Cu^{++} and Mn^{++} were toxic to nauplii. Cu^{++} caused 100 percent mortality at a much lower concentration (20 uM) than did Mn^{++} (20,000 uM). In the presence of EDTA survival of nauplii exposed to Cu^{++} increased, but survival of nauplii exposed to Mn^{++} did not change. At sublethal concentrations, Cu^{++} (0.2 uM) and Mn^{++} reduced the percentage of nauplii that metamorphosed to protozoea. In the presence of EDTA, the percentage of nauplii metamorphosing increased with exposure to both Cu^{++} and Mn^{++}. The beneficial effects probably result from chelation of Cu^{++} and Mn^{++} by EDTA, which decreases the concentration of these ions, reducing their toxicities.

The Effects of Fatty Acid and Shrimp Meal Composition of Prepared Diets on Growth of Juvenile Shrimp, *Penaeus stylirostris*. J.L. Fenucci, A.L. Lawrence and Z.P. Zein-Eldin. In *Journal of the World Mariculture Society* 12(1): 315-324 (1981). $1. TAMU–SG–83–806.

Pelleted diets, containing different amounts of sun-dried shrimp meal and brewer's yeast, were tested. A relationship was observed between the content of the shrimp meal and brewer's yeast in the diets and increased growth of juveniles. Data suggest that in feeds containing five percent squid meal, as much as one-half the shrimp meal can be replaced by brewer's yeast. These feeds should thus contain at least 15 percent shrimp meal and less than 15 percent brewer's yeast. A quadratic correlation was found between growth rate of juveniles and the percentage of linoleic acid in the diets. The best nutritional response should be obtained in rations containing 14.5 percent linoleic acid.

1983–84

Reproductive Activity and Biochemical Composition of *Penaeus setiferus* and *Penaeus aztecus* in the Gulf of Mexico. G.W. Chamberlain, A.L. Lawrence. October 1983. 35 pages, 26 figures, 8 tables. $7. **TAMU–SG–84–203. NTIS–PB–84–121–078.**

Penaeus setiferus and *P. aztecus* compose the bulk of the Texas catch of shrimp, the most valuable fishery product in the state. This study compares the maturation and reproduction of *P. setiferus* and *P. aztecus* near an offshore brine diffuser (at a depth of 21 m) to that at two control locations. Seven 10-day collecting cruises were conducted between October 1979 and September 1980, and approximately 3,000 shrimp were dissected and analyzed. Descriptions and photographs of characteristic size and color of each stage of ovarian maturation are presented for each species.

Developing a Selected Breeding Program for Penaeid Shrimp Mariculture. L. James Lester. In *Aquaculture* 33: 41-50 (1983). $1. **TAMU–SG–84–804.**

Five species of penaeid shrimp are being considered for mariculture production in the southern United States. Four of these, *Penaeus aztecus, P. setiferus, P. stylirostris,* and *P. vannamei,* are the subject of an investigation of genetic differentiation among wild stocks using the electrophoretic technique. Preliminary results indicate a low level of genetic variation and little geographic differentiation within species. The implication of these findings for the creation of a foundation population for the selective breeding program is discussed. Many questions have resulted from the initial efforts to employ a quantitative criterion in the selection of future broodstock from pond-reared adults. One response has been morphometric studies to evaluate other possible selection criteria. Several morphological measures are identified as potential selection criteria and discussed with regard to the handling necessary to make each measurement and the correlation between these measurements and tail weight. An overview of the penaeid mariculture methodology used in Texas is presented as a justification for a program using mass selection rather than other methods to improve tail weight grow-out.

1984–85

Effect of Light Intensity and Male and Female Eyestalk Ablation on Reproduction of *Penaeus stylirostris* and *P. vannamei*. George W. Chamberlain and Addison L. Lawrence. In *Journal of the World Mariculture Society*, 12(2): 357-372 (1981). $1. **TAMU–SG–85–802.**

This 97-day study, conducted during midwinter using a recirculating water system, was designed to evaluate the effect of light intensity and male and female eyestalk ablation on reproduction of *P. vannamei* and *P. stylirostris*. Four light intensities were established using various levels of fluorescent lighting (bright, 14.7uEm^{-2}s^{-1}; moderate, 4.4 uEm^{-2}s^{-1}; dim, 0.6uEm^{-2}s^{-1}; and dark, 0.0uEm^{-2}s^{-1}) and the fifth consisted of artificial lighting supplemented with natural light through a translucent skylight (skylight, 4.7-9.3 uEm^{-2}s^{-1}). Unilateral eyestalk ablation was performed on all male *P. vannamei* in one of each pair of tanks within a treatment. In addition, half of the females in each tank were unilaterally ablated. Ovarian maturation, spawning, molting rate, and survival were monitored daily within each tank. Growth and gonad development were measured at termination. The optimum light intensity for *P. stylirostris* appeared to be lower than that for *P. vannamei*. *P. stylirostris* matured and spawned more frequently in the skylight and dim treatments than in the moderate, dark, and bright treatments. *P. vannamei* matured and spawned more frequently in the skylight, bright, and moderate treatments than in the dim and dark treatments. Natural light supplementation beneficially affected reproduction of both species. Male eyestalk ablation increased gonad size and doubled mating frequency of *P. vannamei* in comparison to unablated controls. This is the first documentation of increased penaeid shrimp reproduction by unilateral eyestalk ablation of males. Even more significant may be recognition that male gonadal development is a limiting factor in reproduction of shrimp in capacity.

Consumption of Frozen and Live Artemia by Protozoea of *Penaeus setiferus*. Joshua A. Wilkenfeld, Joe M. Fox and Addison L. Lawrence. In *Journal of World Mariculture Society*, 12(2): 250-259 (1981). $1. **TAMU–SG–85–804.**

The role of an animal component in the diet of protozoeal penaeid shrimp larvae is not known. Short-term experiments were performed on the larvae of *Penaeus setiferus* (L.) to determine the ability of each protozoeal substage to consume frozen and live *Artemia* nauplii. Significant consumption of frozen *Artemia* took place during the protozoea 2 and 3 substages at rates of 1.0 and 1.6 Artemia nauplii/penaeid larva/hour respectively. Consumption of live *Artemia* occurred in the protozoea 3 substage, at a rate of 0.7 *Artemia* nauplii/penaeid larva/hour. Data suggesting that there is a beneficial role of an animal component in the diet of protozoeal penaeid shrimp larvae are discussed.

Nocturnal Activity of Birds on Shrimp Mariculture Ponds. Jeffrey L. Beynon, David L. Hutchins, Anthony J. Rubino, Addison L. Lawrence and Brian R. Chapman. In *Journal of World Mariculture Society*, 12(2):63-70 (1981). $1. **TAMU–SG–85–805.**

Birds can reduce production of shrimp in mariculture grow-out ponds through predation and competition for feed. This study involved weekly nocturnal enumeration of bird populations and observation of nocturnal avian habits on a series of 0.1 ha experimental ponds at the Texas A&M University Shrimp Mariculture Facility at Corpus Christi, Texas. Observations were conducted hourly from sunset to sunrise during October through December 1980. The rate of predation was evaluated every three hours by comparing the number of feeding attempts to the number of successful prey captures over a known time period. Gulls (Family Laridae) acted primarily as competitors for feed. Active feeding by gulls was restricted to daylight hours, consequently feed loss decreased when the feed was distributed at or after dusk. Major predatory birds included herons and egrets (Family Ardeidae), migratory ducks (Family Anatidae), and, to a lesser extent, grebes (Family Podicipedidae) and shorebirds (Order Charadriiformes). Bird predation decreased pond production by 75 percent in some ponds.

Comparison of Unilateral Eyestalk Ablation with Environmental Control of Ovarian Maturation of *Penaeus stylirostris*. George W. Chamberlain and Neil F. Gervais. In *Journal of World Mariculture Society*, 15:29-30 (1984). $1. **TAMU–SG–85–818.**

Reproduction in captivity remains one of the largest obstacles impeding the growth of the penaeid shrimp farming industry. Temperature and photoperiod regimes have been used as an alternative to hormonal control of reproduction for a host of fishes and for some shrimp. The objective of this study was to compare the reproductive performance of unilaterally ablated *P. stylirostris* with unablated animals from the same population exposed to an increasing temperature and photoperiod regime. Offspring of eyestalk-ablated *P. stylirostris* obtained from the Gulf of California, Mexico, were

raised in ponds to a mean weight of 51 g. Temperature and photoperiod were adjusted from initial levels in step-wise increments. Photophase was simulated using an automatic timer with reversing dimmer. When water temperature reached 25 °C, beginning ovarian maturation was observed in both ablated and unablated females. Daily spawning activity began when temperatures reached 26 °C and continued for the remaining three months. Preliminary results indicate that environmental manipulation compares favorably with eyestalk-ablation in terms of survival, maturation rate, fecundity, and hatching rate.

1985-86

Raising Mudminnows. Kirk Strawn, Peter W. Perschbacher, Robert Nailon, George Chamberlain. May 1987. 8 pages. **TAMU-SH-86-506.** (Rev. May 1992).

The gulf killifish (*Fundulus grandis*), known in Texas as the mudfish or mudminnow and in Alabama as the bullminnow, is a highly desired live baitfish for saltwater fishing. While most effective, and consequently most desired, for flounder, it is used successfully for all major sportfish, especially in areas where live bait shrimp are not readily available. Growing numbers of fishermen and greater awareness of this bait have caused an increase in demand. This, coupled with an erratic and declining supply of wild-caught mudminnows, provides an opportune environment for culture of this fish. This fact sheet details the general characteristics, spawning technique, two- and three-pond systems, feeding and fertilization, harvesting, farm size and marketing procedures.

Relationships Between Trawl Catch and Tow Duration for Penaid Shrimp. Chittenden, Carothers. *Transaction of the American Fisheries Society* 114: 851-856, 1985. **$1. TAMU-SG-86-804.**

The relationship between catch and trawling effort was explored for *Penaeus aztecus, P. setiferus,* and *P. duorarum.* Tow durations of 5, 10, 15, 20, 25, and 30 min bottom time were examined, and data were analyzed with orthogonal polynomials in a randomized complete block design. We found a significant linear relationship between catch and tow duration, which is consistent with the assumption of a constant catchability coefficient. However, tow duration accounted for only a small proportion of the total variation in catch. This indicates that catch-per-unit-effort indices of abundance may be improved when analyzed in statistical designs that consider other sources of variation in catch in addition to fishing effort. Scaling of catch data when tow durations vary is briefly discussed.

Survival, Metamorphosis & Growth of Larvae From Four Penaeid Species Fed Six Food Combinations. Lawerence, Juban. *Aquaculture,* 47 (1985) 151-162. **$1. TAMU-SG-86-806.**

Survival, metamorphosis and growth of four larval shrimp species, *Penaeus aztecus, P. setiferus, P. vannamei* and *P. stylirostris,* were compared after feeding six food combinations. The food combinations consisted of the diatoms, *Skeletonema costatum* and *Chaetoceros gracilis,* or the phytoflagellates, *Isochrysis* sp. and *Tetraselmis chuii,* alone or in combination with live *Artemia* nauplii. Post-larval survival, within each algal food type, was not improved by feeding *Artemia* beginning at the end of the second protozoeal versus the first mysis substage. In addition, larvae fed only algae survived as well as their counterparts fed *Artemia. P. stylirostris* was the only species tested which survived significantly better to the post-larval stage when fed diatoms rather than the phytoflagellates, regardless of treatment. Except for *P. stylirostris* fed phytoflagellates, metamorphic rates to the post-larval stage were not improved by feeding *Artemia* beginning at the second protozoeal versus the first mysis substage. All larval species fed phytoflagellates only rather than diatoms only were delayed metamorphically. Only for *P. stylirostris* did all the diatom treatments result in better metamorphic rates when compared with their phytoflagellate counterparts. Post-larval dry weights, for the four shrimp species studied, were improved when fed *Artemia* at the second protozoeal substage regardless of algal food type. Except for *P. aztecus,* growth was significantly better for all species fed the diatom treatments versus their phytoflagellate counterparts. Larval growth, in terms of biomass rather than survival and/or metamorphic rates, is a better measurement of the nutritional value of a larval diet.

Studies on the Use of Boiled Chicken Egg Yolk as a Feed For Rearing Penaeid Shrimp Larvae. Fuze, Wilkenfield, Lawrence. *The Texas Journal of Science,* Vol. XXXVII, No. 4, 1985. pp. 371-382. **TAMU-SG-86-813.**

The effectiveness of hard-boiled chicken-egg yolk as a food source for larval penaeid shrimp was examined. A small-scale experimental system was employed consisting of one-liter Imhoff cones and a synthetic seawater media. Larvae (*Penaeus setiferus* Linnaeus, *P. aztecus* Ives, or *P. vannamei* Boone) were stocked at a density of 100 per liter and reared from the protozoea-one (P_1) substage to one-day-old postlarvae (PL_1). The animals were fed various combinations of algal (*Chaetoceros gracilis* and *Skeletonema costatum,* or *Tetraselmis chuii*) and animal (*Artemia,* rotifers, and/or boiled chicken-egg yolk) foods, added at the P_1, P_2, P_3, or mysis-one (M_1) substages. Survival of larvae fed algae and egg yolk was equal to, or slightly worse than, survival of larvae fed algae only or algae plus *Artemia.* The more advanced the substage of shrimp larvae when the egg yolk was initially added to the algal diet, the faster was the rate of metamorphosis. In most cases, animals fed egg yolk and algae grew to the same mean dry-weights of PL_1 as those fed algae alone. For all treatments tested, larvae fed algae and *Artemia,* starting at the P_2 substage, grew to the largest mean dry-weights at the PL_1 substage. Larvae did not survive or metamorphose when fed egg yolk alone. Egg yolk did not improve survival, metamorphosis, or growth of animals fed *T. chuii* and rotifers. Overall, there was little evidence that egg yolk was nutritionally beneficial to the larval of the three species of shrimp using any of the different larval diets and experimental conditions evaluated in this study.

Uncertainty Consideration Resulting from Temperature Variation on Growth of Penaeus stylirostris in Ponds. Arye Sadeh, Christopher R. Pardy, Wade Griffin and Addison L. Lawrence. In *The Texas Journal of Science* 38(2):159-173 (1986). **$1. TAMU-SG-86-825.**

Consideration of temperature variations as stochastic factor in scheduling of stocking and harvesting of shrimp in a grow-out pond in Texas is treated. A biological model describing shrimp biomass growth in a pond, as a function of number, size, time and temperature, is adopted and modified to create a set of activities with expected income and associated variance. The economic analysis consists of ranking the activities when uncertainty is taken into consideration.

1986-87

Effect of Eyestalk Ablation on Spermatophore & Sperm Quality in *Penaeus vannamei*. Leung-Trujillo and Lawrence. *Journal of World Mariculture Society* (1985), 16: 258-266. **$1. TAMU-SG-87-806.**

The effects of eyestalk ablation on spermatophore and

sperm quality in *Penaeus vannamei* were investigated in bilaterally, unilaterally, and unablated males stocked at a 1:1 ratio with unilaterally ablated females. Males were evaluated for sperm quality by determining sperm count, percent of live sperm and percent abnormal sperm from males at the initiation of the experiment (baseline), and at the end of the 104-day experimental period. The bilateral treatment group was terminated at 56 days, due to excessive mortality. Data indicate that unilateral ablation enhances gonad weight, gonad index and spermatophore weight. Of critical importance is the fact that the unilaterally ablated males demonstrated a significantly higher mean sperm count (81.8 million) than both the unablated controls (31.9 million) and the bilaterally ablated males (39.4 million). Additionally, neither unilateral nor bilateral ablation caused a decrease in sperm quality. Sperm viability profiles (i.e., percent live, and percent abnormal) determined for all treatments were not significantly different from one another. Values determined for mean percent live sperm were: 89.0, 98.6, and 99.0%, while average percentage for abnormal sperm were: 10.5, 4.5, and 3.3 percent respectively for the control, unilateral, and bilateral treatments. These data suggest that unilateral eyestalk ablation enhances the reproductive capabilities of males by increasing sperm count, without diminishing sperm quality. The effects of these treatment manipulations on mating and hatch rate are briefly discussed.

Effects of Diet & Size on Growth, Feed Digestibility & Digestive Enzyme Activities...*Penaeus setiferus* Linnaeus. Lee, Lawrence. *Journal of World Mariculture Society* (1985), 16: 275-287. **$1. TAMU-SG-87-807.**

Relationships between protein level, size, apparent feed digestibility, digestive enzyme activities and growth of *Penaeus setiferus* were investigated during a 30-day growth trial. Small (3.7 g), medium (9.5 g), and large (14.7 g) shrimp were fed four isocaloric diets with varying protein levels. Apparent total dry matter digestibilities and apparent protein digestibilities were determined for small and medium shrimp. General and acid protease, trypsin, carboxypeptidase A and B, amylase, chitinase, non-specific esterase and lipase activities were also assayed for small and medium shrimp. Shrimp survival was unrelated to diet or size. Instantaneous growth rate, total dry matter and protein digestibilities decreased as shrimp size increased. Small shrimp fed the 22 percent protein diet grew the least but exhibited the highest enzyme activities, especially carbohydrases. Small shrimp fed the 38 percent protein diet displayed the highest dry matter digestibility. Medium shrimp fed the 30 percent protein diet exhibited the lowest survival and growth while medium shrimp fed the 22 percent protein diet exhibited the highest enzyme activities. Higher digestive enzyme activities on the 22 percent protein diet may be evidence of an adaptation to a diet containing less digestible proteins.

Growth, Feed Digestibility & Proximate Body Composition of Juvenile *Penaeus vannamei* and *Penaeus monodon* Grown at Different Dissolved Oxygen Levels. Seidman, Lawrence. *Journal of World Mariculture Society* (1985), 16: 333-346. **$1. TAMU-SG-87-808.**

Growth, feed digestibility (apparent total dry-matter digestibility), and proximate body composition of juvenile *Penaeus vannamei* and *Penaeus monodon* were evaluated at dissolved oxygen (DO) levels of 1, 2, 3, and 4 ppm at a mean temperature of 28°C. The four different DO levels were obtained by aerating different rates of nitrogen gas countercurrent to a constant flow of seawater. A standard formulated diet containing the marker material Cr_2O_3, an a mean 280 percent exchange of 30 to 32 ppt seawater per day were used. Initial wet weights of shrimp were 60.2 and 55.5 mg for *P. vannamei* and *P. monodon*, respectively. Final mean wet weights for shrimp maintained at 1, 2, 3, and 4 ppm DO level after a 16-day growth trial were 0.24, 0.40, 0.42, 0.46 g, and 0.16, 0.26, 0.29, 0.29 g for *P. vannamei* and *P. monodon*, respectively. For both species, a significant reduction in growth and in the instantaneous growth rate (k) was obtained at the lowest DO level. No significant differences were observed for apparent feed digestibility in either shrimp. Laboratory analysis revealed no differences in moisture and lipid content for both species, while protein content was found to differ only in *P. monodon* grown at different DO levels. A description of the experimental system and a discussion of the significance of the data to the production of shrimp in ponds is presented.

Preliminary Investigation of the Effects of Temperature, Bacterial Inoculation & EDTA on Sperm Quality in *Penaeus setiferus*. Bray, Laung-Trujillo, Robertson, Lawrence. *Journal of World Mariculture Society*. (1985), 16: 250-257. **$1. TAMU-SG-87-809.**

A 60-day preliminary study was conducted to determine whether excessive temperature, bacterial infection, or heavy metals contamination contributed to spermatophore and sperm deterioration in laboratory-held *Penaeus setiferus* males. Three treatments were tested in which: 1) culture water temperature was held at 25-26°C; 2) males were inoculated with a killed *Vibrio* sp. bacterin; and 3) EDTA (ethylenediaminetetraacetic acid) was added to culture water at 25 ppm. These were compared with a control treatment at mean ambient temperature of 29.1°C. A combination of males from the primary offshore breeding population (mean weight 43.9 g ± 1.78 S.E.M.) and young-of-the-year males (mean weight 24.5 g ± 0.83) were used. Mean baseline values (± S.E.M.) established at initiation were, per male: sperm count, $38.7 \times 10^6 \pm 10.165 \times 10^6$; percent abnormal sperm, 5.0 percent ± 1.13; and spermatophore weight, 0.103 g ± 0.0215. At the midpoint 30-day samples, mean sperm counts were significantly lower in the ambient and EDTA treatments. The chilled and inoculated treatments showed no decline in sperm counts during the first 30-day period, but the percentage of abnormalities had increased from 5.0 percent ± 1.13 in the baseline to 16.3 percent ± 9.94 and 57.0 percent ± 9.64, respectively. At termination (60 days), only the chilled treatment contained any males bearing sperm (33 percent of males sampled from the treatment), but sperm abnormalities ranged from 53-72%. Results indicate that parameters tested did not prevent decline in male reproductive condition over time.

1987-88

Laboratory Manual for the Culture of Penaeid Shrimp Larvae. Granvil D. Treece and Michael Yates. August 1988. 95 pages. **$20. TAMU-SG-88-202.** (*Available ONLY through Granvil Treece, Sea Grant College Program, 1716 Briarcrest Suite 702, Bryan, TX 77802.*)

This manual is designed as an aid to a short general introductory laboratory course in shrimp culture. In worldwide commercial shrimp aquaculture, penaeids primarily are cultured. Because *Penaeus vannamei* is the most popularly cultured species in the Western Hemisphere and is currently the most available, its culture is concentrated on here; however, for the most part, the techniques presented can be used in the cultivation of any penaeids. Where applicable, the differences between the specific taxa are mentioned. Exercises on the culture of algae and *Artemia* are included, along with technical sheets on sterilization the the use of the hemacytometer, autoclave, and light microscope.

1989-90

Governmental Permitting and Regulatory Requirements Affecting Texas Coastal Aquaculture Operations. M. Hightower, C. Branton, G. Treece. 1990. 69 pages. $10.00. **TAMU-SG-90-504.**

A significant number of federal, state and local government agencies are involved in the regulation of an aquaculture operation. This involvement includes site selection, facility design and construction, operations, stock acquisition, production, processing, and marketing. In most cases, regulatory difficulties arise because of inadequate planning, lack of knowledge of the process by the applicant, and incomplete information concerning the agencies' respective requirements. In view of the need to provide prospective aquaculturists, as well as established operators who may wish to expand, with information and sources of contact regarding applicable government agencies, this manual lists each federal and state agency that has been determined to have authority over aquaculture operations. Under each agency heading are descriptions of the agency's role, responsibility and regulatory requirements.

Handbook of Shrimp Diseases. S.K. Johnson. 1989 25 pages. $2. **TAMU-SG-90-601.**

This handbook is designed as an information source and field guide for shrimp culturists, commercial fishermen, and others interested in parasites or abnormal conditions of shrimp. In addition to descriptions and illustrations of the common parasites and commensals of commercial penaeid shrimp, the publication includes information on the life cycles and general biological characteristics of these disease-producing organisms that spend all or part of their life cycles with shrimp. Several conditions of unknown cause are also described.

Red Drum Aquaculture. Compiled by Dr. G.W. Chamberlain, Dr. R.J. Miget and M.G.Haby. 1990. 236 pages. $15. **TAMU-SG-90-603.**

This practical guide is a revised and updated manual based on presentations at the 1987 Red Drum Aquaculture Conference held in Corpus Christi, Texas. The introduction and overview features "The Life History of Red Drum," "Status of the Commercial and Recreational Fishery" and "Development of an Aquaculture Industry: The Catfish Industry." The book also included chapters on Spawning Technology; Fingerling Production Technology; Biological, Engineering and Regulatory Aspects; and Growout Technology. There is also an annotated bibliography of publications related to red drum and a summary listing of state and federal sources of information and assistance. Numerous charts, graphs, photos and drawings help the reader understand the complexities of raising red drum.

1990-91

Practical Manual for Semi-intensive Commercial Production of Marine Shrimp. Jose R. Villalon. 1991. 104 pages. $15. **TAMU-SG-91-501.**

Shrimp farming, the production of marine shrimp in impoundments or ponds, has developed rapidly in recent years. More than 40 countries around the world now raise shrimp in ponds, and shrimp farmers now produce 25 percent of the shrimp placed on world markets as compared with only 2 percent in 1980. This expansion has been characterized by development of improved technology, which has resulted in more efficient production operations. This manual defines the basic principles and most important steps in the pond culture of marine shrimp. Variations of these techniques and principles can be used at different locations with different species for both semi-intensive and, to some extent, intensive culture systems. The book, tailored specifically for the field operator, describes the methods used by a private company on a commercial scale to raise penaeid shrimp successfully in earthen ponds from the fry or postlarval stages to market size.

Business

1971–72

Extended Results on Optimal Investment Strategies in Shrimp Fishing. R. L. Sielken, Jr., R.G. Thompson and R.R. Wilson. December 1972. 27 pages. $1. TAMU–SG–72–211. NTIS–73–10155.

A method of obtaining optimal investment strategies for shrimp fishermen is developed and illustrated in this report. It is designed to enable shrimp fishermen with a given amount of capital to obtain guidelines for financial decision making. Basis for the method is a deterministic optimal control model of a shrimp fishing firm. This model is explained. Parameters and initial stated values which characterize the environment in which the shrimp fishing firm is assumed to be operating are defined and discussed.

1972–73

Marketing Research. Dewayne Hollin. April 1973. 4 pages. TAMU–SG–73–502.

This bulletin provides for owners and managers of marine-related small businesses a discussion of six basic marketing research procedures: problem definition, preliminary investigation, research planning, information collection, information interpretation, decision making. A list of free publications with marketing research suggestions is included.

1973–74

An Evaluation of a Proposed Solution for the Marine Insurance Problems of the Texas Shrimping Industry. Wayne E. Etter. August 1974. 41 pages. $2. TAMU–SG–74–202. NTIS–COM–74–10181.

This publication is the text of an address by Richard I. Hoskins, Gulf Oil Company Vice President for Marine Operations, which was delivered May 10, 1974, at the Licensing, Commissioning and Awards Ceremony of the Texas Maritime Academy of the Texas A&M University Moody College of Marine Sciences and Maritime Resources.

Financial Planning for the Texas Port System. Wayne E. Etter and Robert C. Graham. March 1974. 81 pages. $3. TAMU–SG–74–210. NTIS–COM–74–11429/AS.

This study evaluates the ability of seven Texas ports to secure sufficient funds to finance needed capital improvements. Port financial projections are presented through 1990 and governmental powers of the Texas ports are reviewed. Present sources of funds are surveyed and the possibility of future state support for port system development is considered.

Planning Business Expansion. Dewayne Hollin. December 1973. 4 pages. TAMU–SG–74–501.

This bulletin provides owners of marine-related industries with factors to be considered in planning an expansion of their businesses and gives representative examples of marine-related industrial firms experiencing expansion. A list of publications with additional information on business expansion is included.

1975–76

Utilization of Finfishes Caught Incidental to Shrimp Trawling in the Western Gulf of Mexico, Part II: Evaluation of Costs. John P. Nichols, Melvin Cross, Vito Blomo and Wade L. Griffin. January 1975. 42 pages. $2. TAMU–SG–76–203. NTIS–PB–251–192/AS.

This report presents estimates of the cost of operating several alternative systems for holding and landing finfish caught incidental to shrimp trawling operations. Freezer units, brine immersion tanks, an on-board fish meal plant, an extra crew member and a mother-ship concept are the systems evaluated. Break-even prices are estimated that would be necessary to cover operating costs and a 10 percent return on investment.

1976–77

Marine Products Liability. Ed Bluestein, Jr. and Charles E. Hayden. October 1976. 8 pages. TAMU–SG–77–501.

Products liability is the legal liability in damages of those who deal in products or services which, when defectively made or rendered, injure the person or property of those who use of are otherwise affected by them. Two aspects of marine products liability are examined in this advisory bulletin: products liability law and products liability loss control.

1977–78

Maritime Law and the Small Boatowner. Leonard C. Jacques. June 1978. 8 pages. TAMU–SG–78–501.

This marine advisory bulletin is a reprint of a two-part article which appeared in the May/June and July/August 1977 issues of *Case and Comment* magazine. The article is designed not only for the land-locked lawyer but also for the consumer in need of legal advice in maritime matters. Areas examined through case studies include purchase and sale of boats, co-ownership, maritime liens, governmental regulation, insurance, maritime torts, liability, chartering of boats, rules of the road, boat safety laws and salvage. A checklist providing advice to boatowners concludes the eight-page bulletin.

1978–79

Vessel Long-Term Financing. Dave S. Miller. April 1979. 12 pages. TAMU–SG–79–502.

This marine advisory bulletin is based on a talk presented at a marine industry management workshop in Corpus Christi during March 1979. It provides an in-depth look at five alternatives to financing a million dollar vessel: bank debt. Title XI financing, commercial finance company, privately placed long-term debt, and leasing. The bulletin is supplemented by six pages of tables which evaluate and compare these alternatives according to terms and conditions of each, tax effects, closing costs, negotiation processes, depreciation, repayment schedules, prepayment penalties, restrictive covenants, vessel ownership and total cash outflow.

1979–80

Texas Charter Fishing–Bay and Gulf. Steven A. Woods and Robert B. Ditton. September 1979. 4 pages. TAMU–SG–80–504.

Thirty-five Texas bay and Gulf charter fishermen were interviewed in 1976 to obtain financial data about the day-to-day operations of the average charter fisherman in each area. From that information, a representative profit and loss statement for each type of operation was developed as a guide for the prospective charter operations investor. This marine advisory bulletin includes statistical information and sample profit and loss statements for both bay and Gulf charter fishing operations.

1982–83

Marine Offshore Outlook–1983. Dewayne Hollin (comp.). June 1983. 26 pages. $5. **TAMU–SG–83–504. NTIS–PB–83–216–630.**

Discussions at the 1983 Marine/Offshore Industry Outlook Conference in Houston, Texas, are summarized. This yearly conference, sponsored by the Texas A&M University Sea Grant College Program and the Marine Services Association of Texas, is one of the most popular seminars offered to the industry. Topics at the 1983 meeting included market supply and demand, regulatory problems and trends, technological developments, labor availability, financial trends and special problems and opportunities in today's marine/offshore industries. Included in the summary are remarks from G. Allen Brooks, vice president, Offshore Data Services, Inc.; Damon B. Bankston, president, Tidewater, Inc.; I.R. Foster, Jr., senior vice president, McDermott Marine Engineering, McDermott Inc.; John R. Huff, president, Western Oceanic, Inc.; J. Wesley Rogers, president, Oceaneering International, Inc.; David S. Holland, senior vice president, exploration, Pennzoil Exploration and Production Company; Frank J. Iarossi, president, Exxon Shipping Company; Lester V. Martin, general manager, Todd Shipyards Corporation, Galveston Division; and R. Jere Shopf, president, Halter Marine, Inc.

1983–84

Marine Offshore Outlook–1984. Dewayne Hollin (comp.). June 1984. 24 pages. $5. **TAMU–SG–84–509.**

This is an executive summary of what industry experts were saying in the first part of 1984 about industry problems and trends in market supply and demand, regulatory problems and trends, technological developments, labor availability, and financial trends. The discussions were part of the 1984 Marine/Offshore Industry Outlook Conference in Houston, Texas. This conference, sponsored by the Texas A&M University Sea Grant College Program and the Marine Services Association of Texas, looked at trends through 1986. Included in the summary are remarks from Robert G. Burke, Offshore Magazine; K.W. Waldorf, Zapata Offshore Company; Ogden Thomas, Jr., Seahorse, Inc., Herb F. Hamilton, Raymond Offshore Constructors, Inc.; John V. Harter, Taylor Diving and Salvage Co., Inc.; B.S. Flowers, Shell Offshore, Inc.; Robert E. Bradbury, Marathon Marine Engineering Co.; Berdon Lawrence, Hollywood Marine, Inc.; Neal S. Platzer, Platzer Shipyard, Inc.; and James G. Tompkins, III, Lykes Bros. Steamship Co., Inc.

1984–85

Marine Offshore Outlook–1985. Dewayne Hollin (comp.). April 1985. 33 pages. $5. **TAMU–SG–85–502.**

Remarks presented by top executives at the 1985 Marine/Offshore Industry Outlook Conference are summarized here. A panel previewed the market for marine and offshore equipment operators, and a second panel summarized the outlook for offshore and marine equipment builders, repairers and support service industries. Equipment operator panelists were William E. Chiles, Chiles Drilling Co.; Dr. Philip Oxley, Tenneco Oil Exploration and Production; Joseph H. Pyne, Dixie Carriers, Inc.; and Kenneth W. Waldorf, Zapata Gulf Marine Corporation. Members of the second panel were Carl A. Wendenburg, Marathon LeTourneau Offshore Co.; Bruce Gilman, Sonat Subsea Service, Inc.; John Dane, III, Moss Point Marine, Inc.; and A.B. Crossman, Brown and Root International, Inc.

1985-86

Marine/Offshore Industry Outlook - 1986. Dewayne Hollin (comp.). May 1986. 35 pages. $5. **TAMU–SG–86-111.**

These remarks were presented at the 1986 Marine/Offshore Industry Outlook Conference in Houston. The annual conference in sponsored by the Texas A&M University Sea Grant College Program and the Marine Services Association of Texas. William J. Johnson, president of Standard Oil Production Co., gives a two-year forecast for the oil and gas industries from an exploration and development standpoint. An overview of energy developments related to the oil and gas exploration and production industry, recognized marine/offshore industry leaders discuss how developments in the energy industry will impact on the following specific industry segments: offshore drilling, marine/offshore equipment fabrication and manufacturing.

Fishing Tournament Information and Retrieval System Manual. Raymond L. Bartley. September, 1985. 62 pages. $5. **TAMU-SG-86-603.**

This manual accompanies the Fishing Tournament Information and Retrieval System (FTIRS), a generic tournament software program that computerizes the record-keeping functions of fishing tournaments, both salt and freshwater. The software can be used to develop background marketing information and produce a list and mailing labels for promoting future tournaments. The software can also be tailored to individual tournaments. The manual is written in simple, understandable form for individuals without computer or programming experience. Persons interested in the software should first read this manual to learn the software's capabilities and insure hardware compatibility. A detachable software order form is included in each manual. **Important:** to ensure hardware compatibility, persons should read through and complete the form before ordering the system software.

1987-88

1988 Directory of Texas Shipyards. Dewayne Hollin, compiler. June 1988. 11 pages. No charge for single copies. **TAMU-SG-88-605.**

Organized by port/city, this directory lists nearly 70 shipyards with facilities ranging from small to huge. Entries list address, phone number, management, services, facilities, and specializations where appropriate.

Economics

1970–71

Work Plan for a Study of the Feasibility of an Offshore Port Terminal in the Texas Gulf Coast Region. Dan M. Bragg and James R. Bradley. June 1971. 30 pages. **TAMU–SG–71–212. NTIS–COM–71–00876.**

Recent trends in ship sizes threaten to make existing Texas ports obsolete, and there has developed a growing need for a port with water depth adequate to handle larger ships. A necessary prerequisite to constructing such a port is the study of its physical and economic feasibility. The work plan described here identifies individual studies required. Estimated cost of these studies is $460,000, and total time required should not exceed 18 months.

Port and Harbor Development System. Russell L. Stogsdill. November 1971. $4. **TAMU–SG–71–216. NTIS–COM–72–10238.**

Containerization, supersized vessels, ocean-going barges and new cargo handling techniques are but a few of the most recent developments to which ports must respond. Another, spawned by necessity and massive social pressure, is the need for preserving environmental balance. Clearly, ports and harbors of the future must be planned and designed to accommodate change. The purpose of this report is to aid those who are involved in and responsible for port and harbor planning and design. It is hoped that through the use of the guidelines presented herein, marine facilities may be developed which are more rational, flexible and thus more functional.

1971–72

The Economic Impact of Deepwater Terminal in Texas. Daniel M. Bragg and James R. Bradley. November 1982. 55 pages. $3. **TAMU–SG–72–213. NTIS–COM–73–10514.**

This report is the first known effort to assess the economic multiplier effect of an offshore, bulk-unloading ship terminal in the United States. The primary impact of a Texas deepwater liquid-bulk terminal will be reflected in growth of the oil refining and related industries in the state. Discussion considers not only what effects are expected to result from construction and operation of the facility, but also what may happen to the state's economy if the terminal is not built. A study area is defined, a methodology for economic impact determination is established, and the nature of the inputs into the Texas Input-Output Model are described.

1972–73

Economic Analysis of the Petrochemical Industry in Texas. Norman C. Whitehorn. May 1973. 78 pages. $3. **TAMU–SG–73–203. NTIS–COM–73–11409.**

Based on data collected from 74 Texas petrochemical firms for the year 1971, this study attempts to determine the petrochemical industry's total economic impact upon the economy of Texas by analyzing employment and payrolls, sales, value added to manufacture, capital expenditures and investments according to the multiplier concept. Major factors concerning raw materials, markets, transportation and the economic outlook for the petrochemical industry in the future are discussed.

Texas Waterborne Commerce Commodity Flow Statistics. Jack T. Lamkin, W.R. Lowery. June 1973. 115 pages. $3. **TAMU–SG–73–207. NTIS–COM–74–10083.**

Data developed and depicted in 17 figures and 88 tables provide information on the importance of waterborne commerce, especially that moving over the intracoastal and inland waterway system, to the Texas economy.

1973–74

Primary Economic Impact of the Gulf Intracoastal Waterway in Texas. John Miloy and Christian Phillips. March 1974. 203 pages. $3. **TAMU–SG–74–211. NTIS–COM–74–11552/AS.**

A study to identify and quantify marine-related activities of the Waterway that contribute directly to the economy of Texas is reported. In addition to analyses of current and future economic impact, particular emphasis was placed on history, land use, commodity flows, industrial users and technological innovations relating to the Waterway.

A Survey of the Economic and Environmental Aspects of an Onshore Deepwater Port at Galveston, Texas; Part I: Potential Economic Effects; Part II: Environmental Considerations. D. Bragg, R. Hann, Jr. and W. James. April 1974. Part 1 - 57 pages. $3. Part II - 45 pages. $3. **TAMU–SG–74–213** and **214. NTIS—COM–74–11030/AS** and **COM–74–11031/AS.**

Results of a brief, organized effort to assess the nature and magnitude of the two main factors that significantly affect decisions made concerning onshore deepwater port facilities are reported. In Part I economic effects are discussed, and in Part II, the environmental implications of this project are covered.

Indirect Economic Effect From Intracoastal Waterway Commerce in Texas. Christian Phillips. July 1974. 115 pages. $3. **TAMU–SG–74–218. NTIS–COM–75–10065/AS.**

This report evaluates effects of marine-related activities on non-basic sectors of the economy. Emphasis was placed on industrial development relating to numerous, inexpensive services provided by water transportation. Determination of indirect economic effects was based on an initial calculation of the Gulf Intracoastal Waterway's contribution to the five coastal standard metropolitan statistical areas. Included are discussions of historical trends, population, employment, income, industrial growth, effects of World War II, indirect economic stimuli and transportation.

1974–75

Impact of Commercial Shrimp Landings on the Economy of Texas and Coastal Regions. Lonnie L. Jones, John W. Adams, Wade L. Griffin and Jeffrey Allen. December 1974. 18 pages. **TAMU–SG–75–204.**

Amount of economic activity generated by the shrimp industry for the state of Texas and for three coastal regions in Texas is estimated in this report. In 1971, the value of commercial shrimp landings in the state of Texas was $63.9 million. In the coastal regions of Brownsville-Aransas Pass, Port Lavaca-Galveston and Beaumont-Port Arthur, this value was $37.6, $23.6 and $2.7 million, respectively. Direct, indirect and induced impacts of commercial shrimp landings are estimated.

1975-76

Cost-Efficient Cargo Distribution Among Transportation Modes. Christian Phillips. March 1976. 78 pages. $3. **TAMU–SG–76–206. NTIS–PB–253–969/AS.**

Operational efficiency of transportation network connecting five selected locations that are accessible by rail, truck and barge modes is evaluated. Costs of moving the existing and anticipated flow of commodities on the Texas Intracoastal Waterway are determined. It is hypothesized that the present method of distributing chemicals, fuel, primary iron and steel products among specified locations is inefficient. A linear programming model is formulated to minimize total cost of distributing a given volume of commodities among specified locations.

1976–77

Mexico's 200-Mile Offshore Fishing Zone: Its Impact on the U.S. Gulf of Mexico Shrimp Fishery. Wade L. Griffin and Bruce Beattie. August 1977. 35 pages. $2. TAMU–SG–77–210. NTIS–PB–273–665/AS.

The expected economic impact of the 200-mile extended jurisdiction limit by Mexico on the U.S. shrimp fleet was explored. Average annual shrimp catch and effort expended by the U.S. fleet in Mexican waters are estimated. Economic effect of the U.S. shrimp fishery due to shifting the effort from Mexican waters to U.S. waters is estimated in terms of rent loss to the fishery and break-even product prices required to achieve open-access equilibrium.

1977–78

Economic and Production Aspects of the Gulf of Mexico Shrimp Fishery. John P. Nichols, Wade L. Griffin and Vito Blomo. June 1978. pp. 301-315. $1. TAMU–SG–78–801. NTIS–PB–286–071/AS.

This originally appeared as a chapter in the book *Drugs and Food From the Sea - Myth or Reality?*, edited by P.N. Kaul and C.J. Snidermann and published by the University of Oklahoma Press. It includes a discussion of the U.S. shrimp industry since 1950 and the Gulf of Mexico shrimp fishery. Trends in fishing effort, landings catch per unit effort, and costs and returns are discussed for the period 1962 - 1974.

1978–79

Costs and Returns Data: Texas Shrimp Trawlers Gulf of Mexico, 1974-1975. Wade L. Griffin, John P. Nichols, Robert G. Anderson, James E. Buckner and Charles M. Adams. September 1978. 97 pages. $4. TAMU–SG–79–601. NTIS–PB–294–837/AS.

This report summarizes estimates of costs and returns for vessels of different characteristics that anchor in Texas and shrimp-trawl in the Gulf of Mexico. Data for 1974 and 1975 were obtained from vessel owners. Results are presented in self-explanatory tables. No attempt is made to draw inferences or discuss implications of trends, or relationships, which may be apparent in the data.

Costs and Returns Data: Florida-Based Gulf of Mexico Shrimp Trawlers, 1977. Vito J. Blomo and Wade L. Griffin. October 1978. 34 pages. $3. TAMU–SG–79–604. NTIS–PB–292–193/AS.

This report summarizes estimates of costs and returns for vessels of different characteristics that anchor in Florida and shrimp-trawl in the Gulf of Mexico. Data for the calender year 1977 were collected from vessel owners. Results are presented in self-explanatory tables. No attempt is made to draw inferences or discuss implications of trends, or relationships which may be apparent in this data.

1979–80

Economic Impacts of Recreational Boat Fishing in the Houston-Galveston Area of the Texas Coast. R.B. Ditton, A.R. Graefe and G. Lapotka. September 1980. 46 pages,16 tables. $2. TAMU–SG–80–206. NTIS–PB–81–140–980.

The saltwater fishing patterns and economic impacts generated by recreational boat fisherman in the Houston-Galveston area of the Texas coast were investigated. Data were obtained through a mail survey of registered boat owners residing in an 8-county area surrounding Galveston Bay. Saltwater boat fishermen spent more than $31 million for their fishing trips in 1978, with bay fishermen spending $26,460,000 and offshore fishermen spending $5,046,000. Non-local bay fishermen spent $7,439,000 in bayshore communities and non-local offshore fisherman spent $1,970,000 in coastal communities. The economic impact of saltwater boat fishing trips in the region was $79,751,000. Also discussed are other factors to be considered when assessing the values and benefits of saltwater boat fishing.

Costs and Returns Trends in the Gulf of Mexico Shrimp Industry, 1971–78. John P. Warren and Wade L. Griffin. In *Marine Fisheries Review*, February 1980. pp. 1-7. 4 figures, 5 tables. TAMU–SG–80–817.

The profitability for Gulf shrimp vessels in recent years has been highly variable, due largely to changes in input costs; shrimp prices; landings; and the cost, financing terms, and configuration of vessels. It has also been shown that based both on the results of very good years and on the results of a number of highly varied years, ownership of a Gulf shrimp vessel can be a satisfactory investment over an extended ownership period.

1982–83

A Generalized Budget Simulation - Installation Manual for Budget Simulation System. Wade L. Griffin, Charles M. Adams, Linda A. Jensen. October 1983. 92 pages. $3. TAMU–SG–83–201

This manual describes the installation and testing of either the Aquaculture Budget Simulation System or the Vessel Budget Simulation System. The basic designs of each system is similar enough that installation procedures are the same except for reference-to-file names specific to one system or the other. This manual is written in general terms; specific references to the individual systems are in the tables. It is designed to be used in conjunction with the specific operating manuals for aquaculture (TAMU–SG–83–202) or vessels (TAMU–SG–83–203).

A Generalized Budget Simulation Model for Aquaculture. Wade L. Griffin, Charles M. Adams, Linda A. Jensen. October 1983. 113 pages. $5. TAMU–SG–83–202. NTIS–PB–83–144–626.

The Aquaculture Budget Simulator System enables a user to build and operate a model of an aquaculture or mariculture facility. The primary use of this system will be to create budgetary information to aid potential investors in decision making and to provide a tool for economic research efforts concerning aquaculture. This system consists of two programs, a data management program in COBOL and a budget simulation program in FORTRAN. This manual describes the use of each. It is intended to be used in conjunction with the separate installation manual (TAMU-SG-83-201).

A Generalized Budget Simulation Model for Fishing Vessels. Wade L. Griffin, Linda A. Jensen, Charles M. Adams. January 1983. 120 pages. $5. TAMU–SG–83–203. NTIS–PB–83–171–771.

The Vessel Budget Simulator System enables a user to

select and equip a vessel to be operated in any fishing ground normally frequented by U.S. owned vessels. The physical flow of inputs into the production process aboard a vessel is simulated to produce the information required for financial reports. The system consists of two programs, a data management program in COBOL and a budget simulation system in FORTRAN. This manual describes the use of each. It is intended to be used in conjunction with the separate installation manual (**TAMU–SG–83–201**).

User Guide for General Bioeconomic Fishery Simulation Model (GBFSM). Wade Griffin and William E. Grant. April 1983. 117 pages, 14 figures. $5. **TAMU–SG–83–204. NTIS–PB–83–205–088.**

This manual describes a General Bioeconomic Fisheries Simulation Model (GBFSM) designed for use in management programs of marine fish species that do not exhibit a significant relationship between the size of the parental population and the number of young recruited into the fishery. The purpose of GBFSM is to predict how alternate management policies will affect a fishery. GBFSM's design is versatile enough to be applicable to a wide range of fisheries.

1985-86

Implications of Investing Under Different Economic Conditions on the Profitability of Gulf of Mexico Shrimp Vessels Operating Out of Texas. Ernest Tettey, Christopher Pardy, Wade Griffin and A. Nelson Swartz. In *Fishery Bulletin* 82(2): 365-373 (1984). $1. **TAMU-SG-86-809.**

Due to the inflationary trend in recent years coupled with fluctuating shrimp prices, the shrimp business has become a highly uncertain undertaking. The financial performance of a sample of the Gulf of Mexico shrimping fleet, operating out of the Texas coast, was examined over a 10-year period (1971-80). The results indicate that investments made in the early part of the 1970s performed better than those made in the latter part. Periods of low inflationary levels appeared to be more favorable to investments in the shrimp fishery than periods of high inflationary levels. In terms of economic profits, steel vessels generally did better than wooden ones. Medium-sized vessels were the most efficient vessels to operate in the Gulf of Mexico.

Implications of Tax policy on Investment in a Common-Property Resource. Tettey, Griffin, Penson, Stoll. North *American Journal of Fisheries Management* 6:100-104, 1986. **TAMU-SG-86-834.**

This study employs a financial model to examine the aggregate investment expenditures for Gulf of Mexico shrimp vessels. Specifically, the impacts of tax policies—investment tax credits and income taxes—on investment decisions in the Gulf shrimp fishery are evaluated. Contractionary tax policy is an effective tool in limiting entry to the shrimp fishery and, thereby, controlling the problem of overcapitalization. Decreases in the investment tax credit rate, increases in the income tax rate, or a combination of both policies will curtail investment activities in the fishing industry. Implementation of such tax schemes should raise total revenues of vessel owners, in the long run, from what they otherwise would have been.

Economics of Penaeid Culture in the Americas. Wade Griffin, Addison Lawrence and Michael Johns. In *Proceedings of the First International Conference on the Culture of Penaeid Prawns/Shrimps.* 1984. SEAFDEC Aquaculture Department. pp. 151-160. $1. **TAMU-SG-86-835.**

Investment and production costs are examined for a semi-intensive farm that purchases postlarvae and operates in the southern United States. Total investment decreases as pond size increases for a given size facility. Investment per kilogram of annual average production ranges from just under US $20.00 for a 20-surface ha farm using 2-ha ponds to $80.00 for a 400-ha system using 20-ha ponds. Operation costs per kilogram decline as the size of the system and the size of the ponds increase. It costs $10.10 to produce one kilogram of shrimp on a 20-surface ha farm using 2-ha ponds compared to $5.50 on a 400-surface ha farm using 20-ha ponds. In comparing the operation of a semi-intensive 200-ha farm in Ecuador with a similar farm in the United States, costs of production were $3.12 and $5.83 per kilogram, respectively. The after-tax internal rate of return (IRR) was 59 percent in Ecuador and 21 percent in the United States. These IRRs were calculated under the assumption that production, costs and prices received are constant over the investment period (10 years) considered. When risk and timing of investment are considered, these IRRs are reduced.

1988-89

The Gulf Coast Intracoastal Waterway. W. Younger. 1989. 7 pages. Single copies free. **TAMU-SG-89-103.**

The GIWW is an integral part of the total inland transportation system of the United States. Stretching for more than 1,300 coastal miles of the Gulf of Mexico, this manmade, shallow-draft canal moves a large variety and great number of vessels and cargos, supplying both domestic and foreign markets with essential goods. The canal provides access to sport and commercial fishing by physically connecting the bay systems of the coast. It also has been used as a recreational outlet for boating, birding, water skiing and other leisure pursuits. Although direct users are well acquainted with the GIWW, many others are unaware of the impact it has on their lives. This brochure describes the GIWW system.

1989-90

Texas Commercial Fisheries Profile. M. Haby, D. Hollin and M.C. Russell. 1989. 6 pages.No charge for single copies. **TAMU-SG-90-501.**

During 1988, Texas producers landed 96.5 million pounds of seafood products with a dockside value of $181.4 million. Total seafood production in Texas has averaged 97.9 million pounds valued at more than $180.5 million in the last 11 years. Total landings have ranged from 81.4 million pounds in 1979 to 116 million in 1986. Cumulative dockside value has ranged from about $148 million in 1978 to slightly more than $246 million in 1986. The Texas seafood complex is big business. The harvesting component alone employs 15,000 people, and there are about 7,500 vessels licensed to fish in Texas (as of 1987). On a statewide basis, Texas seafood production generates an annual economic impact of approximately $650 million. Statistics are given for various components of Texas' commercial fisheries, of which shrimp is by far the largest.

Education

1971–72

Industry's Interest in Ocean Engineering Education Programs. John B. Herbich. November 1971. 84 pages. $3. TAMU–SG–72–101. NTIS–COM–72–10305.

A survey was conducted to determine the viewpoint of industry regarding the subject matter which should be included in an ocean engineering educational program. Questionnaires were mailed to over 1,000 individuals. Twenty-seven percent of the replies received indicated involvement in some aspect of ocean engineering. Results of the study are summarized in graph and tabular form.

Marine Affairs: The Student View. Roger D. Anderson. June 1972. 8 pages. TAMU–SG–72–513.

A synopsis of a conference in which 72 students met with 34 professionals to discuss marine activities at both the federal and state levels. Professional participants are identified along with brief descriptions of their activities.

1972–73

Second Student Conference on Marine Affairs. March 1974. 12 pages. TAMU–SG–74–503.

This publication contains the proceedings of Texas A&M's second Student Conference on Marine Affairs, September 23-25, 1973, presented in conjunction with A&M's Moody College of Marine Sciences and Maritime Resources and the Link Foundation and sponsored by the Sea Grant Program. Participants - students and professionals - considered a broad range of problems relating to management and development of coastal zone resources and career opportunities.

1976–77

Proceedings of the Third Student Conference on Marine Affairs. September 1976. 12 pages. TAMU–SG–77–502.

Activities at the Third Student Conference on Marine Affairs, held September 1975 in Galveston, Texas, are summarized. Topics included "Energy From the Sea," " Coastal Area Management," "Recreation and Tourism," "Seafood - Technology and Marketing," "Law of the Sea," "Marine Operation and Management," "Seaward Expansion" and "Education - Personnel Needs and Opportunities." Keynote address was by Dr. Athlestan Spilhaus, special consultant, of the National Oceanic and Atmospheric Administration. The conference was sponsored by the Texas A&M University Sea Grant College Program and the Link Foundation. A list of the 69 students from 35 colleges and universities who attended is included.

1977–78

Living With The Sea: Proceedings of the Fourth Student Conference on Marine Affairs. September 1978. 12 pages. TAMU–SG–78–502.

The proceedings summarize panel discussions and activities of the Fourth Student Conference on Marine Affairs, sponsored jointly in October 1977 by the Texas A&M University Sea Grant College Program and the Link Foundation. Included are reviews of the presentations of 14 professional panelists and speakers, representing governmental, industrial, private and educational marine-related interests. Among the topics are the future of marine education, archaeological history under the sea, man's future in the sea, diving, seafood industry conflicts, recreational fishing, and a summary of conference panel sessions.

1978–79

Sea Sources: Bibliographic and Resource Material of Children's Literature of the Sea. Norma Bagnall. January 1979. Revised February 1981. 192 pages. $4. TAMU–SG–79–402. NTIS–PB–294–198.

Selected bibliographic and resource materials on the subject of children's literature of the sea are gathered in this useful compendium for teachers. The 192-page book includes five sections of text which begin with an introduction by the author. An annotated bibliography of children's literature of the sea lists 745 titles.

Trying to Marinate Your Curriculum? May 1992 (rev.) 7 pages. TAMU-SG-79-406 (rev.)

This brochure lists the teacher support publications now available through the Texas A&M Sea Grant Program. Listings are divided by books, brochures, posters and videos.

1979–80

Children's Literature - Passage to the Sea: A Guide for Teachers. Norma Bagnall. February 1980. 56 pages, 4 questionnaires, 22 pages of illustrations/patterns. $2. TAMU–SG–80–401.

This marine awareness learning package, for use in grades kindergarten through 7, is based on eight books by nationally recognized authors, including *Noah's Ark* by Peter Spier, *The Cay* by Theodore Taylor and *Island of the Blue Dolphins* by Scott O'Dell. At least one book is appropriate for each elementary grade and all have a sea or coastal setting. Each book is related to interest center activities which allow students to experiment with or express what they have learned from the book. Complete directions for 39 such activities are included, allowing teachers to select those most adaptable for their individual classrooms. The activities include kindergarten children building their own wooden replicas of ships to older children plotting latitude and longitude and tracking the path of a hurricane. Students also can learn seashell and marine flag identification, sea chanties, knot tying, net making and the elementary principles of physics and engineering which apply to flotation. The material is interdisciplinary; it contains activities related to language arts, music, art, science and social studies.

Vocational-Technical Marine Career Opportunities in Texas. Dewayne Hollin. March 1980. 22 pages, 7 photographs. TAMU–SG–80–402. NTIS–PB–80–206–071.

This publication is to assist high school counselors, teachers and students better understand the career opportunities available in the Texas marine industry. It provides background information and descriptions of jobs in the maritime transportation, offshore mineral, oil and gas, commercial diving, commercial fisheries and shipbuilding industries. Information about the training needed to enter particular positions also is included. Organizations and schools, with addresses, are listed at the end of each section for reference.

Marine Organisms in Science Teaching. John D. Hunt (ed.). September 1980. 198 pages. $4. TAMU–SG–80–403.

This laboratory-oriented workbook includes 42 activities for using living marine organisms in existing science programs. The activities are intended for grades 4 through 12, with the level of difficulty progressing with the grade level. The workbook is presented in a discovery type format which

includes two sections for the teacher (a pre-lab printed on green paper and a post-lab printed on yellow) and a student investigation section. The student sections are formatted to allow easy duplication on school copying equipment. The activities use such organisms as brine shrimp, oysters, ghost, fiddler and hermit crabs, sea anemones, mussels, barnacles and sponges. Instructions for establishing a living marine materials center within the classroom are included, as well as sources for acquiring the organisms.

1980–81

Fairy Tales of the Sea. Elizabeth Cowan and Karen Davis (comp.). February 1981. 152 pages, 9 original illustrations. $4.50. **TAMU–SG–81–402.**

This collection of fairy tales represents another in a vast resource of treasures from the sea. The world of the sea suggests legends, images, inspirations and poetry, and this collection provides readers with a healthy escape into the sense of beyond. It includes tales from very inhabited continents - America, Asia, Australia, Europe and Africa - so that American children (and adults) can enjoy their varied heritage. It is believed that this collection is the only volume of international folk and fairy tales exclusively about the seas. The tales range from the familiar such as Hans Christian Andersen's *The Little Mermaid* - to the lesser known - such as Pearl Buck's adaptation of *The Flying Ship*. Twenty-five tales are included. The book is designed in an easy-to-read format to allow even the youngest readers to enjoy the fairy tales. While the collection is complete in itself, there is an accompanying teacher's guide (TAMU-SG-81-403) which suggests varied classroom uses.

Fairy Tales of the Sea - Teacher's Guide. Donna Wiseman. February 1981. 28 pages. $2. **TAMU–SG–81–403.**

The communication potential of *Fairy Tales of the Sea* (TAMU-SG-81-402) lends itself to a language arts curriculum. Although many teachers are expected to use a set of basic texts, the collection offers an opportunity for teachers to originate and adopt ideas from a different literary source. The guide is written with objectives according to the English Language Arts Curriculum Framework suggested by the Texas Education Agency. Activities cover the language arts of listening, reading, speaking and writing. Although designed for grades 4 through 9, there are some activities suitable for younger or older students who are particularly motivated toward the study of the sea.

How to Set Up and Maintain a Saltwater Aquarium. Russell Miget. June 1981. 8 pages, 7 illustrations. **TAMU–SG–81–504.**

This pamphlet outlines the basic steps to establishing a saltwater aquarium anywhere in the country. Presented in as simple language as possible, with accompanying cartoon illustrations, the guide is designed for young children but is equally useful for older students and adults. Detailed instructions are given on the materials needed, food preferences, synthetic saltwater, filter systems and potential problems.

Marine Education Through Children's Literature. Norma Bagnall. In *Current/The Journal of Marine Education*, Vol. 1 No. 2, Winter 1980. pp. 5-8. **TAMU–SG–81–801. NTIS–PB–81–115–313.**

Originally printed in *Current/the Journal of Marine Education*, this article describes the pilot program and field testing that led to development of *Children's Literature–Passage to the Sea*. As detailed in the article, learning center activities were tested in 12 Texas elementary classrooms ranging from kindergarten through grade seven. The learning abilities of the participating students ranged from gifted to slow learners. All students were pre-tested to determine their knowledge of common sailor's knots, seashells, hurricanes, longitude and latitude and marine flags. They were later tested again after participating in the learning center activities to determine how much they had learned and the appropriateness of the material. Descriptions of the field test activities are included as well as the test, teachers' reactions to both the activities presented and the overall concept of marine education.

Without Losing the Wonder: An Interview With Jan Adkins. Norma Bagnall. In *Language Arts*, May 1980. pp. 560-566. $1. **TAMU–SG–81–802.**

In an interview originally printed in *Language Arts*, author-illustrator Jan Adkins gives insight into the imagination and humor that have created more than a dozen books for children and adults. Adkins is described as one not fitting a standard mold, an artist who counts each letter on a manuscript page to see that the finished product is aesthetically pleasing. He is also a man of definite ideas–on what children enjoy reading, on their innate creativity that Adkins feels often becomes stifled as they grow up, and on the value of lying to children. The latter idea may seem contrary to most concepts of child psychology, yet Adkins insists it develops "a person who has found that you must discover things for yourself" and that "faith is an overrated virtue."

Theodore Taylor: His Models of Self-Reliance. Norma Bagnall. In *Language Arts*. May 1980. pp. 86-91. $1. **TAMU–SG–81–803.**

Theodore Taylor believes a writer should rely on his own experiences, travels and observations for inspiration. In an interview originally printed in *Language Arts*, Taylor tells how many of his young protagonists are based on children he has met during years of traveling throughout the world. He is particularly adept at writing for young people, although Taylor says he never consciously tries to create a story for a specific age group. He says his characters such as Ben O'Neal, Phillip and Teetoncey are the kind of peer models that young people can like and respect. All also are self-reliant and self-sufficient, and Taylor believes young people like this type of person. He would hope these models aim his readers toward self-reliance of their own; if so, according to Taylor, he does a good job.

1981–82

Hurricane Warning! November 1981. 16 pages. **TAMU–SG–82–401.**

Owlie Skywarn talks about hurricanes in this revision of an earlier National Oceanic and Atmospheric Administration brochure. *Hurricane Warning!* is written for elementary students, and is printed in large type for easy reading. It tells of Hurricane Camille in story form, and includes a checklist of do's and don't's when a storm threatens. There is also a safety certificate (to be signed by a teacher or other adult), signifying that the student knows the appropriate safety rules. The original NOAA publication was for Florida on the East Coast; this one has been revised to show the Texas coastline and the tracking chart.

Venomous Marine Animals. July 1982. Poster. 24 1/4" X 18 1/4". $1. **TAMU–SG–82–403.**

The Gulf of Mexico is a great attraction to swimmers, boaters, fisherman and offshore workers. There are some marine organisms living in these waters, however, that are potentially dangerous and demand respect. This full-color poster is intended to help the lay person deal with this danger.

Ten categories of marine organisms are illustrated - jellyfish, catfish, rays, sea urchins, toadfish, stargazers, worm, sponge and octopus. The accompanying descriptions can help coastal residents and visitors become more aware of how problems with these animals might develop, how they can be avoided and how certain injuries should best be treated if they occur.

1982–83

Marine Education - A Seagoing Educational Experience. Richard K. Tinnin. December 1982. 28 pages, 3 data collection sheets. $1. TAMU–SG–83–401. NTIS–PB–83–167–296. ***Revised December 1987.***

This workbook was prepared as part of a working cruise program for high school students and teachers that is offered by The University of Texas Marine Science Institute at Port Aransas. The book also may be useful to high school and junior college science students and teachers who have access to a research vessel. Included are descriptions for the Corpus Christi Bay area and the study sites, field equipment, analytical procedures and data collection. Detailed instructions for on-board activities are given.

Life on Board American Clipper Chips. Charles R. Schultz. January 1983. 36 pages, 3 photographs, 2 drawings. $1. TAMU–SG–83–402. NTIS–PB–83–176–685.

In this book the author has relied on sailors' actual diaries and logs kept by clipper ship captains. The book also includes an introduction that defines the clipper ship era, suggestions for further reading, and a glossary. Photographs of American-built clipper ships, supplied by Mystic Seaport Museum, are included, as is a redrawing of an 1850-era world chart that shows the major routes followed by the clipper ships. In addition to its interest to the general reader, this book is intended to supplement English or American history classes in grades 8 through 10. It also can be used with younger, gifted students.

Field Trips ... Logistics Is Key to It All. John Norris. May 1983. 4 pages. TAMU–SG–83–403.

Science field trips provide opportunities for students that can make the teachers' work well worth the effort. The excursion allows students to see and experience things they have never seen or felt before, and creates a hands-on approach to study. Students experience the theories and facts that have been discussed in the classroom. To be successful, a field trip must be thoroughly planned and thought through. This monograph provides teachers with detailed, step-by-step guidelines to follow in planning a field trip, taking one and following it up in the classroom. Post-trip evaluation guidelines and references also are included.

1983–84

Whales and Dolphins Off the Texas Coast. 36 x 23" poster. $3. TAMU-SG-84-505.

This poster depicts the five species of whales and dolphins most frequently stranded along the Texas coast. This is a full-color reproduction of a specially commissioned work by artist Lori Grassman. The Atlantic bottlenosed dolphin, spotted dolphin, pygmy sperm whale, beaked whale and great sperm whale are included, along with a brief description of each species.

1984–85

Marine Education - It Matters Now. Bonnie Blackburn and Amy Broussard. In *Proceedings of Oceans '84*, Sept. 10-12, 1984. pp. 842-844. 3 figures. $1. TAMU–SG–85–807.

The ocean is like the air...it's always been there...won't go away soon...so why spend precious class time talking about it? This is the attitude that seems to prevail among educators as we travel throughout Texas and neighboring states, conducting inservice workshops for elementary and secondary school teachers. Some teachers are better informed. Either they live near the coast or have a natural interest in the marine environment. These teachers are beginning to realize that the ocean is the new thrust, not just of education, but of Americans' lives and economic well-being. The concept of education about the world of water is new only in a degree. There always have been the elements of marine education in the curricula, simply because it has been unavoidable. It is doubtful that teachers have tried to ignore the world of water, but its importance has been submerged beneath what appears to be greater urgencies. We are already late in calling for education about the marine environment. A marine literate society will take at least a generation to develop, even after momentum toward the goal of such a society is achieved. Before this generation passes, however, the problems of this marine environment will loom larger in the public eye.

1985-86

Bird Island Basin Environmental Study Area. Richard V. Harris. September, 1985. 36 pages. $2. TAMU-SG-86-401.

The concept of environmental study areas was a direct outgrowth of the ecology movement of the 1970s. The idea was to designate specific areas where school groups, youth groups or others could enjoy a directed study experience in the field and where specific ecological principles could be demonstrated. The Bird Island Basin Environmental Study Area, located at Padre Island National Seashore, is just such a place. This guide contains a number of exercises that are designed as points of departure for hands-on learning experiences. Most of the activities are presented in a format similar to high school-level laboratory experiments, but are written with the Bird Island Basin area in mind, they can be easily adapted to other environments than those found on Padre Island. Many of the activities are described can be done on the school lawn, on the playground or in a nearby city park.

Annotated Guide to the Barnacles of the Northern Gulf of Mexico. Stephen R. Gittings, George D. Dennis and Harold W. Harry. Spring 1986. 40 pages. $3. TAMU-SG-86-402.

The 49 species of thoracican barnacles (the goose and acorn barnacles) that are known to occur in the northern Gulf of Mexico are differentiated by a taxonomic key based on external characters, with extensive illustrations and a glossary. The guide also includes an annotated list of these species and three systematically questionable ones, with a real range bathymetry, substratum type and other data; a list of 16 species that have been found in the southern Gulf of Mexico but not in the northern Gulf; directions for collecting and examining specimens, and a list of references.

Readership Survey of Marine Education. Larry G. Gresham and Alan J. Bush. September 1985. 37 pages, 30 tables, appendix. $2. TAMU-SG-86-204.

An independent readership survey of the quarterly newsletter Marine Education was undertaken to assess reader feedback on the current content of the publication, readers' opinions of the value of the newsletter as a source of marine-related information for classroom use, and their recommendations for improvement. Questionnaires were sent to a random sample of the more than 5,000 subscribers; responses were received from individuals in 47 states. This report summarizes the survey results in both narrative and tabular form.

1986-87

Questions About Careers in Oceanography. Aubrey L. Anderson. January 1987. 18 pages. **TAMU-SG-87-401.**

There have been a number of changes in the field of oceanography since the forerunner to this brochure was published in 1979. The goal of this brochure is to provide concise, but informative answers to questions that educators and information sources are often called upon to answer. The publication is directed to high school students, teachers and guidance counselors, and to college students with questions about careers in oceanography. The following questions are addressed: What is an oceanographer?; where does one study oceanography?; who hires oceanographers?; who supports oceanographers?; and where does one obtain in-formation?

Water, How Safe are You? September 1987. **TAMU-SG-87-402.**

As the weather turns hot there is nothing so inviting as the thought of cool water and swimming, skiing, boating, fishing or just lazing away the afternoon. Below that placid surface is danger, however, and each year in Texas an average of 650 people get so involved in their activities that the end result is death by drowning. Drowning is the second leading cause of accidental death of Americans between the ages of 1 and 44. Since most victims are teenaged males between 15 and 19 years old, this bulletin points out some of the more obvious, but often forgotten, safety practices. Written primarily for a teenaged audience, it covers swimming, river recreation and boating. It includes a list of reference brochures, films, books and courses that can be used to supplement water safety instruction.

1990-91

Freshwater Inflow: Survival in a Sea of Salt. Amy Broussard and Laura Murray. 1991. 16 pages.No charge. **TAMU-SG-91-101.**

Thousands of miles of streams and rivers carry freshwater runoff from more than two-thirds of the 48 contiguous states into bays and estuaries bordering the Gulf of Mexico. As a result, some of the most productive ecosystems in the U.S. are found from the Texas/Mexico border to southwest Florida. Intended for a general audience, this full-color booklet uses photographs and a brief text to describe the importance of freshwater inflows along the Gulf of Mexico and serves as an introductory piece for community groups, schools and visitors to the Gulf States.

1991-92

Flower Garden Banks National Marine Sanctuary. 1991. Texas A&M University Sea Grant College Program. 24 panels, 17 photographs. Single copies free. **TAMU-SG-92-101.**

The northern-most living coral reef on the U.S. continental shelf, the Flower Garden Banks recently attained National Marine Sanctuary status. The East and West Banks were first named by commercial fishermen around the turn of the century when bits of colorful coral and other organisms were brought up in the nets. In recent years, the Banks have been subjected to human pressures, most notably anchor damage caused both by the shipping industry and recreational boats. This brochure gives an overview of the importance of the Flower Garden Banks and describes the protection that will be afforded by Sanctuary status.

A Garden in the Gulf: Flower Garden Banks National Marine Sanctuary. 1991. 34 x 22 poster, 16 color photographs. Texas A&M University Sea Grant College Program. $3. **TAMU-SG-92-102.**

This poster intended both for the general public and the classroom tells the story of the Flower Garden Banks, the habitats, the problems created by humans, and the protection offered by National Marine Sanctuary status. Each Bank includes different biotic zones, which are described and illustrated on the poster. Activities that will now be regulated are itemized on the back of the poster, and a general description of the National Marine Sanctuary Program is included.

Aquatic Science: Marine Fisheries Biology. May 1992. 18 pages. Single copies free. **TAMU-SG-92-401.**

Few publications deal exclusively with organisms that inhabit the bays, estuaries and shores of Texas. This illustrated booklet focuses on animal life in the marine areas of Texas and can be used as a handbook for the novice beachcomber or as an educational supplement in the classroom. Information is available on waves, tides and currents; shoreline organisms; estuaries; coastal food chains; fish and shellfish identification (including descriptions and line drawings of fish indigenous to Texas waters); and special project ideas related to the life history and management of coastal organisms. A list of related reading materials is included. This is a revised and updated version of an earlier Sea Grant publication by James Davis and Deborah Lightfoot.

Engineering

1969–70

Proceedings of the Second Dredging Seminar. June 1970. 93 pages. $3. TAMU–SG–70–113. NTIS–PB–194–787.

Proceedings of a one-day conference held November 19, 1969, sponsored by the Texas A&M University Center for Dredging Studies, the Sea Grant Program, and the Gulf Chapter of the World Dredging Association, covering such topics as pollution control and dredging effects of air content on dredge pump performance, the Hofer system, dredge pump and pipeline energy losses, and cavitation in dredge pumps.

1970–71

Interaction of a Train of Regular Waves with a Rigid Submerged Ellipsoid. V. Seetharama Rao and C.J. Garrison. May 1971. 156 pages. $3. TAMU–SG–71–209. NTIS–COM–71–00879.

The practical and rigorous solution of the potential flow problem associated with interaction of a train of regular surface gravity waves with a fixed rigid submerged half spheroid resting on the bottom is presented. Numerical results obtained include amplitudes; phase shifts of the dynamic pressures; horizontal and vertical force and moment coefficients; and phase shifts of the forces and moment. Results are complete in that they include all data necessary for practical engineering design. Several checks are made on numerical results, indicating that they are valid and accurate.

Soil Parameters Required to Simulate the Dynamic Lateral Response of Model Piles in Stiff Clay. Roger A. Brown and Harry M. Coyle. August 1971. 119 pages. $3. TAMU–SG–71–218. NTIS–COM–71–01101.

Methods to obtain the soil parameters needed to simulate the dynamic response of a laterally loaded pile were developed in this research. Instrumented model piles of various diameters and embedded length were driven into stiff clay and tested laterally under free vibration conditions. Field data of bending moments and accelerations versus time were obtained.

Soil Parameters Required to Simulate the Dynamic Lateral Response of Model Piles in Sand. David A. Wright and Harry M. Coyle. August 1971. 85 pages. $3. TAMU–SG–71–219. NTIS–COM–71–01053.

Three instrumented model piles of varying diameters and embedded lengths were driven into sand and field tested laterally under free vibration conditions. The dynamic response of each model pile was measured in the field. Bending moment and acceleration versus time data were obtained. An analytical computer solution was used to predict the response of the model piles. A modified Voight-Kelvin rheological model was utilized in the analytical computer solution to model to the nonlinear load-displacement characteristics of the soil. The predicted response of the model piles was correlated with the measured field data. Using these correlations and laboratory data obtained from tests on soil samples taken at the site, the soil parameters required to simulate the dynamic field response of the model piles were evaluated.

1971–72

Control of Oil Spills. John B. Herbich. March 1962. 37 pages. $3. TAMU–SG–72–102. NTIS–COM–72–10810.

Much research for the prevention, containment, removal and treatment of an oil spill at sea and in estuaries has been conducted by the federal government, industry and in universities. Results of such studies are described in this report. The use of a pneumatic barrier to contain a spill is presented in detail. The Texas A&M Low Tension Barrier, a mechanical barrier designed to be parachuted and rapidly moved into position by two vessels, is described. Removal of oil from the water's surface with the Sea Sweep, a paten-ted oil skimming system, is presented; also the Vortex principle (a French method) and the Absorption method are given.

A Field Investigation of Rollover Fish Pass, Bolivar Peninsula, Texas. S.H. Prather and R.M. Sorensen. September 1972. 116 pages. $3. TAMU–SG–72–202. NTIS–COM–73–10157.

A field study of Rollover Fish Pass, an artificial tidal inlet connecting Galveston East Bay, Texas with the Gulf of Mexico, was conducted. The objectives of this study were, (1) to evaluate the flow and stability characteristics of the inlet, (2) to investigate the propagation of the tidal wave through the connected bay system, and (3) to evaluate the effect of the inlet on tidal fluctuations and flushing of East Bay. Field work included hydrographic surveys of the inlet and adjacent Gulf beaches, collection and analysis of sediment samples from the inlet and beaches, measurement of tidal fluctuations at selected locations in East Bay, and current measurements in the inlet. Tidal data from the Gulf provided by the Galveston District, Corps of Engineers, were analyzed with the field data.

Effects of Inclined and Eccentric Load Application on the Breakout Resistance of Objects Embedded in the Sea Floor. John L. Colp and John B. Herbich. May 1972. 91 pages. $3. TAMU–SG–72–204. NTIS–COM–72–10862.

This study considers the forces required to break out model circular plate anchors embedded in three soil materials at depths of two and eight diameters under certain specified conditions. Data obtained from model pullout tests using a three-inch diameter plate buried in tanks of dense, dry Ottawa sand; dense, submerged Ottawa sand; and Gulf of Mexico marine sediments are presented. Also presented is a review of published material on mooring and anchoring systems, embedded anchors and anchor withdrawal studies. Explanation of mechanisms invoked during anchor pullout using existing soil mechanics theory is discussed. The resulting quasi-theoretical equations are listed.

1972–73

Investigation of Shoreline Changes at Sargent Beach, Texas. William N. Seelig and Robert M. Sorensen. September 1973. 153 pages. $3. TAMU–SG–73–212. NTIS–COM–74–10157.

Objectives of this environmental study at Sargent Beach, Texas, were to determine beach characteristics, magnitudes of changes that occurred and analysis of factors controlling the observed beach changes. Results showed that the beach had eroded at an increasing rate since 1930 or earlier with recent shoreline retreat rates averaging 30 feet per year. The effects of storms, hurricanes, delta entrapment and river alterations are discussed.

1973–74

Proceedings of the Sixth Dredging Seminar. Center for Dredging Studies, Texas A&M University. March 1974. 99

pages. $3. TAMU–SG–74–104. NTIS–COM–74–11597/AS.

Held January 1974 at Texas A&M University, and sponsored jointly by the Center for Dredging Studies and the Sea Grant College Program at Texas A&M, this seminar included presentations in the areas of hydraulic dredging - the 1973 Mississippi Flood; chemical contaminants in dredge spoil; systems engineering and dredging - the feed back problem; estuarine impacts related to dredge spoiling; environmental statement on shell dredging - San Antonio Bay, Texas; dredge specification standards; and dredge for 1984. Participants are listed. Twenty-seven figures.

An Experimental and Theoretical Study of the Flow Field Surrounding a Suction Pipe Inlet. William J. Apgar and David R. Basco. October 1973. 71 pages. $3. TAMU–SG–74–203. NTIS–COM–74–10172.

The object of this study was to develop a mathematical model of the flow field around a single suction pipe inlet near a horizontal boundary in an infinite reservoir. The basis for the theoretical approach was potential flow theory which neglects frictional and viscous effects. For simplicity, a point sink was employed. To investigate the actual flow conditions, an experimental apparatus was developed to test a model suction inlet. The inlet was a simple cylindrical pipe placed at various heights from and at an angle to the horizontal boundary.

Field Study of an Unconfined Spoil Disposal Area of the Gulf Intracoastal Waterway in Galveston Bay, Texas. D.E. Bassi and D.R. Basco. January 1974. 74 pages. $3. TAMU–SG–74–208. NTIS–COM–74–11351/AS.

Grain-size analysis of bottom sediment samples, depth soundings and wooden stakes were employed in field investigations to determine the approximate location of material from an unconfined, submerged spoil area over a five-month period after disposal. A brief summary of dredging and spoil disposal practices is included.

1974–75

Numerical Solutions for Determining Wave-Induced Pressure Distributions Around Buried Pipelines. N.W. Lai, R.F. Dominguez and W.A. Dunlap. December 1974. 93 pages. $3. TAMU–SG–75–205. NTIS–COM–75–10503/AS.

Numerical models using both the finite difference and finite element technique are developed to simulate the interaction of a two-dimensional pipe-soil-wave system. The wave-induced pressure distribution in the soil region without an embedded pipe is first studied and solutions validated by comparing with existing analytical and experimental results. Numerical models are then used to solve the dynamic pressure distribution around buried pipes. Results are obtained for both a square pipe and a circular pipe and comparisons are made for different cases of input wave and soil parameters. Forty-four figures.

Quantitative Analysis of Shoreline Change, Sargent Texas. James E. Sealey, Jr. and Wayne M. Ahr. August 1975. 179 pages. $3. TAMU–SG–75–209.

A method for shoreline stability analysis is examined, which could be used together with conventional studies of land erosion rates to provide a more thorough understanding of interaction of waves, the longshore current, and coastal sediments. A method for predicting erosion and deposition rates related to interaction of longshore currents and sediment discharged at the mouth of the river is developed and applied to the new Brazos River delta near Freeport, Texas. Includes 75 figures, 10 tables.

An Investigation into the Properties and Characteristics of Homogeneous Tapered Cables. Russell O. Decastongrene and Richard F. Dominguez. August 1975. 81 pages. $3. TAMU–SG–75–211. NTIS–COM–75–11219/AS.

The tapered cable concept is explored and developed. The introduction is followed by a review of historical background, examination of several types of taper from a geometrical viewpoint, and the derivation of the equilibrium equations pertaining to two cases of general interest: the axially suspended cable and the catenary cable configuration. These equations are then used to make comparisons between the optimum, tapered cable and the common cable. Advantages and disadvantages of the tapered cable are summarized and a set of tables is provided to assist in constant stress catenary cable calculations.

Wave Forces on Models of Submerged Offshore Structures. P. Verowsky and J. Herbich. August 1975. 124 pages. $3. TAMU–SG–75–215. NTIS–PB–253–059/AS.

Results of a model study of the forces caused by oscillatory waves on large, rectangular and tank-like submerged objects are presented. Three phases of the problem were examined: (1) description of the forces in terms of dimensionless parameters, (2) description of the effect of large wave heights which are of importance to the designer, and (3) presentation of a format to be used in model studies on submerged structures. Relationships between fluid particle displacement and coefficients of mass and drag were evaluated. Experimental results are given in dimensionless form and can be used to determine the forces on prototype structures in the ocean. Fifty figures.

1975–76

Proceedings of the Seventh Dredging Seminar. John B. Herbich. September 1975. 245 pages. $6. TAMU–SG–76–105. NTIS–PB–249–587/AS.

Held in November 1974, presentations included topics on remote sensing for dredging; dredged material research; variables affecting performance of hydraulic pipeline dredge model; maintenance dredging; catamaran hulls for seagoing cutterhead dredges, port of New Orleans, submarine pipeline construction; compressibility, strength, permeability and drainage characteristics of dredging; reclamation of dredged material; hopper dredge A. Mackenzie; and effect of sediments on estuary organisms.

Foundation Stability of Buried Offshore Pipelines: A Survey of Published Literature. Richard N. Manley and John B. Herbich. February 1976. 40 pages. $3. TAMU–SG–76–204. NTIS–PB–256–104/AS.

A literature survey dealing with foundation stability of buried offshore pipelines was conducted as preliminary to a laboratory investigation of scour around pipelines by wave action. Pipeline alignment, beach stability, soil type, wave parameters and scour are discussed as well as pipe flotation, need for soil exploration, and a new idea of pipe anchoring. Recommendations for future research are given. Abstracts of the more important papers of presented, and annotated bibliography and references are given in the Appendix.

Shoaling Characteristics of the Gulf Intracoastal Waterway in Texas. John Michael Atturio, David R. Basco and Wesley P. James. May 1976. 93 pages. $5. TAMU–SG–76–207. NTIS–PB–259–101/AS.

Maintenance dredging records were used to compute average shoaling rates in 5,000-foot reaches for the entire Texas Gulf Intracoastal Waterway. Environmental data per-

tinent to the waterway were gathered from published and unpublished sources. Computed shoaling rates and selected environmental features were plotted on Composite Factors Maps. Similar reaches were grouped and examined using analysis of variance techniques to determine effects of selected environmental factors on shoaling rates. A model was developed to predict the shoaling rate in a reach with known environmental factors.

Sediment Movement Induced by Ships in Restricted Waterways. Yi-Chung Liou and John B. Herbich. August 1976. 85 pages. $4. TAMU–SG–76–209. NTIS–PB–260–922/AS.

A numerical model using the momentum theory of the propeller and Shields' diagram was developed to study sediment movement induce by a ship's propeller in a restricted waterway. Velocity distribution down stream of the propeller was simulated by the Gaussian normal distribution function. Shear velocity and shear stress were obtained using Sternberg's formulas. Once the ship's speed, depth of the waterway, RPM and diameter of the propeller, and draft of the ship are given, the velocity distribution and the grain size of the initial motion could be obtained from this model. A computer program was developed to solve it.

Influence of the Supramolecular Marine Environment on Pitting Corrosion. Denton B. Harris, Bob M. Gallaway and John B. Herbich. August 1976. 42 pages. $3. TAMU–SG–76–211. NTIS–PB–260–924/AS.

A mechanism is proposed for the process of corrosion pit nucleation in the marine environment. Rupture of the passive film is described in terms of its sensitivity to attack by negatively hydrated ions. A corollary is suggested which describes the inhibiting effect of various positively hydrated ions. The role of marine microorganisms is discussed as it relates to those environmental modifications that may contribute to pit nucleation.

Supplemental Lighting for Underwater Photography. A Computer Program for Design Analysis. Bernard D. Greeson and Robert E. Randall. September 1976. 76 pages. $4. TAMU–SG–76–212. NTIS–PB–260–927/AS.

This paper discusses mathematical expressions which can be used to analyze the design of an underwater lighting system, introduces a computer program to solve these expressions by numerical techniques, and illustrates the use of this program in the design of two hypothetical lighting arrangements. This program can be used to determine the best camera and lamp arrangement, correct camera exposure settings, and the optimum type of lamp.

1976–77

Proceedings of the Eighth Dredging Seminar. John B. Herbich. December 1976. 240 pages. $8. TAMU–SG–77–102. NTIS–PB–269–383/AS.

Held November 8, 1975, the seminar included papers on the following subjects: dredged material containment, disposal contaminants release; hydrologic and sedimentologic study, and environmental impacts associated with dredged material disposal; remote sensing to evaluate turbidity plume; Houston-Galveston vessel traffic system; Galveston dredging regulations; national dredging study and physical factors affecting dredged material islands.

Proceedings of the Ninth Dredging Seminar. John B. Herbich (ed. and comp.). December 1977. 263 pages. $8. TAMU–SG–77–115. NTIS–PB–275–723/AS.

Held November 5, 1976, presentations included are: stabilization of coastal subaerial dredged materials; development of biological habitats; reduction of turbidity; research to deepwater dredged material; and primary consolidation and compressibility of dredgings. Also, environmental aspects of dredging; mining phosphates by dredge; availability of sediment-adsorbed heavy metals to benthic deposit-feeding organisms; future of the dredging market; cost effectiveness analysis of solids-liquid separation alternatives in disposal operations; stabilization of polluted dredgings by electro-osmosis; and *Corbicula manilensis* Phillipi in the Arkansas River.

Estimation and Analysis of Horizontal Bottom Velocities Due to Waves. John B. Herbich and Shashikant B. Brahme. August 1977. 43 pages. $3. TAMU–SG–77–208. NTIS–PB–272–136/AS.

Maximum bottom velocities caused by waves were calculated using digital computers. Four wave theories, Airy, Stokes Third Order, Cnoidal and Solitary, were applied in the computations. Results of the study are tabulated and presented graphically highlight the importance of various parameters affecting the maximum bottom velocity.

Additional Computer Programs in Ocean Engineering. Wei-Yih Chow, David H. Harris, E.J. Chacko, Roy Shilling and John B. Herbich. August 1977. 106 pages. $4. TAMU–SG–77–209.

The computer programs assembled in this report were developed or adapted from the AMDAHL 470 V/6 computer available on the College Station campus of Texas A&M University. They include: Stokes Fifth Order Wave Theory; Horizontal Wave Force on a Large Submerged Rectangular Body; Wave Forces and Moments on a Circular Cylindrical Pile; Wave Forces and Moments Produced on a Vertical Pile Using the Stream Function Theory; and REDSEA Re-visions - Program to Estimate the Combined Effects of Re-fraction, Diffraction of Water Waves and of Bottom Friction. Each program includes a description of the computational technique involved. Notation and reference sources are given.

1977–78

Characteristics of Coral and Coral Dredging. B.R. Schlapak and John B. Herbich. June 1978. 53 pages, 35 figures. $5. TAMU–SG–78–207. NTIS–PB–285–416.

This report was prepared to fill the information gap for civil engineers involved with the dredging of coral and its use as construction material. Eighteen kinds of coral are discussed and illustrated in terms of engineering properties, excavation data, coral reef formation and world-wide distribution.

1978–79

Dilution of a Dense, Vertical Jet in Stagnant Homogeneous Fluid. Ignacio Vergara and Wesley P. James. May 1979. 65 pages, 16 figures, 3 tables. $5. TAMU–SG–79–202. NTIS–PB–297–486.

The Federal Energy Administration (FEA) has proposed to implement the Strategic Petroleum Reserve (SPR) program under the Energy Policy and Conservation Act of 1975. The most attractive option under consideration is to store the oil in solution-mined salt cavities along the coast of the Gulf of Mexico, and to discharge the resulting brine into the sea employing a diffuser. From an environmental standpoint, a maximum allowable increase in salinity over ambient must be specified and used as a basis for diffuser design, especially under very poor disposal conditions such as exist in the absence of currents. The objective of this study was to investigate experimentally the influence of three diffuser design

parameters - port or nozzle, jet velocity at the nozzle and riser height - on the resulting brine concentration at the ocean bottom near the diffuser, under stagnant conditions. Twenty-seven test conditions were considered. Measurements of the jet height were taken and compared with those from previous studies. From these measurements, the relative effect of each of the three diffuser parameters was analyzed. In addition, observations were made concerning the direct application of this model to an actual case with emphasis on the qualitative nature of the results.

1979–80

Proceedings of the Eleventh Dredging Seminar. J.B. Herbich (comp.). October 1979. 400 pages. $12. **TAMU–SG–80–103. NTIS–PB–80–225–683.**

Co-sponsored by the Center for Dredging Studies and the Sea Grant Program at Texas A&M University, the Gulf Coast Dredging Association, and the Gulf Chapter of the World Dredging Association, the Eleventh Annual Dredging Seminar was held November 9-10, 1978 at the Monteleone Hotel, New Orleans, La. Topics discussed include: Stability and Fate of Dredged Material, Impacts of Open-Water Dredged Material, Dredged Material: A Manageable Resource, Dredging Containment Areas as Sedimentation Basins, Design of Weirs for Effluent Quality Maintenance, Dredged Material Disposal Operations Research and Dewatering by Explosive Trenching, Dredging Technology for PCB Removal in the Hudson River, A History of Dredging at the Mouth of the Mississippi River, Dredging the Panama vs. the Suez: Unique Problems Facing Each of these Water Passages to the World, Consolidation of Confined Dredged Material, Stability of Retaining Dikes for Containment of Dredged Material, Laboratory Determination of Bulking Factors, and Weir Design for Dredging Containment Areas.

Proceedings of the Twelfth Dredging Seminar. J.B. Herbich (comp.). August 1980. 400 pages, 12 photographs, and many figures. $10. **TAMU–SG–80–112.**

Co-sponsored by the Center for Dredging Studies and the Sea Grant Program at Texas A&M University, the Gulf Coast Dredging Association, and the Gulf Chapter of the World Dredging Association, the Twelfth Annual Dredging Seminar was held November 1-2, 1979, at Holiday Inn Central, Houston, Texas. Titles of presentations include: Design of Fine-Grained Dredged Material Sedimentation Basins; Measurement and Prediction of Consolidation of Dredged Material; Early Dredging on the Texas Coast; Performance Testing at the Georgia Iron Works Hydraulic Laboratory; Building and Management of Dredged Material Islands for Use by Wildlife in North America, Center for Dredging Studies; Application of the Biotal Ocean Monitor System to In Situ Bioassays of Dredged Material; Contamination of James River Beds Sediments with Kepone; Open-Water Disposal of Dredged Material on Bottom Topography along the Texas Coast; Physical and Chemical Characterization of Dredged Material Influents and Effluents in Confined Land Disposal Area; Improving the Efficiency of Dredging Several Feet of Contaminated Sediment Off the Top of Uncontaminated Sediment. Participants are listed.

The Potential Cost of Deep Ocean Mining Environmental Regulation. John E. Flipse. July 1980. 50 pages, 2 figures. $2. **TAMU–SG-80–205. NTIS–PB–80–225–451.**

The major potential environmental threats posed by the at-sea aspects of Deep Ocean Mining are benthic and surface plumes produced by the dredging process. Engineering analysis of these plumes, their formation and dispersion, resulted in several concepts to limit to acceptable levels possible ecological impacts. The financial penalties, capital and operating costs of applying these concepts were estimated. Several environmental regulations requiring application of the foregoing concepts were postulated and the impact of their capital and operating costs were evaluated in the con-text of the Deep Ocean Mining Cost Model developed at the Massachusetts Institute of Technology (MIT) for the National Oceanic and Atmospheric Administration (NOAA). Effect on the model's rate of return on investment for an ocean mining company to conform to the postulated regulations was found to be negligible, and modification of the MIT Cost Model to accommodate secondary environmental cost impacts was deemed unnecessary. The model is well equipped to handle the primary capital, operating and delay costs which make up the significant at-sea mining system impacts, if any, of environmental mitigation.

1980–81

Simultaneous Wave and Current Forces on a Cylinder Near the Bottom Boundary. David A. Knoll and John B. Herbich. May 1981. 85 pages, 6 tables, 44 figures. $5. **TAMU–SG–81–203. NTIS–PB–81–243–990.**

The purpose of this paper is to provide the design engineer with insight into the fluid force parameters of interacting waves and currents and their effects on a cylinder near the bottom boundary. Forces on a model pipeline were measured in a two-dimensional wave-flume tank and compared to forces predicted by various theories of wave propagation in a current. Forces on the horizontal cylinder were evaluated with the Morison equation. Input parameters in the Morison equation were investigated individually to eliminate compensating errors in the force calculations. Several wave theories for waves propagating in still water were modified by various combinations of their horizontal velocity fields to include values using coefficients from this study and those predicted by the modified wave theories. Data are compared to previously published results for the individual cases of waves and currents. Results demonstrate the apparent acceptability of superimposing the velocity fields of the wave and the current to predict the total velocity field for determination of the fluid force.

Electrochemical Inactivation of Marine Bacteria. H.P. Dhar, J. O'M Bockris and D.H. Lewis. In *Journal of the Electrochemical Society*, Vol. 128, No. 1. January 1981. pp. 229-231, 3 figures. **$1. TAMU–SG–81–817.**

This report concerns the bactericidal properties of hydrogen peroxide, which is formed from dissolved oxygen present in an electrolyte at low power densities on the metal surface. Direct observations of bacterial activity of *Vibrio anguillarum*, a marine species of bacteria, were made in a cell constructed of transparent conducting tin oxide glass, using dark field and phase contrast microscopic techniques. The cell used involved a transparent Nafion cationic membrane #425 to separate the anode and cathode compartments. The dimensions of each compartment were 3 cm x 2 cm x 0.02 cm, and 400 x magnification allowed observation of the cathode surface, while eliminating transfer of anodically produced chlorine. The bacterial viability was assessed in addition to direct observations.

1981–82

Proceeding of the Thirteenth Annual Dredging Seminar. J.B. Herbich (comp.). September 1981. 177 pages, illustrations. $10. **TAMU–SG–82–102. NTIS–PB–197–849.**

The Thirteenth Dredging Seminar was held November 6-

7, 1980, at Texas A&M University, College Station. The seminar was partially supported by the Texas A&M University Sea Grant Program. Papers included in the proceedings are the following: Mt. Saint Helens Eruption: Restoration of Columbia and Cowlitz River Channels; Operating Characteristics of Cutterhead Dredges; Dredging Work in the U.S. Army Corps of Engineers; Effects of Sediment Particle Size Distribution and Related Factors on Survival of Three Aquatic Invertebrates; Implications for the Conduct of Dredged Sediment Bioassays; Dredging and the National Waterways Study; High-Speed Hydrographic Surveying; and Sizing of Containment Areas for Dredged Material.

An Economic Analysis of a Pioneer Deep Ocean Mining Venture. John E. Flipse. August 1982. 131 pages, 4 figures, 7 tables. $3. **TAMU–SG–82–201. NTIS–PB–83–118–612.**

A three million ton per year, three metal, vertically integrated, ocean exploration, mining, transportation and ore-processing and metal-marketing system is defined and the capital and operating costs estimated in 1980 U. S. dollars. A basic return-on-investment "pay-out" analysis model is presented with several alternate cases investigated. A series of tests is performed to determine the system's sensitivity to realistic variations of key costs and schedule.

Deep Ocean Mining Pollution Mitigation. John E. Flipse. In *Proceedings of the 12th Annual Offshore Technology Conference*, 1980, pp. 353-357. 2 figures. $1. **TAMU–SG–82–804.**

During an investigation of costs of minimizing pollution caused by deep ocean mining, the major threats to the marine environment were identified, and means to minimize damage were proposed. The major threats are the benthic plume of suspended particulate matter (sediments and macerated marine biota) and the surface plume (ingested benthic matter and abraded manganese nodules). Techniques are described that would minimize disturbance of the sea floor, limit ingestion of benthic material in the dredge pipe and control the surface plume, limiting damage to the euphotic zone. It is recommended that industry and the scientific community evaluate the effectiveness of these approaches.

Offshore Pipeline Design Elements. John B. Herbich. 233 pages. $39.50. **TAMU–SG–82–826.** ***Order from Marcel Dekker, Inc., publisher, 270 Madison Avenue, New York, NY 10016.***

This book gives design engineers access to the most up-to-date methods for the design of successful and safe offshore pipelines and the newest information of the effects of waves and currents on submerged pipelines. It presents all the critical environmental factors that must be considered in the design process, such as corrosion, scour, hydrodynamic wave and current forces, buoyancy due to liquefaction of sediment.

1982–83

Proceedings of the Fourteenth Dredging Seminar. John B. Herbich (comp.). October 1982. 307 pages, illustrations. $8. **TAMU-SG-83-103. NTIS–PB–83–138–248.**

The Fourteenth Annual Dredging Seminar was held November 12-13, 1981 in New Orleans, Louisiana. The proceedings include the following papers: Burial of Dredged Sediment under the Sea Floor: Can you do it?; Dredging and Locks: Focus on the National Waterway Study Recommendation; Construction of a Hopper Dredge; Contaminant Levels in Disposal Area Effluents - Problem Identification and Proposed Rationale; Effects of Suspended Volcanic Ash on Susceptibility of Fish to Disease; Deepening the Hampton Roads - The EIS Process; Predictions of Shoaling Rates for Deepened Navigation Channels; Resolution of International Dredging Disputes by Arbitration; Deep Draft Access to the Ports of New Orleans and Baton Rouge, Louisiana and the Capability of the U.S. Private Dredging Fleet to Accomplish Simultaneously New U.S. Port Deepening Projects in the Years Ahead; Alternative on Slope Protection for Arctic Islands; Water Quality Impact of Dredged Sediment Disposal in the Gulf of Mexico off Galveston, Texas; and Contemporary Approaches in Biological Monitoring.

Proceedings of the Fifteenth Dredging Seminar. John B. Herbich (comp.). June 1983. 149 pages, figures and illustrations. $10. **TAMU–SG–83–111. NTIS–PB–83–241–885.**

The proceedings of the Fifteenth Dredging Seminar include the following presentations: Field Study of the Sediment Resuspension Characteristics of Selected Dredges; Precussion Demolition of Submerged Rock; Long-Term Monitoring of Habitat Development Field Sites Built of Dredged Material; and Luncheon Address, given by Col. Robert C. Lee. Other papers included: Dredged Material Research in the Eighties; U.S./Dutch Memorandum of Understanding; Complex Oil-Hydraulic System Special Purpose Vessels and James River Dredging Demonstration in Sediments Contaminated with Kepone.

The Use of *In Situ* Electrochemical Reduction of Oxygen in the Diminution of Adsorbed Bacteria on Metals in Seawater. H.P. Dhar, D.W. Howell and J. O'M Bockris. In *Journal of the Electrochemical Society*, 129(10): 2178-2182, 1982. 9 figures. $1. **TAMU–SG–83–807.**

An electrochemical study on the prevention of bacterial attachment in seawater has been completed in contact with air. Two kinds of marine bacteria have been examined. The electrodes were tin oxide-coated glass and titanium metal, in the potential ranges 0.2 to -0.6V (HNE). Applications of steady-state potentials decrease bacterial concentration on cathode and anode by ca. 100-300 times. Potential in the form of pulses was less effective. Current densities were 20-30 uA cm^{-2} and the cell potential was ca. 1.8V. Some differences in the results in seawater compared to those for a 3 percent NaCl solution have been explained in terms of the buffering activity of seawater. The effect of potential on bacteria arises because of the *in situ* electrochemical reduction of O_2 to H_2O and OH-· The contributions from the long-range Van der Waals and coulumbic forces in the anti-fouling process are insignificant. The pH at the cathode surface is 9.5, which is within the borderline for the formation of $Mg(OH)_2$ and $CaCO_3$. No precipitates were detected over a 24-period.

1983–84

The Economic Viability of a Four-Metal Pioneer Deep Ocean Mining Venture. B.V. Andrews, J.E. Flipse and F.C. Brown. Oct. 1983. 201 pages, 43 tables, 27 figures. $5. **TAMU–SG–84–201.**

A pioneer vertically integrated deep ocean mining venture is described which explores for and transports manganese nodules, processes them into four metals (manganese, nickel, copper and cobalt) and markets the products. The system is defined, and capital and operating costs are estimated in 1982 U.S. dollars. A basic return-on-investment or payout analysis model is presented and used to evaluate the financial returns of the project. Several alternate cases are investigated. A series of tests is performed to determine the venture's sensitivity to realistic variations of key costs and schedule.

A Comparison of Actual and Theoretical Values of Waves Generated by Hurricane Allen. John B. Herbich and Ronald K. Watanabe. In *Proceedings of the Sixth Canadian Hydrotechnical*

Conference, June 2-3, 1983, pp. 759-775. 3 tables, 5 figures. $1. **TAMU–SG–84–801.**

A tropical depression was formed some 2,092 km (1,300 miles) east of the Windward Islands on Aug. 1, 1980. It crossed the Islands on Aug. 3 and was upgraded to a hurricane named Allen. The hurricane passed about halfway between Venezuela and Puerto Rico, entering the Gulf of Mexico just north of the Yucatan Peninsula. It crossed the Texas coast some 48 km (30 miles) north of Brownsville. Maximum storm surges ranged from 2.68 m (8.8 ft) near Brownsville, Texas, to 2.71 m (8.9 ft) at Port Aransas, Texas. Inland surges were observed to be from 2.44 to 2.90 m (8.0 to 9.5 ft) along South Padre Island, to 2.44 m (8.0 ft) in the upper Corpus Christi Bay. During the period from Aug. 8 to Aug. 10, hurricane Allen passed almost directly over the recording site of a Texas A&M University Waverider buoy moored in a water depth of 60 ft, some 18.5 km (11.5 miles) east of Padre Island. A hindcast of wave characteristics (based on meteorological data obtained by the National Weather Service and the National Hurricane Center) was calculated employing the U.S. Army Corps of Engineers' methods. The actual and hindcasted values compared reasonably well.

1984–85

Proceedings of the Sixteenth Dredging Seminar. J.B. Herbich (comp.). November 1984. 246 pages. $10. **TAMU–SG–85–105. NTIS–PB–85–220–770/AS.**

The texts of the following papers are presented: Feasibility of Using Hopper Dredgers Under Arctic Environments; Techniques to Reduce the Sediment Resuspension Caused by Dredging; Dredging Curves for Humboldt Harbor and Bay, California; Dredging in the Panama Canal; Management of Lakes Through Sediment Removal; Deep Draft Port User Charges, and What It Means to Ocean Shipping; Strategic Planning in Navigation; Build Up of Sable Island and Fabric-Reinforced Dikes Floated on Soft Dredged Material Foundation.

Economic Analysis of Deep Seabed Mining Systems: Effects of Production Rate, Inflation and Depletion Using a Revised Financial Model. Allen H. Magnuson, John E. Flipse, Francis C. Brown and Benjamin V. Andrews. 183 pages, 19 tables, 16 figures. $5. **TAMU–SG–85–203.**

The effects of several variables affecting the economic performance of proposed manganese nodule mining ventures are evaluated using an improved version of Texas A&M University's Ocean Mining Payout Analysis Program. After Tax Internal Rate of Return (discounted cash flow) was used as the primary criterion of performance along with total funding requirements. Variables studies included ore production rate (throughput), processing plant location, construction period, depletion, corporate structure type, processing plant type and financing. Metal pricing used in the analysis was "normal" 1970s pricing which (with the exception of cobalt) is higher than current metal prices. Overall results show that favorable combinations of the variables can produce after-tax rates of return as high as 30 to 35 percent. The "pioneering" ventures (analyzed in 1982 and 1983) with 1.5 and 3.0 million dry tons per year throughput were scaled up to 4.5 and 9 million tons by using a large collector, larger capacity lift pipe, mining ship or ships, ore transport systems and scaled up ore processing and waste disposal systems. Significant economies of scale were present in going from the 3 million ton to 4.5 million ton four-metal system, although diminishing returns are setting in at the 4.5 million ton throughput. No further improvement was seen in going from 4.5 to 9.0 million ton throughput.

Corrosion of Cu and Cu-Ni Alloys in 0.5M NaCl and in Synthetic Seawater. H.P. Dhar, R.E. White, G. Burnell, R. Cornwell, R.B. Griffin and R. Darby. In *Corrosion* 41(6): 317-323 (1985). 2 tables, 6 figures. $1. **TAMU–SG–85–826.**

Electrochemical corrosion rates of Cu and Cu-Ni alloys have been measured in oxygenated 0.5M NaCl and in synthetic seawater using the Tafel extrapolation procedure. In addition, Cu corrosion has been measured with the linear polarization procedure. A rotating disk electrode system was used in the measurements with rotation rate varying from 500 to 6000 rpm. The corrosion characteristics of Cu and 90Cu-10Ni alloy in the two media, and 70Cu-30Ni alloy in 0.5M NaCl have been found to be similar. For these systems, the variation of corrosion current, corrosion potential, and anodic partial current with rotation rate of the electrode could be explained in terms of a convective diffusion controlled corrosion mechanism incorporating the generation of a soluble copper complex on the electrode surface. The 70-30 alloy in synthetic seawater behaved differently. Corrosion current, corrosion potential, and the anodic partial current were all constant with rotation rate, indicating a surface kinetic-controlled corrosion mechanism.

Corrosion Behavior of 70Cu-30Ni Alloy in 0.5M NaCl and in Synthetic Seawater. H.P. Dhar, R.E. White, G. Burnell, L.R. Cornwell, R.B. Griffin and R. Darby. In *Corrosion* 41(4):192-196 (1985). 1 table, 5 figures. $1. **TAMU–SG–85–827.**

Electrochemical corrosion rates of 70Cu-30Ni alloy have been measured in oxygenated 0.5M NaCl and in synthetic seawater by the Tafel extrapolation procedure using a rotating disk electrode system. The rotation rate was varied from 500 to 6000 rpm. A log-log plot of the corrosion current vs rotation rate was linear, with a slope of 1/6 for alloy in 0.5M NaCl; the corrosion potential for the same system became more negative at a rate of approximately -20 mV/dec of rotation. The anodic partial currents at potentials close at the corrosion potential in 0.5M NaCl increased linearly with the square root of the rotation rate. Corrosion current and corrosion potential as well as the anodic partial current for the alloy in synthetic seawater remain unchanged with rotation rate. The anodic Tafel slopes were 60 and 90 mV in 0.5M NaCl and synthetic seawater, respectively. The cathodic Tafel slope was 200 mV for both systems. Two separate corrosion mechanisms for the alloy in two electrolytes have been recognized. In 0.5M NaCl, the corrosion proceeds through the formation of a soluble $CuCl_2^-$ complex. In synthetic seawater, the corrosion proceeds through a surface kinetic process, possibly because of the formation of Cu_2O and $Cu_2(OH)_3Cl$ on the surface. The cathodic reduction of oxygen is probably the same in both systems.

1985-86

Proceedings of the Eighteenth Dredging Seminar. John B. Herbich, compiler. $10. **TAMU-SG-86-105.**

The texts of the following papers are presented: Design and Construction—Theodore Ship Channel; Optimizing Navigation Channel Dimensions; A PC Data Base for Economic Evaluation of Channel Deepening Projects; Interim Results for the Duwamish Waterway Capping Demonstration Project; Shoaling of Port of Astoria, Oregon, by Sediment from Mt. St. Helens Eruption; Numerical Modeling of the Physical Fate of Dredged Material Dumping at the Alcatraz Open Water Disposal Site; The Dynahoist Applied to Dredging; Pugent Sound Dredged Disposal Analysis (PSDDA)...A Corps of Engineers Perspective on an Interagency Effort; National Port Dredging Issues—A Summary of Assessment.

Nonparametric and Parametric Estimation of Wave Statistics and Spectra. Hidekatsu Yamasaki and John B. Herbich. September 1985. 173 pages, 15 tables, 48 figures. $10. TAMU-SG-86-202.

A nonparametric bivariate density estimation technique is developed, employing tensor product B-splines to provide a concise wave data summary. Most existing nonparametric techniques involve a certain level of subjectivity in the choice of smoothing parameters. A criterion based on the least square concept is proposed to remove the subjective choice of smoothing parameters. Numerical experiments, in which random variables are generated from a known bivariate independent normal distribution and the modified Longuet-Higgens, show that the technique reproduces the population density functions well. An alternative spectral estimation procedure is proposed; this is the second moment of the wave height of the joint probability density function (pdf) in terms of the frequency domain, and is named the PDF spectra. The nonparametric joining pdf provides a concise representation of long-term data from which one can obtain not only the usual wave statistics, but the wave spectra as well.

Monthly Wave Characteristics. Hidekatsu Yamasaki and John B. Herbich. 3 Volumes. $25. TAMU-SG-86-205.

A three-volume set of monthly wave characteristics data is available to complement TAMU-SG-86-202.

1986-87

Hydraulic Model Studies for Suction Cutterheads. Shashikant B. Brahme and John B. Herbich. In *Journal of Waterway, Port, Coastal and Ocean Engineering* 112(5): 591-606 (1986). $1. TAMU-SG-87-805.

The maintenance and deepending of existing waterways and navigational channels by dredging are vital to the nation's economy. Cutterhead dredges share the major burden of dredging in the United States. Sediments in the waterways have become polluted over the years and this has become a matter of concern. A substantial increase in turbidity has been observed in the vicinity of cutterhead dredges. A need exists, therefore, to study the complex nature of flow around the cutterhead, and to investigate the factors contributing to turbidity generation and ways of reducing the turbidity. Hydraulic model studies provide an ideal tool for studying the flow around a cutterhead. Systematic studies of cutterhead design carried out in the past decade were mainly related to the establishment of a similitude criteria for flow at the suction intake of a cutterhead, the sediment pickup behavior at the intake of a suction pipe, and the cutting ability of cutterheads of different shapes. Previous investigations were extended in the current investigation to include studies on flow field and sediment pickup at the cutterhead intake. The sediment pickup phenomenon was found to follow the Reynolds type similitude relationship. The study on sediment resuspension at the cutterhead has helped to identify various parameters related to the sediment resuspension mechanisms at the cutterhead.

1987-88

Proceedings of the Nineteenth Dredging Seminar. John B. Herbich compiler. October, 1986. 186 pages. $10.00 TAMU-SG-88-102.

The 19th annual dredging Seminar was held Oct. 15, 1986, in Baltimore, Maryland, in conjunction with the Western Dredging Association meeting. The texts of the following papers are presented: "Dredging Applications of High Density Polyethylene Pipe," Virginia R. Pankow; "Integrated Dredging and Processing of Alluvial Mineral Deposits," Maria C. Rockwell; "Baltimore Harbor Channels Responding to the Increase in Ship Drafts, David F. Bastian; "Criteria for Subaqueous Borrow-Pit Disposal Sites," h.j. Boluniewicz; Luncheon address by Major General Henry Hatch; "The Success Story of Gaillard Island, a Corps Confined Disposal Facility," Mary C. Landin; "Proposal to Reduce Dredge Litigation," Thomas M. Turner; "The Requirements and Application for the Use of Simulation Techniques at Caorf as an Engineering Design Tool in the Ship Navigation, Channel Design and Maintenance Optimization Process," Joseph J. Puglisi; "The Use of Simulation Techniques for the Development and Validation of a Proposed Widening Solution for the Gaillard Cut Section of the Panama Canal," Edmund J. Kaufman; "Perspectives of an A&E Firm on the Cost Sharing Legislation," Richard F. Thomas; "The Capability of the Pneuma Pump for Continuous High Solids Transport," William J. Courtney; "Introduction to Cost-Sharing Panel" W.R. Murden; "The Effects of Recent Legislation on Harbor Development," Mark D. Sickles; "Impact of the New Cost-Share Regime on the Public Port Industry," Erik Stromberg;" An Industry Perspective on Cost Sharing Legislation: Are We Getting Well?," Rich Dickson; "Widening the Gaillard Cut," Guillermo Van Hoorde, Jr.

Environmental Quality

1973–74

Management of Tank Washings in Marine and Coastal Commerce. John Ball, Donald G. Adams and Charles Alva Stryker. February 1975. 74 pages. $3. TAMU–SG–74–221. NTIS–COM–75–11087/AS.

A one-year project directed toward developing a management plan for treating and disposing of tank-cleaning wastes from barge-cleaning facilities is described. The project was limited to shipyards along the Texas Gulf coast and included both field and laboratory investigations. Background information was obtained primarily from companies engaged in tank-cleaning and treatment of wastewater and from personnel involved in regulating tank-cleaning activities. Presently, the ten commercial companies heavily engaged in barge-cleaning activities in Texas generate 75 to 100 million gallons of wastewater per year. Characteristics of this wastewater, its pollution potential and present treatment methods are discussed. A system designed to adequately treat the wastewater and enhance the water quality of the Texas Gulf coast is proposed.

1974–75

The Interrelationship of Material Toxicity, Stream Properties and Quantity of Spilled Material in Assessing the Risk of Hazardous Material Spills. Paul Alfred Jensen and Roy W. Hann, Jr. May 1976. 261 pages. $5. TAMU–SG–75–212. NTIS–COM–75–11219/AS.

Current status of regulatory efforts for bulk carriage of oil and hazardous materials is reviewed. The hazard posed to water resources is examined using the method of risk analysis. A weakness of present regulatory efforts is identified. With risk defined as the product of spill probability and severity, a procedure is suggested to better quantify one element of water pollution risk: severity of spill impact, concentration of material in the water and the concentration at which the material causes acute toxic effects. Methods are developed to quantify spill concentration in the water on a relative scale for use with existing relative toxicity ratings. Twenty-five figures, four tables, three appendices.

Analytical Models for the Evaluation of Supplemental Aeration in Texas Estuaries. Clark Alan Benson, Roy W. Hann, Jr. and Tom W. Reynolds. January 1976. 132 pages. $3. TAMU–SG–75–213. NTIS–PB–259–098/AS.

In this study a one-dimensional dynamic mathematical model was developed for computer solution of estuarine dispersion problems. The math model was based on the one-dimensional mass transfer equation for the longitudinal distribution of a substance in a variable area estuary. Finite-difference approximations of the mass transfer equation were used to develop the numerical model. Several researchers have used similar modeling techniques, and a summary of their work is included. The mathematical model described in this work was applied to three dispersion problems.

1976–77

Maintenance Dredging Effects on Vegetation Adjacent to the Gulf Intracoastal Waterway-Cedar Lakes Section. Randy Vaughn and Clarissa Kimber. June 1977. 64 pages. $3. TAMU–SG–77–207. NTIS–PB–269–568/AS.

The relationship of dredged materials deposition and bank erosion to habitat condition and vegetation is examined in six sites along the Gulf Intracoastal Waterway in Brazoria County, Texas. Vegetation maps of an abstract nature depict the pattern of assemblages for each site. Alternatives for the placement and management of dredged materials are presented which allow some control of the distribution and composition of vegetation.

1977–78

Supplemental Aeration System Design for the Houston Ship Channel. Thomas Wayne Hoskings, Tom D. Reynolds and Roy W. Hann, Jr. October 1978. 220 pages. $5. TAMU–SG–78–201. NTIS–PB–279–959/AS.

The oxygen demand on the Houston Ship Channel exceeds its natural assimilative capacity. Dissolved oxygen (DO) is depleted so that warm weather and low flow commonly produce zero DO concentration in the upper 14 miles of the channel. This study develops and demonstrates a technique for designing an in-channel supplemental aeration system as an alternative to advanced waste treatment. A mathematical model is used to calculate the capacity of systems capable of producing 2 and 4 milligrams per liter (mg/l) DO under critical conditions, and to locate aeration equipment for maximum efficiency. A general system design consisting of required oxygen transfer capacities under critical and average conditions, and site locations is developed. Side-stream oxygenation, diffused aeration, diffused oxygen and surface aeration systems are evaluated for their ability to meet the requirements of the general design, for their economic desirability, and for their physical feasibility. The 1975 cost of supplemental aeration by side-stream oxygenation is estimated at 2.0 to 2.5 cents per pound of oxygen transferred.

Environmental Management of a Ship Channel-Harbor Complex. Marvin William Reavis and Roy W. Hann, Jr. November 1977. 145 pages. $4. TAMU–SG–78–202. NTIS–PB–278–145/AS.

This study discusses the environmental management of a typical ship channel-harbor complex located along the Texas Gulf Coast. Available information is supplemented by field studies of the Port of Corpus Christi Inner Harbor, along with a non-point-source pollution study of the Port of Brownsville watershed. Most important pollution sources and how to counteract their impacts are explained. Long-range environmental implications of various activities are discussed to facilitate decisions by management entities that are conducive to both an active industrial climate and a healthy environment.

Technical and Philosophical Aspects of Ocean Disposal. Marchi C. Zapatka and Roy W. Hann, Jr. November 1977. 170 pages. $4. TAMU–SG–78–203. NTIS–PB–279–971/AS.

Seven major technical aspects of ocean disposal are discussed in this report. They include qualitative and quantitative aspects of waste materials, disposal methods, transport of materials through water, effects of wastes, legislation, regulations, critical quantities, disposal sites, alternatives to ocean disposal and future trends of this disposal method. Twenty-two philosophies relating to ocean disposal are discussed, and relationships between technical aspects and philosophies are shown in figures. This report can serve as a reference for educational, governmental, industrial and decision-making bodies.

Environmental Considerations Relating to Operation and

Maintenances of the Texas Gulf Intracoastal Waterway. Wesley P. James, Steven Giesler, Robert DeOtte and Masamichi Inoue. November 1977. 230 pages. $5. TAMU–SG–78–204. NTIS–PB–278–146.

This study aims to identify potentially adverse environmental factors (other than dredging) associated with operation and maintenance of the Gulf Intracoastal Waterway (GIWW). This includes physical, chemical and biological information; field sampling programs; evaluation of water and sediment quality; circulation studies; and recommendations for operation of the Waterway.

1979–80

Galveston Island - A Changing Environment. Arthur R. Benton, Jr., Carolyn A. Clark and Wallace W. Snell. January 1970. 46 pages, 9 photographs. $2. TAMU–SG–80–201.

This is the final report of a one-year remote sensing study of baseline conditions at Galveston Island, Texas. The purpose of the study was to provide the City of Galveston with environmental documentation needed to guide the future development of the island. Discussed are the general appearance of the island, vegetation systems, beach erosion, the impact of construction, and the maps which have been produced as a result of this project. The researchers concluded that two distinct barrier island regimes are now being threatened by natural forces and by currently unrestricted human activities. The wetlands system, which includes all of the areas bayward of the dune crest, is being both diminished and stressed by overgrazing and by construction. The beach areas, running from dune top to the shoreline, are under the combined attack of coastal erosion, vehicular traffic and beachfront construction.

Bacterial Indicators and Environmental Factors as Related to Contamination of Oysters by Enteroviruses. Charles P. Gerba, Sagar M. Goyal, Irina Cech and Gregory F. Bogdan. In *Journal of Food Protection*, Vol. 43, No. 2. 1 table. $1. TAMU–SG–80–812. NTIS–PB–81–112–393.

Studies along the upper Texas Gulf coast, where a substantial amount of quantitative virological data was collected, are compared statistically to bacteriological indicators and other environmental factors. A product-moment correlation matrix showed that there was a moderate correlation between viruses in water and total coliforms in water, total coliforms in oysters and fecal coliforms in oysters. However, no correlation was found between viruses in water and viruses in oysters. The only significant regression coefficient found for the model relating the concentration of viruses in the water to bacterial indicators and other environmental variables was concentration of coliforms in oysters. Multiple regression analysis showed that approxiametely 25 percent of the variance in the number of viruses detected in water was statistically accounted for by the linear correlation with the total coliforms in oysters. The amount of variation in the number of viruses explained by this indicator, however, was not large enough to make the concentrations of coliforms in oysters a good predictor of the concentration of viruses in water. Furthermore, not one of the bacterial or other environmental variables was found to be a good predictor of the concentration of viruses detected in oysters.

Relationships Between Environmental Factors, Bacterial Indicators, and the Occurrence of Enteric Viruses in Estuarine Sediments. Raymond L. LaBelle, et. al. In *Applied and Environmental Microbiology*, Vol. 39, No. 3, 1980. pp. 588-596. 3 tables, 3 figures. $1. TAMU–SG–80–815. NTIS–PB–80–209–372.

Current standards for evaluation of public health safety of recreational and shellfish-harvesting waters are based upon bacteriological analysis, but do not include an evaluation of the number of viruses. The objective of this study was to determine the occurence of enteric viruses in estuarine sediments and to find a relationship, if any, between the presence of viruses in seawater or sediment or both, and various biological and physiochemical characteristics of the environment. Viruses were found in greater numbers in sediment that in overlying seawater on a volume basis. Several types of enteroviruses were isolated: coxsackievirus types A16, B1, and B5, echovirus type 1, and poliovirus type 2. On several occasions, viruses were isolated from sediments when overlying seawaters met bacteriological water quality standards for recreational use. Statistical analysis of the relationship between viruses in seawater or in sediment and other variables measured yielded only one significant association: the number of viruses in sediment was found to be positively correlated with the number of fecal coliforms in sediment. No other physical, chemical, or biological characteristic of seawater or sediment measured showed statistically significant association with viral numbers. No correlation was found between bacterial indicators and virus in the overlying waters.

Influence of Estuarine Sediment on Virus Survival Under Field Conditions. Raymond L. LaBelle and Charles P. Gerba. In *Applied and Environmental Microbiology*, Vol. 39, No. 4, 1980. pp. 749-755. 3 figures, 2 tables. $1. TAMU–SG–80–816. NTIS–PB–81–119–216.

The survival of poliovirus I (LSc) and echovirus I (Farouk) in estuarine water and sediment was studied in Galveston Bay, Texas. Viruses were suspended in estuarine water and sediment both in dialysis tubing and in chambers constructed with polycarbonate membrane walls. Virus inactivation rates in seawater were similar in both types of chambers. Virus adsorption to sediment greatly increased survival time. The time required to inactivate 99 percent (T-99) of poliovirus increased from 1.4 days in seawater alone to 6.0 days for virus adsorbed to sediment at a relatively nonpolluted site. At a more polluted site, poliovirus T-99 inactivation time was increased from approxiametely one hour to 4.25 days. These data show that the microbiological quality of sediment may be an important indicator of the public health safety of recreational estuarine areas which is currently not evaluated but which should be considered in the evaluation of microbiological hazards present in such areas.

1980–81

Type and Strain Dependence of Enterovirus Adsorption to Activated Sludge, Soils and Estuarine Sediments. Charles P. Gerba, Sagar M. Goyal, Christon J. Hurst and Raymond L. LaBelle. In *Water Research*, Vol. 14, 1980. pp. 1197-1198. 1 table. $1. TAMU–SG–81–805. NTIS–PB–81–199–481.

This study was undertaken to determine if quantitative differences existed in adsorptive behavior between different types and strains of enteroviruses toward surfaces known to influence their distribution in nature. Poliovirus type 1 (strain LSc), echovirus types 1, 7 and 29, and coxsackievirus types B4 and B3 were used as reference reagents. Several enteroviruses isolated from groundwater beneath a wastewater land disposal site also were studied. These included three strains of echovirus type 1, and two strains of coxsackievirus type B4.

Results indicate that virus adsorption to natural solids is not only dependent on the type of virus but on the specific strain as well. The greatest variability in adsorption of the

different viruses was seen in their behavior toward the soil samples and the least with the estuarine sediments. It is possible that the high salt concentration of seawater may act to lessen the difference in adsorptive capacity of the solid. Many of the viruses which adsorbed poorly to soil also adsorbed to a lesser degree to sludge and sediment.

Thermostabilization of Enteriviruses by Estuarine Sediment. Pei-Fung Liew and Charles P. Gerba. In *Applied and Environmental Microbiology*, Vol. 40, No. 2, August 1980. pp. 305-308. 5 figures. $1. **TAMU–SG–81–808. NTIS–PB–81–194–698.**

The effect of estuarine sediment on the thermoinactivation of poliovirus type I and echovirus type I was evaluated. Poliovirus survival was prolonged at 24 and 37°C but not at 4°C in the presence of sediment over the time periods observed. Further inactivation studies were performed at 50 and 55°C to maximize thermal effects, and similar protection was observed. The supernatant fluid from a mixture of seawater and sediment lacked the protective effect against thermoinactivation, suggesting that prolonged virus survival in the presence of sediment was due to adsorption to particulates. From these observations, it appears that the adsorption of enteroviruses to estuarine sediments may play a significant role in protecting them against thermoinactivation.

Phytogeography of South Padre Island, Texas. Robert I. Lonard and Frank W. Judd. In *the Southwestern Naturalist* 25(3), November 14, 1980. pp. 313-322. 2 tables. $1. **TAMU–SG–81–813. NTIS–PB–81–199–879.**

Phytogeographic affinities of native flora of South Padre Island, Texas, are analyzed and probable dispersal agent(s) for each species are identified. The native flora consists of 99 species. Forty-four percent of the species also occur on the adjacent Texas mainland and 28 percent of the native species have tropical affinities. Only three species probably have dispersed from the island to the mainland. Two species may be endemic to Padre Island and the Tamaulipan barrier islands. Most of the tropical species have reached the island by oceanic drift, but the most important dispersal agents for the native species are birds. Man is responsible for the introduction of 117 species, which are listed.

Accumulation of Glutamate in Sea Anemones Exposed to Heavy Metals and Organic Amines. Margaret R. Kasschau, Merton M. Skaggs and Edward C. M. Chen. In *Bulletin of Environmental Contaminant Toxicology* 25 (1980). pp. 873-878. 2 tables. $1. **TAMU–SG–81–815. NTIS–PB–81–197–956.**

The Gulf Coast sea anemone, *Bunodosoma cavernata*, was used as the test animal, and free amino acid levels of whole animals were measured following stressed conditions. The animals were exposed to sublethal concentrations of the metals, mercuric chloride and cadmium chloride, and the organic amines, aniline, diethanol amine (DEA) and ethylene diamine (EDA). Chloride salts of mercury and cadmium were chosen in preference to other anions because chloride is the most abundant anion in seawater. These two particular metals were chosen as challenge compounds due to their high toxicity in aquatic systems. The three organic amines were chosen for their relatively high water solubility and low vapor pressure in an aqueous solution, thus ensuring that the toxic compound is retained in the test solution. Since organic amines are used extensively in the Gulf Coast industrial complex, there is a high probability of these compounds contaminating the marine environment.

Uptake and Survival of Enteric Viruses in the Blue Crab, *Callinectes sapidus*. T. W. Hejkal and C. P. Gerba. In *Applied and Environmental Microbiology*, Vol. 41, No. 1, January 1981. pp. 207-211. 3 figures. $1. **TAMU–SG–81–816.**

Uptake of poliovirus 1 by the blue crab, *Callinectes sapidus*, was measured to assess the likelihood of contamination by human enteric viruses. Virus was found in all parts of the crab within 2 hr after the crab was placed in contaminated artificial seawater. Highest concentrations of virus were found in the hemolymph and digestive tract, but the meat also contained virus. Concentration of virus in crabs generally was less than in the surrounding water. Changes in salinity did not substantially affect the rate of accumulation. An increase in temperature from 15 to 25°C increased the rates of both uptake and removal. Poliovirus survived up to 6 days in crabs at a temperature of 15°C and a salinity of 10 g/kg. When contaminated crabs were boiled, 99.9 percent of poliovirus 1, simian rotavirus SA11, and a natural isolate of echovirus 1 were inactivated within 8 min. These data demonstrate that viruses in crabs should not pose a serious health hazard if recommended cooking procedures are used.

The Terrestrial Flora of South Padre Island, Texas. Robert I. Lonard and Frank W. Judd. July 1981. 74 pages. $4.95 **TAMU–SG–81–824.** ***Order from Publications Department, Texas Memorial Museum, The University of Texas at Austin, 2400 Trinity, Austin, Texas 78705.***

This indexed field guide with key and illustrated glossary is intended to enable the user to identify the flowering plants of South Padre Island as well as plants on other Texas barrier islands and on the Mexican barrier islands. It should be useful to teachers, students, coastal zone managers and individuals conducting environmental impact assessments. The keys are based on collections deposited in the Pan American University Herbarium. A illustrated glossary of technical terms and an index of generic and common names of plants are included.

1982–83

Simple Apparatus for Collecting Estuarine Sediments and Suspended Solids to Detect Solids-Associated Virus. Theodore G. Metcalf and Joseph L. Melnick. In *Applied and Environmental Microbiology* 45(1): 323-327 (1983). 3 tables, 2 figures. $1. **TAMU–SG–83–817.**

Laboratory trials of a new sampler for collecting estuarine sediment-associated viruses resulted in a recovery effectiveness averaging 30 percent for two enteroviruses and rotavirus SA11. A minimal recovery potential of 54 percent was calculated when losses caused by inadequacies in the virus-concentration procedure were excluded. Viruses associated with sediments and suspended solids were collected with the sampler. Recoveries of 61 and 60 percent of poliovirus and rotavirus, respectively, were obtained for saltwater-suspended, solids-associated virus. The unique advantage of the sampler for selective collection of virus-associated top layers of sediment, plus collection over extensive areas, resulted in recovery of more virus than was obtained with a commonly used dredge-type sampler.

1983–84

Plants of the Texas Shore - A Beachcomber's Guide. Mary Michael Cannatella and Rita Emigh Arnold. March 1985. 78 pages, photographs, 1 map. $5.95 (plus shipping and applicable sales taxes). **TAMU–SG–84–301.** ***Order from Texas A&M University Press, Texas A&M University, College Station, Texas 77843.***

Each year thousands of tourists flock to the Texas shores,

where land meets sea for nearly 400 miles. The coastline teams with life, from tiny ghost crabs scurrying across sandy beaches to whooping cranes standing five feet tall. But plants—the basis of life in the wetlands and a source of beauty and diversity—are often ignored as a part of the background mosaic of sea and sun. This paperback book, skillfully blending photographs and drawings with a readable text, is a handy field guide for anyone wishing to explore plant life along the Texas coast. In nontechnical language, the authors offer readers a firsthand glimpse of coastal flora in its various habitats: barrier island, bays and marshes and chenier plains. The book, which also includes information on the many state parks and wildlife refuges of the area, is an invaluable guide for tourists and amateur naturalists visiting Texas shores.

ß-Alanine Metabolism and High Salinity Stress in the Sea Anemone, *Bunodosoma cavernata*. M.R. Kasschau, C.M. Skisak, J.P. Cook and W.R. Mills. In *Journal of Comparative Physiology Bulletin* 154:181-186 (1984). 6 tables. $1. **TAMU–SG–84–807.**

During high salinity stress, ß-alanine accumulates to high levels in the sea anemone, *Bunodosoma cavernata*. Following a salinity increase from 26‰ to 40‰ ß-alanine increased 28-fold from 1.5 to 41.9 µmoles/g dry weight. Both whole animal studies and experiments with cell free homogenates indicate that under high salinity conditions an increase in the rate of ß-alanine synthesis from aspartic acid as well as a decrease in the rate of ß-alanine oxidation are responsible for the observed accumulation of ß-alanine is about three times greater in anemones acclimated to 40‰ than for those in normal salinity water (26‰). ß-alanine oxidation to CO_2 and acetyl-CoA proceeds 2.5 to 3 times slower in high salinity adapted *B. cavernata* than in those acclimated to normal salinity. There is always a rapid degradation of uracil to ß-alanine, but this does not change with salinity.

Free Amino Acid Pool of a Sea Anemone: Exposure and Recovery After an Oil Spill. M.R. Kasschau and C.L. Howard. In *Bulletin of Environmental Contamination and Toxicology* 33:56-62 (1984). $1. **TAMU–SG–84–810.**

Numerous studies have been performed to determine the physiological effects of oil spills and water contamination on marine animals. Much has been learned about the physiological effects of oil pollution even though the majority of these studies have been performed under constant laboratory conditions rather than a field situation. During a 19-month field study to determine the effects of natural environmental parameters on the FAA pools of the Gulf Coast sea anemone, *Bunodosoma cavernata* (Howard and Kasschau 1980), an oil tanker collision occurred about eight miles off Galveston Island. More than 95,000 barrels of Nigerian crude oil spilled, 85 percent of which burned. The initial spill from the Burma Agata occurred on November 1, 1979 with large leakages continuing for several weeks. Oil reached shore in different areas at different times. There was no visible sign of oil on the first collection date 13 days after the spill, but 11 days later the anemones were covered with an oil sheen. Because of this natural exposure to the oil, it was decided to monitor the sea anemomes for the changes in the FAA pool during the oil exposure and recovery period. Results indicate that the sea anemome, *Bunodosoma cavernata*, can tolerate an oil sheen, at least during cold weather and normal salinity conditions, without any dramatic change and immediate adverse effects. The major changes in the FAA pool take about two weeks to appear, and show up as increases in a number of FAA's. *B. cavernata* apparently returns to normal about seven weeks following exposure.

1984–85

Airphoto Analysis of the Impact of Hurricane Alicia on Galveston Island. Arthur R. Benton, Jr. and Jim M. Bolleter. November 1984. 61 pages, 22 figures. $2. **TAMU–SG–85–201. NTIS–PB–85–220276/AS.**

This study compares aerial photographs taken shortly after the passage of Hurricane Alicia across Galveston Island, Texas, August 1983, to similar photographic sequences taken in 1979, 1977, 1967 and 1952, and other photos. The purpose of the study was to quantify the erosional impact of the hurricane, and to determine whether that impact was a departure from, or merely a continuation of, the ongoing pattern of mid- to long-term shoreline movement on the island. The authors conclude that, considering the implications of the Texas Open Beaches Act and the probability of continued long-term erosion along Galveston's West Beach, purchase of a beachfront home in that area is a chancy proposition at best. They suggest that any new waterfront structure be set back sufficiently far from the vegetation line to accommodate at least 30 years of projected erosion for the particular stretch of beach on which it is to be located.

Isolation of Enteroviruses from Water, Suspended Solids, and Sediments from Galveston Bay: Survival of Poliovirus and Rotavirus Adsorbed to Sediments. V. Chalapati Rao, Karsten M. Seidel, S.M. Goyal, Theodore G. Metcalf and Joseph L. Melnick. In *Applied and Environmental Microbiology* 48(2): 404-409 (1984). 1 figure, 7 tables. $1. **TAMU–SG–85–809.**

The distribution and quantitation of enteroviruses among water, suspended solids, and compact sediments in a polluted estuary are described. Samples were collected sequentially from water, suspended solids, fluffy sediments (uppermost layer of bottom sediments), and compact sediment. A total of 103 samples were examined of which 27 (26 percent) were positive for virus. Polioviruses were recovered most often, followed by coxsackie B viruses and echoviruses 7 and 29. Virus was found most often attached to suspended solids: 72 percent of these samples were positive, whereas only 14 percent of water samples without solids yielded virus. Fluffy sediments yielded virus in 47 percent of the samples, whereas only 5 percent of compact botton-sediment samples were positive. When associated with solids, poliovirus and rotavirus retained their infectious quality for 19 days. The same viruses remained infectious for only 9 days when freely suspended in seawater. Collection of suspended solids at ambient water pH appears to be very useful for the detection of virus; it has advantages over collecting and processing large volumes of water, with accompanying pH adjustment and salt addition for processing.

Persistently Infected Cultures as a Source of Hepatitis A Virus. Robin S. Simmons, Gyorgy Szucs, Theodore G. Metcalf and Joseph L. Melnick. In *Applied and Environmental Microbiology* 49(4):749-755 (1985). 4 figures, 3 tables. $1. **TAMU–SG–85–819.**

Primary African green monkey kidney, continuous African Green monkey kidney cell line BS-C-1, and buffalo green monkey kidney cultures were infected with a uniform inoculum of hepatitis A virus (HAV). Although both the cell line BS-C-1 and primary African green monkey kidney produced useful amounts of virus, HAV was detected earlier in greater quantities in primary African Green monkey kidney cultures. A persistently infected primary African green monkey kidney culture was developed. The influence of incubation time (4 to 40 days) and concentration (2 to 15 percent) of fetal calf serum in the maintenance medium on production of HAV by

this culture was examined. An incubation period of 24 to 28 days was found to be optimal; reducing this period led to decreased yields of HAV. No significant difference in the amount of HAV produced was observed with differing concentrations of fetal calf serum. Three different methods of extraction and the effect of multiple extractions on the recovery of HAV from cell lysates were examined. Sonication was a critical factor. Two extractions yielded more than 90 percent recoverable virus. Yields in excess of 10^{11} physical particles of HAV per 850-cm^2 roller bottle were routine. The total yield could be increased by concentrating HAV present in spent maintenance medium by using bentonite or organic flocculation.

1986–87

Red Tide in Texas—An Explanation of the Phenomenon. November 1986. 4 pages. **TAMU-SG-87-502.**

Following the red tide outbreak off the Texas coast in 1986, there were many questions about this phenomenon, which is rare in Texas. This fact sheet explains the causes of the red tide bloom, when and where it occurs, its impacts on marine life and on humans, and the economic aspects of red tide.

Detection of Hepatitis A Virus in Seeded Estuarine Samples by Hybridization with cDNA Probes. Xi Jiang, Mary K. Estes, Theodore G. Metcalf and Joseph L. Melnick. In *Applied and Environmental Microbiology* 52(4):711-717 (1986). $1. **TAMU-SG-87-829.**

The development and trials of a nucleic acid hybridization test for the detection of hepatitus A virus (HAV) in estuarine samples withing 48 h are described. Approximately 10^4 physical particles of HAV per dot could be detected. Test sensitivity was optimized by the consideration of hybridization stringency, ^{32}P energy level, probe concentration, and nucleic acid binding to filters. Test specificity was shown by a lack of cross-probe concentration, and nucleic acid binding to filters. Test specificity was shown by a lack of cross-hybridization with other enteroviruses and unrelated nucleic acids. Potential false-positive reactions between bacterial DNA in samples and residual vector DNA contamination of purified nucleotide sequences in probes were eliminated by DNase treatment of samples. Humic acid at concentrations of upt to 100 mg/liter caused only insignificant decreases in test sensitivity. Interference with hybridization by organic components of virus-containing eluates was removed by proteinase K digestion followed by phenol extraction and ethanol precipitation. The test is suitable for detecting naturally occurring HAV in samples from polluted estuarine environments.

1987-88

Water Rights for Texas Estuaries. Ronald A. Kaiser and Sharon Kelly. September 1987. In *Texas Tech Law Review*, 18(4): 1121-1156. $1 **TAMU-SG-88-801.**

At first glance, river flow may seem unrelated to the ecological and economic integrity of saltwater bays and estuaries; closer examination reveals otherwise and underscores an important issue in water use and allocation. Coastal rivers and reservoirs provide the freshwater essential to estuarine integrity, and the balancing of estuarine freshwater inflow needs against upstream diversions of water for agricultural, industrial, and municipal uses is a problem of increasing significance. This article examines the legal mechanisms that exist in Texas to allocate freshwater for estuarine inflows. Texas' experience with inflow protection raises policy and legal issues important to other coastal states—namely, what legal mechanisms are available under appropriate water law to protect freshwater inflows.

The *M/V Wellwood* Grounding: A Sanctuary Case Study. S.R. Gittings and T.J. Bright. 1988. In *Oceanus*, 31(1): 35-41. **TAMU-SG-88-812.**

In August 1984, a 6000-ton freighter ran aground on Molasses Reef in the Key Largo National Sanctuary. Extensive damage was caused to the reef. The affected coral, reef fish and algal populations were monitored over the following 2-yr period. Recovery to pre-impact conditions is estimated to require at least several decades. Several management procedures to facilitate recovery are suggested.

1990-91

Salt, Seeps, and Symbiosis in the Gulf of Mexico. J.M. Brooks, D.A. Wiesenburg, H. Roberts, R.S. Carney, I.R. MacDonald, C.R. Fisher, N.L. Guinasso, Jr.. W.W. Sager, S.J. McDonald, R.A. Burke, Jr., P. Aharon, and T.J. Bright. In *Eos*, Vol. 71, No. 45, November 6, 1990, Pages 1772-1773. **TAMUG-SG-91-808.**

Seafloor oil seepage on the continental slope of the Gulf of Mexico drives a number of distinct biological, chemical and geological processes. Macroseepage of oil and gas controls the extent and distribution of chemosynthetic "oil seep" communities, the seafloor configuration, sediment character and sediment geochemistry. Besides providing substrates for chemosynthetic communities, these macroseeps charge the sediments with gas and oil resulting in acoustic wipe-out zones, the formation of gas hydrates, massive carbonate formation and in extreme cases, create mud volcanos with blow-out craters. Besides gas and oil, brine is also seeping upward into and out of Gulf of Mexico continental slope sediments. In many areas, the gas and salt migrate together, forming seabottom salt pools charged with methane and hydrogen sulfide, which support chemosynthetic organisms. Since the discovery of oil-and gas-fueled chemosynthetic communities in the Gulf of Mexico in 1984, studies have been conducted on the communities to determine their carbon and energy sources, metabolic and enzymatic characteristics, genetic makeup and taxonomy. All these studies have been of communities in relatively shallow water (< 1000 m). In April 1990 we used the Deep Submergence Vehicle (DSV) *Alvin* for 12 dives to continue studies of the associations among salt, seepage, seafloor configuration and deep-ocean symbiosis at the seafloor of the Gulf of Mexico.

Infection of Phytoplankton by Viruses and Reduction of Primary Productivity. C.A. Suttle, A.M. Chan and M.T. Cottrell. In *Nature*, Vol. 347, No. 6292, pp. 467-469, 4th October, 1990. **TAMU-SG-91-809.**

Natural marine waters contain roughly 10^6 to 10^9 virus particles per ml, yet their role in aquatic ecosystems and the organisms that they infect remain largely unknown. Electron microscopy has been used to study interactions between viruses and their hosts, focusing mainly on pathogens to prokaryotic organisms[1-5]. Here we demonstrate that viral pathogens infect a variety of important marine primary producers, including diatoms, cryptophytes, prasinophytes and chroococcoid cyanobacteria. Also, addition to sea water of particles in the 0.002-0.2 μm size range, concentrated from sea water by ultrafiltration, reduced primary productivity ([^{14}C]bicarbonate incorporation) by as much as 78 percent. These results indicate that, in addition to grazing and nutrient limitation, infection by viruses could be a factor regulating phytoplankton community structure and primary productivity in the oceans.

Fisheries

1970–71

Ecological Aspects of Selected Crustacea of Two Marsh Embayments of the Texas Coast. Fred S. Conte and Jack C. Parker. June 1971. 184 pages. $3. **TAMU–SG–71–211. NTIS–COM–71–00963.**

Research reported here was aimed at sampling and identifying the assemblage of Crustacea collected in two highly saline marsh embayments near West Bay, Texas. Seasonal abundance of these organisms with respect to temperature and salinity were determined for the purpose of comparing seasonal variations in abundance, the coefficient of condition and the size distribution of each of the commercial penaeid shrimp, *Penaeus setiferus* (Linnaeus) and *Penaeus aztecus* Ives. The extent to which commercial shrimp use marsh bayous as nursery grounds and the effect of the pesticide malathion on commercial penaeid shrimp were also studied.

1971–72

A Hydrophonic Study of the Feeding Activities of Western Atlantic Parrotfishes. John D. Sartori and Thomas J. Bright. 92 pages. $3. **TAMU–SG–72–203. NTIS–COM –73–10073.**

A passive acoustic technique for monitoring feeding activities is described. A relationship between amount of calcareous material removed from a coral substrate and number of feeding sounds heard was derived, whereby it was calculated that 1050 kg/ha/yr of calcareous material would be removed by grazing parrotfishes in the study area.

1972–73

Artificial Reefs for Texas. December 1973. 39 pages. $3. **TAMU–SG–73–214. NTIS–COM–74–10853/AS.**

This report discusses some of the criteria that must be considered in the development of artificial saltwater reefs for the Texas coast. Materials of past and future reefs, site locations that reduce risks and enhance usability, project financing and possible alternatives and legal institutional issues are examined.

1975–76

Aspects of the Life History of the Atlantic Croaker, *Micropogon undulatus*. Michael L. White and Mark E. Chittenden, Jr. March 1976. 54 pages. $2. **TAMU–SG–76–205. NTIS–PB–256–105/AS.**

A validated scale method of age determination is described for the Atlantic croaker, *Micropogon undulatus*. Two age classes were generally observed, but only one was abundant. Mean total lengths were 155-165 mm at age 1 and 270-289 mm at age 11 based on three methods of growth estimation. Fish matured near the end of their first year of life when they were about 140-170 mm in total length. Spawning occurred September through March and reached a peak in October. Contrasts are presented to illustrate differences in the life histories of croaker found north and south of Cape Hatteras, N.C.

Composition of the Ichythofauna Inhabiting the 110-M Bathymetric Contour of the Gulf of Mexico, Mississippi River to the Rio Grande. Mark E. Chittenden, Jr. and Donald Moore. July 1976. 15 pages. $1. **TAMU–SG–76–210. NTIS–PB–259–595.**

This paper documents the ichthyofauna of the 110-m bathymetric contour of the northern Gulf from the Mississippi River to the Rio Grande. Sixty-nine species were identified. Analyses presented are based on trawl surveys conducted 1962-1964 by the Bureau of Commercial Fisheries. Implications of the present findings are discussed in Chittenden and McEachran (**TAMU-SG-76-208**) which reviews the demersal fish communities on the continental shelf for the entire Gulf.

1976–77

Stop Shrimp "Black Spot". Ranzell Nickelson, II and Bruce Cox. April 1977. 4 pages. **TAMU–SG–77–504.**

Black spot, its occurrence and its prevention are discussed in this advisory bulletin. The use of sodium bisulfite in the prevention of black spot formation, both as a powder sprinkled on layers of harvested shrimp and in solution as a dip, is explored. It was determined that the dip, in the proportions given, was far more effective due to more even distribution. Frequent changes of the dip solution ensure maximum effectiveness. The use of sodium bisulfate as related to shrimp packers and processors, as well as to consumers, is also discussed.

1977–78

Proceedings of the Second Annual Tropical and Subtropical Fisheries Technological Conference of the Americas. Ranzell Nickelson, II (comp.) October 1977. 338 pages. $10. **TAMU–SG–78–101. NTIS–PB–279–405.**

The conference was held April 17-20, 1977 in Biloxi, Mississippi. Twenty-eight papers were given on topics related to production, processing packaging, distribution or utilization of tropical and subtropical fish species.

1978–79

Proceedings of the Third Tropical and Subtropical Fisheries Technological Conference of the Americas. September 1978. 365 pages. $10. **TAMU–SG–79-101. NTIS–PB–289–998.**

Thirty-three papers presented at the Annual Conference of the Tropical and Subtropical Fisheries Technological Society of the Americas in New Orleans, April 23-26, 1978, appear in this proceedings. Topics include utilization, production and processing of fishery products.

1979-80

Proceedings of the Fourth Annual Tropical and Subtropical Fisheries Technological Conference of the Americas. Ranzell Nickelson, II (comp.). September 1979. 254 pages. $10. **TAMU–SG–80–101.**

The fourth annual conference of this professional and educational association of fishery technologists was held April 22-25, 1978 in St. Petersburg, Florida. The proceedings includes 29 papers from the conference which focused on fisheries production, processing, packaging, distribution, utilization and related topics. Graphs, tables and photographs accompany many of the papers.

1980–81

Proceedings of the Fifth Annual Tropical and Subtropical Fisheries Technological Conference of the Americas. Ranzell Nickelson, II (comp.). September 1980. 256 pages. $10. **TAMU–SG–81–101.**

The fifth annual meeting of this professional and educa-

tional association of fishery technologists was held in Charleston, South Carolina in April, 1980. Twenty-four papers are included in the proceedings of this meeting which focus on the problems related to the harvesting and utilization of tropical and subtropical fishery species.

Immunoenzyme Microscopy for Differentiating Among Systemic Bacteria Pathogens of Fish. D.H. Lewis. In *Can Journal of Fishery Aquatic Sciences* 38: 463-466 (1981). $1. TAMU-SG-81-819.

Immunoenzyme techniques were developed for detecting subclinical infections of *Yersinia ruckeri* and differentiating acute yersiniosis from motile *aeromonas septicemia* in channel catfish *Ictalurus punctatus*. Immunoenzyme techniques were comparable to immunofluorescence and cultural procedures for detecting and differentiating *Y. ruckeri* and *Aeromonas hydrophilia* infections in catfish. The availability of immunoenzyme microscopic techniques extends immunostaining microscopy to laboratories possessing only conventional microscopes.

1981–82

Proceedings of the Sixth Annual Tropical and Subtropical Fisheries Technological Conference of the Americas. Ranzell Nickelson, II (comp.). December 1981. 219 pages. $10. TAMU-SG-82-101.

The sixth annual meeting of the Tropical and Subtropical Fisheries Technological Society of the Americas was held in San Antonio, Texas, in April, 1981. This proceedings includes 21 papers which focus on factors associated with the harvesting and utilization of tropical and subtropical fishery species. Topics range from the status of the fishing industry and seafood technology in Asia, Central America and South American to reviews of the crawfish and alligator meat industries in the southern United States. Graphs, tables and photographs accompany many of the papers.

Proceedings of the Seventh Annual Tropical and Subtropical Fisheries Technological Conference of the Americas. Ranzell Nickelson, II (comp.). April 1982. 389 pages, many figures and tables. $10. TAMU-SG-82-110. NTIS-PB-82-235-094.

The Seventh Annual Tropical and Subtropical Fisheries Technological Conference of the Americas was held January 11-14, 1982 in New Orleans. The proceedings includes 38 papers addressing two general topics, inspection and quality control of fisheries products, and fisheries economics and production. More specifically, the papers concern bacteriology, seafood storage techniques, public health, underutilized species, price forecasting, marketing and extension services, and management.

Description of Eggs and Larvae of Laboratory Reared Red Drum, *Sciaenops ocellata*. J. Holt, A.G. Johnson, C.R. Arnold, W.A. Fable, Jr. and T.D. Williams. In *Copeia*, 1981(4): 751-756. $1. TAMU-SG-82-816.

Egg and early larval development and pigment patterns of the red drum *Sciaenops ocellata* are described through day 13 after hatching. The pelagic, spherical eggs averaged 0.95 mm in diameter and usually contained one oil globule averaging 0.30 in diameter. About 25 percent contained two to six oil globules that coalesced into one globule by 13 h. Hatching (at 22-23°C) occurred 28-29 h after fertilization. Standard length (SL) at hatching was 1.71-1.79 mm. Yolk-sac larvae were negatively buoyant and drifted downward (head first) about 95 percent of the time. Larvae began swimming in a horizontal position in pursuit of prey after the yolk was temperature-dependent. Length of the yolk-sac stage varied from 40 h at 30°C to 84 h at 20°C. Growth was rapid after the larvae had begun to feed. Mean SL was 1.74 at hatching and 5.11 mm at 300 h. Larvae were fed rotifers *Brachionis plicatilis* and *Artemia salina nauplii*.

Differences in Hemoglobin Phenotypes among Spanish Mackerel, *Scomberomorus maculatus*. L.C. Skow and M.E. Chittenden, Jr. In *Northeast Gulf Science*, 5: 67-70 (1982). $1. TAMU-SG-82-817.

Hemoglobin from Spanish mackerel can be fractionated into two electrophoretic patterns. Analysis of the frequencies of the two hemoglobin phenotypes suggests that Spanish mackerel from the northwestern Gulf of Mexico and from the East Coast constitute separate populations.

Reproduction, Movements and Population Dynamics of the Sand Seatrout, *Cynoscion arenarius*. Philip A. Shlossman and Mark E. Chittenden, Jr. In *Fishery Bulletin* 79(4): 649-669 (1981). $1. TAMU-SG-82-820.

Cynoscion arenarius females mature at 140-180 mm total length (TL) as they approach age I. Spawning occurs from early March through September, with peaks in spring (March-May) and late summer (August-September). Spawning occurs in the inshore Gulf of Mexico, coinciding with the periodicity of shoreward winds and surface currents that probably transport eggs or larvae to estuarine and inshore nurseries, which are usually in water shallower than 18 m. Both spawned groups winter in the Gulf of Mexico. TL averages 210-280 mm. The largest trawled specimen was 342 mm TL, and 99.5% were less than 280 mm TL. No more than three spawned groups or two year classes occurred at any one time. The typical maximum lifespan is one to two years based on trawl data, and possibly as much as two to three years based on other collection methods. Total annual mortality rate was 99.79% based on trawl data and no less than 80-90% if maximum lifespan typically is as long as three years. Regressions of TL with total weight, girth and standard length are presented.

The Imprinting Hypothesis and Sea Turtle Reproduction. David W. Owens, Mark A. Grassman and John R. Hendrickson. In *Herpetologica* 38(1): 124-135 (1982). $1. TAMU-SG-82-822.

Carr proposed that sea turtles learn characteristic components of their natal beach early in life and use olfaction and possibly other senses to locate their natal beach for nesting. Several aspects of sea turtle life history have hampered verification of this hypothesis using experiments designed to artificially imprint turtles to a new beach. Laboratory tests suggest that loggerheads *Caretta caretta* acquire a food preference that has an olfactory component but that food imprinting does not occur because the turtle rapidly loses this initial food preference. A preliminary laboratory attempt at artificially imprinting on chemical cues is equivocal. An alternate hypothesis is the "social facilitation model" proposed by Hendrickson, which supposes sociality for maturing turtles in which first-time nesters encounter and follow experienced adults to the nesting beach, which they then "learn" by olfactory and other navigation systems. The latter model appears to have parsimonious attributes, thus warranting increased consideration for at least some populations.

Dynamic Modeling of the Eastern Gulf of Mexico Shrimp Fishery. Vito J. Blomo, John P. Nichols, Wade L. Griffin and William E. Grant. In *American Journal of Agricultural Economics*. 64: 475-482 (1982). $1. TAMU-SG-82-825.

Using simulation techniques, the authors analyze the impacts of alternate management schemes on the shrimp fishery

of the eastern Gulf of Mexico and compare them to a baseline. Modeling of the fishery's biological and economic functions includes intraseasonal shrimp growth rates, differences in demand for shrimp by size, and a heterogenous fishing fleet. Using consumer and producer surplus techniques, the comparisons suggest that new fishing regulations appear socially optimal. A rent-maximization scheme increases social surplus to its highest level. However, applying such a scheme to only one part of the Gulf shrimp fishery is not recommended.

1982–83

Proceedings of the Eighth Annual Tropical and Subtropical Fisheries Conference of the Americas. Ranzell Nickelson II (comp.). August 1983. 269 pages, figures and tables. $10. **TAMU–SG–83-112. NTIS–PB–84–104–488.**

The proceedings includes 25 papers presented at the conference. Topics include fisheries production and management, fish community ecology, fishing gear and methods, parasitology, pathology and microbiology and seafood technology.

Saltwater Fishes of Texas: A Dichotomous Key. Edward O. Murdy. August 1983. 220 pages, spiral bound, 500 + drawings. $10. **TAMU–SG–83–607. NTIS–PB–83–256–842.**

In the 10 years since the second edition of *Key to the Estuarine and Marine Fishes of Texas* was published, many studies have improved our knowledge of Texas marine fishes. Notable among these works are Bright and Cashman (1974), Hoese and Moore (1976) and the FAO Species Identification Sheets for the Western Central Atlantic (1978). These publications and other sources have provided the impetus and new information for *Saltwater Fishes of Texas*. The new key retains the format and style of the earlier key, but roughly 50 percent of the keys have been updated at the ordinal, familial and species levels. *Saltwater Fishes of Texas* includes 130 species not found in the earlier volume and contains more than 500 drawings of fishes and diagnostic structures referred to in the keys.

Contracting Problems and Regulation: The Case of the Fishery. Ronald N. Johnson and Gary D. Libecap. In *American Economy Review* 72(5): 1005-1022 (1982). $1. **TAMU–SG–83–809.**

The paper examines common property conditions of the Texas bay shrimp fishery and other fisheries. It analyzes the limited nature of private territorial rights, customs and formal state regulation. The study argues that the heterogeneity of fishermen, a result of different skills, labor/leisure decisions and capital endowments, increases the costs of bargaining within fishing groups for controls on fishing effort and affects the types of regulations that ultimately emerge. The study demonstrates that fishermen, in general, support regulations increasing total yields without disrupting status quo rankings of fishermen, such as season closures and gear restrictions protecting juvenile shrimp. An analytical model is presented, illustrating hazards to fishermen of quota arrangements and limited entry with transferable licenses. These arrangements can redistribute income and reduce total rents in the fishery, and they explain the lack of support among shrimpers for intense regulation. The incentive of shrimpers to agree to internal effort constraints, however, increases as the fishery becomes economically overfished. At that point, detailed limited entry and quota schemes may be adopted. The paper reveals the importance of widespread support of regulations reducing enforcement costs and increasing the probability of success. While better, more productive fishermen may be few in number, their endorsement of any regulatory effort is crucial, given the high esteem they hold in fishing communities.

Development and Extinction of Food Preferences in the Loggerhead Sea Turtle, *Caretta caretta*. Mark A. Grassman and David W. Owens. In *Copeia* 1982(4): 965-969 (1982). $1. **TAMU–SG–83–810.**

Hatchling loggerhead sea turtles developed preferences for the first foods they ate after hatching. These preferences did not persist after the animals had eaten foods different from their initial diets. Thus, our results do not support the food-imprinting hypothesis in turtles. Because sea turtles fed a particular diet readily adapt to a new diet under laboratory conditions, we suggest that headstarted turtles could adapt to natural foods encountered in the wild. Finally, because the turtles chose their initially preferred diets whether or not the foods were visually disguised, chemoreception appeared significant in the turtle's food-choice behavior.

Effects of Temperature and Salinity on Egg Hatching and Larval Survival of Red Drum, *Sciaenops ocellata*. Joan Holt, Robert Godbout and C.R. Arnold. In *Fisheries Bulletin* 79(3): 569-573 (1981). $1. **TAMU–SG–83–811.**

Eggs were obtained from laboratory spawnings induced by manipulations of temperature and photoperiod simulating natural seasonal changes. Brood-tank temperatures ranged from 24 to 26°C and salinities from 26 to 32 ppt. The best conditions for hatching and 24-hour larval survival were 30 ppt and 25°C. Poorest survival was at 15 ppt and 30°C. Temperature was associated with significant differences in survival of two-week-old larvae. The lowest temperature used (20°C) resulted in reduced survival rate. The effect of temperature on larval growth rate was pronounced. Growth at 20°C was much slower than at 25 or 30°C. Salinity had little influence on growth.

Spawning, Age Determination, Longevity and Mortality of the Silver Seatrout, *Cynoscion nothus*, in the Gulf of Mexico. Douglas A. DeVries and Mark E. Chittenden, Jr. In *Fisheries Bulletin* 80(3): 487-500 (1982). $1. **TAMU-SG-83-812.**

Cynoscion nothus females from the Gulf of Mexico off Texas matured at 140-170 mm SL as they approached age I. Spawning occurred from early May through late October but primarily in two periods, May and August-September. Greatest spawning occurred in the August-September period when two distinct spawned groups (intrayear class cohorts) were produced. The multiple-spawned group structure within a year class may be important to the population dynamics and stability of *C. nothus*. This species reached 130-190 mm SL at age I. Only one year class occurred or dominated in any one month, and only two year classes were ever present at once. The largest specimen captured was 190 mm SL and 99% were <160 mm. The maximum life span (t_L) was only 1-1.5 years off Texas but might be 2 years in the northcentral gulf. The total annual mortality rate was best estimated at 99.83% and probably is no lower than 90% if the life span is as long as 2 years. Larger *C. nothus* almost disappeared during winter suggesting an offshore movement for overwintering.

Reproduction, Movements and Population Dynamics of the Longspine Porgy, *Stenotomus caprinus*. Paul Geoghegan and Mark E. Chittenden, Jr. In *Fisheries Bulletin* 80(3): 523-540 (1982). $1. **TAMU–SG–83-813.**

Stenotomus caprinus mature at 90-125 mm TL as they approach age I. Spawning occurs once a year in a discrete period of 50-80 days from January through April, peaking in February or March. The male/female ratio was 1-to 1.21 during spawning. Spawning occurs in waters deeper than 17 m,

coinciding with the periodicity of onshore surface currents in the northern Gulf of Mexico. These currents probably carry eggs and larvae inshore to nursery areas less than 27 m deep where recruitment occurs. As they mature, young-of-the-year gradually disperse to waters of 36-55 m, where age I and II fish are most abundant. *S. caprinus* are most vulnerable to trawling at night. Growth in length is fastest in the first eight months but slows greatly as they mature and divert energy toward reproduction. TL averaged 110-135 mm at age I, 130-155 mm at age II, and 160 mm at age III. Maximum TL is about 200 mm , and maximum lifespan is 2.5-3 years. Total annual mortality rate is 83-99%, but postspawning survival, mortality rate and lifespan vary greatly with year class. Total weight/TL, length/width, and girth/TL relationships are presented. The population dynamics of *S. caprinus* appears quite different from that of *S. chrysops*, and the genus may show zoogeographic change at Cape Hatteras, N.C.

Changes in LH and Progesterone Associated with the Nesting Cycle and Ovulation in the Olive Ridley Sea Turtle, *Lepidochelys olivacea*. Paul Licht, David W. Owens, Kim Cliffton and Cuauhtemoc Penaflores. In *General Comparative Endocrinology* 48: 247-253 (1982). $1. **TAMU–SG–83–815.**

Studies of a large nesting population of the olive ridley sea turtle on the Pacific coast of Mexico established that ovulation is completed in most animals within a few days after nesting in this multiclutched species. By three days postoviposition, eggs in the oviduct contain thin, partially calcified shells, even though eggs may not be laid for as long as a month. Analysis of serum samples demonstrated the presence of a pronounced "ovulatory surge" in luteinizing hormone (LH) and progesterone (Pro). Levels of both hormones increase by more than an order of magnitude within a day after oviposition and return to near baseline levels within 2 to 3 days, by the time the egg shell membrane appears. Testosterone and estradiol levels change little in the preovulatory period. These increases in LH and Pro are highly correlated in both time and magnitude. Increases in Pro comparable to the ovulatory surge could not be induced by injection of extracts of homologous pituitaries into preovulatory animals before nesting. Also, gonadotropin releasing hormone and a potent agonistic analog were inactive in both sexes of the breeding turtle.

Growth of Juvenile Red Snapper, *Lutjanus campechanus*, in the Northwestern Gulf of Mexico. Scott A. Holt and Connie R. Arnold. In *Fisheries Bulletin* 80(3): 644-648 (1982). $1. **TAMU–SG–83–816.**

Red snapper were collected off Texas from an artificial reef (sunken liberty ships) with fish traps, and from the outer continental shelf by trawling. The largest fish trapped were 100-110 mm, and the smallest trawled were 20-29 mm. Bimodal size distributions indicate that juvenile red snapper grow more slowly than previously reported. Data indicate the fish grow to 110-130 mm the first year and 200-230 mm the second year. The distinct bimodality in length frequencies in snapper less than 220 mm from June through December indicated the presence of two year classes within this size range. Tagging studies indicated that snapper stay around the artificial reef during the summer and fall, but none were captured there or elsewhere after December.

Simple Apparatus for Collecting Estuarine Sediments and Suspended Solids to Detect Solids-Associated Virus. T.G. Metcalf and J.L. Melnick. 1983. In *Appl. Env. Microbiol* 45(1): 323-327. **TAMU-SG-83-817.**

Laboratory trials of a new sampler for collecting estuarine sediment-associated viruses resulted in a recovery effectiveness averaging 30 percent for two enteroviruses and rotavirus SA11. A minimal recovery potential of 54 percent was calculated when losses caused by inadequacies in the virus-concentration procedure were excluded. Viruses associated with sediments and suspended solids were collected with the sampler. Recoveries 61 and 60 percent of poliovirus and rotavirus, respectively, were obtained for saltwater-suspended, solids-associated virus. The unique advantage of the sampler for selective collection areas, resulted in recovery of more virus than was obtained with a commonly used dredge-type sampler.

The Commercial Production of Mudminnows (Fundulus grandis) for Live Bait: A Preliminary Economic Analysis. Benita P. Waas, Kirk Strawn, Michael Johns and Wade Griffin. In *Texas Journal of Science* XXXV(1): 51-60 (1983). $1. **TAMU–SG–83–820.**

The economic feasibility of operating a commercial mudminnow farm was determined using the Generalized Budget Simulation Model for Aquaculture developed at Texas A&M University. A ten year planning horizon was used. Initial investment costs, annual budgets and cash flows were estimated to determine cost, returns and profit. Economic profit, break-even analysis and net present value were used to evaluate the economic feasibility. Based on a grow-out stocking density of 400,000/ha, 85 percent projected survival, two crops per year and achieved production at 80 percent of capacity, the 24-ha facility showed an economic profit of $41,160 for the sixth year of operation. The break-even price of $0.40/dozen was $0.25 less than the market price of $0.65. The break-even production of 278,705 dozen/year is 174,629 dozen less than the assumed annual production of 453,334 dozen.

1983–84

Western Gulf of Mexico Sea Turtle Workshop Proceedings. David Owens, et al. October 1983. 74 pages, 3 tables, 1 photograph. $3. **TAMU–SG–84–105. NTIS-PB-84-121-177.**

This publication summarizes the presentations made at the Western Gulf of Mexico Sea Turtle Workshop, held January 13-14, 1983 at Texas A&M University. The following presentations were made: "Current Status of the Kemp's Ridley Population", "Historical Background of the International Conservation Program for Kemp's Ridley", "Padre Island Hatchery Research", "Headstarting Kemp's Ridley", "Experimental Marking of Sea Turtles by Tissue Modification", "Random Notes on Sea Turtles in the Western Gulf of Mexico", "Sea Turtle Stranding and Salvaging Research", "Turtle Excluder Device" and "Oil and Gas Impacts on Marine Turtles in the Gulf of Mexico."

The Texas Shrimp Fishery: Analysis of Six Management Alternatives Using the General Bioeconomic Fishery Simulation Model. W. Griffin, J. Warren, J. Nichols, W. Grant and C. Pardy. October 1983. 66 pages, 20 tables, 9 figures. $3. **TAMU–SG–84–202. NTIS–PB–84–104–306.**

Six alternatives for managing the Texas shrimp fishery, proposed in recent fishery management plans or legislation, are analyzed with the General Bioeconomic Fishery Simulation Model. Alternatives are closure of specified areas for particular periods of time, changes in count size regulations, or both. They are evaluated in terms of their impact on total landings, amount of discards, costs and returns, and fishing effort. Impacts are estimated for the first year and for a long-run situation giving the industry time to adjust by increasing or decreasing the number of bay boats and Gulf vessels. For given levels of coefficients of growth and natural mortality the model's results were very close to historical landings in

terms of volume, size and seasonal distribution.

Cutting Fuel Costs: Alternatives for Commercial Fishermen. Dewayne Hollin and Steven Windh. January 1984. 17 pages, 2 charts, 2 graphs, 9 illustrations. **TAMU–SG–84–504.**

If you're looking for ways to reduce fuel consumption or increase fuel efficiency, this publication is a place to start. It describes 14 alternatives for commercial fishermen, including long-term maintenance measures and long-term alternatives such as management aids, devices to improve engine performance and vessel modifications. Advantages and disadvantages of each alternative are listed along with cost and economic data estimates. Although costs vary with time and geographic location, the estimates can help you decide which alternatives you might want to investigate more thoroughly. Alternatives described include speed reduction, hull maintenance, self-polishing paints, fuel flow meters, track plotters, LORAN C equipment, turbochargers, engine changeout, diesel fuel preheaters, controllable pitch propellers and bulbous bows. A payback formula worksheet and example are included to help you calculate how long it would take for any particular device or modification to save enough fuel to pay for itself.

Seasonal Occurrence of Black Drum, *Pogonias cromis*, and Red Drum, *Sciaenops ocellatus*, off Texas. Jeffrey L. Ross, John S. Pavela and Mark E. Chittenden, Jr. 1983. In *Northeast Gulf Science* 6(1): 67-70 (1983). $1. **TAMU-SG-84-802.**

The black drum, *Pogonias cromis*, and red drum, *Sciaenops ocellatus*, are important recreational and commercial fishes commonly captured on the Atlantic coast of the United States from Virginia to Key West, Florida and along the Gulf of Mexico (Gulf) to at least northern Mexico. The literature describes various aspects of the life history of both species, but their winter distribution has not been well defined. This paper provides data on the seasonal occurrence and distribution of black drum and red drum off Texas.

Texas Shrimpers: Community Capitalism and the Sea. Robert Lee Maril. September 1984. 222 pages. $18 (plus shipping and applicable sales taxes). **TAMU–SG–84–805.** ***Order from Texas A&M University Press, Texas A&M University, College Station, Texas 77843.***

In preparing management plans for the shrimp fishery of the Gulf of Mexico, the Gulf of Mexico Fisheries Management Council is instructed to consider socioeconomic data as well as that related to fisheries biology. Until this book was published, however, the social and economic situation of Texas shrimpers had not been documented. The book describes the work and life of a shrimper and tabulates information obtained in interviews with shrimpers, such as incomes, families, age, ethnicity, work attitudes, costs and returns for vessels, and landings.

1984–85

Proceedings of the Ninth Annual Tropical and Subtropical Fisheries Conference of the Americas. Ranzell Nickelson, II (comp.). November 1984. 344 pages, numerous figures and tables. $12. **TAMU–SG–85–106. NTIS–PB–85–221141/AS.**

This proceedings includes 21 papers presented at the conference. Topics include fisheries production and management, seafood technology, pathology and microbiology, parasitology and seafood marketing.

Components of the Seston and Possible Available Food for Oysters in Galveston Bay, Texas. Thomas M. Soniat, Sammy M. Ray and Lela M. Jeffrey. In *Contributions in Marine Science* 27: 127-141 (1984). $1. **TAMU–SG–85–814.**

Seasonal changes in components of the seston such as particulate lipid, carbohydrate and protein as well as chlorophyll-a, particulate inorganic matter (PIM), ash-free dry weigh (AFDW) and seston dry weight (DW) were measured over an annual cycle in Galveston Bay, Texas. Food for the oyster was defined as the sum of the concentrations of lipid, carbohydrate and protein a food index was calculated as the percentage food in the total seston. Wind speed appears to be an important forcing function, especially in regard to its ability to resuspend bottom material. PIM and non-algal material dominate the suspended particulate "food" measure, and the food index were intercorrelated and were higher in the spring and summer than in the fall and winter. Presumably, the nutritional quality of the seston was greater during the spring and summer period.

Reproduction, Movements, and Population Dynamics of the Banded Drum, *Larimus fasciatus*, in the Gulf of Mexico. Gary W. Standard and Mark E. Chittenden, Jr. In *Fishery Bulletin* 82(2): 337-363 (1984). $1. **TAMU-SG-85-817.**

Collections of the banded drum, *Larimus fasciatus*, were made from 5 to 100 m in the Gulf of Mexico along a cross-shelf transect off Texas during the period October typical maximum life span (tL) in the northwestern Gulf is only 1-2 years, but may be 2-3 years if the stock ranges in both the northwestern and north central Gulf. Apparent mean time-specific and cohhort-specific total annual mortality rates are 92-100%, in the northwestern Gulf but true values probably are 80-90%. For a stock the ranges in both the northwestern and north central Gulf. Fecundity, weight, girth, and length relationships are presented.

Aspects of Reproduction, Larval Development, and Morphometrics in the Pyramidellid *Boonea impressa* (*Odostomia impressa*) (*Gastroposa: Opistobranchia*). Marie E. White, Christopher L. Kitting and Eric N. Powell. In *The Veliger* 28(1): 37-51 (1985). $1. **TAMU–SG–85–823.**

Boonea impressa is an important ectoparasite of the American oyster, *Crassostrea virginica*. Here, the reproductive and larva life history, intraspecific variation in certain shell characters, and the internal anatomy of the feeding apparatus are described for population of *B. impressa* from the western Gulf of Mexico (Texas) and, for the latter two subjects, the western Atlantic (North Carolina). Larval development in the Pyramidellidae is reviewed. The life-span of *B. impressa* was approximately one year. Reproduction occurred throughout the year, but peaked in mid-summer. Eggs (182-238 um diameter) were deposited in numbers of 20-250 per egg mass. Larval development from oviposition to be hatched veliger required 3.3-4.8 days. Two days after hatching, the veligers became negatively phototaxic. Metamorphosis occurred within one week of hatching. The developmental mode of *B. impressa* fits that designated as Type II-lecithotrophic, and agrees with that expected for an opistobranch with a stable food source. The short pelagic life-span may facilitate dispersal for a species with a non-mobile, but patchy host. Recently metamorphosed *B. impressa* often attached near the aperture of an adult. This behavior may protect the young snail from predation and increase access to its food supply. The internal anatomy of the feeding apparatus differed from European odostomians in the absence of a well developed first buccal pump. Shell sculpture (number of cords per whorl) was most dependent on the length of the whorl. Adult snail size, whorl length, whorl width, and the number of spiral cords varied significantly between populations collected from Texas and North Carolina. Egg size, size of the components of the feeding apparatus, whorl length-width

ratio, and protoconch size differed less. These latter characters might be employed advantageously in the study of interspecific differences among odostomians where, heretofore, characters with greater intraspecific variability typically were used.

1985-86

Proceedings of the Tenth Annual Tropical and Subtropical Fisheries Conference of the Americas. D.R. Ward and G.D. Treece, (comps.). November 1985. 313 pages. $15. **TAMU–SG–86–102. NTIS–PB–86–140–688/AS.**

The 10th annual meeting of the Tropical and Subtropical Fisheries Technological Society of the Americas was held in New Orleans, Louisiana, in January 1985. This proceedings includes 26 papers which focus on economics, fisheries production and management, seafood processing, pathology and microbiology, and seafood technology. This volume also includes an author and subject index for Volumes 1 through 10. Volumes 2 through 9 are still available through the Texas A&M University Sea Grant College Program.

Proceedings of the Shrimp Yield Prediction Workshop. André M. Landry, Jr., and Edward F. Klima, editors. $10. **TAMU-SG-86-105.**

Shrimp stocks of the Gulf of Mexico represent an extremely valuable commodity whose management falls under the jurisidiction of state and federal fisheries agencies. The Shrimp Yield Prediction Workshop traced the evolution of state and federal programs designed to manage shrimp resources. Management strategies and goals of various regulatory agencies' shrimp research programs were discussed. Insight was gained into the significance of abundance and size data obtained by traditional sampling methods, correlations of life history trends and hydrological factors, census data gathered from the bait-shrimp fishery and density information acquired from new quantitative techniques as predictive tools for shrimp resource management. The workshop also assessed the state of the art of predicting shrimp yield and identified critical problems in redering meaningful predictions.

Economics of Harvesting and Market Potential for the Texas Blue Crab Industry. Charlotte L. Miller and John P. Nichols. September 1985. 118 pages, 24 tables, 18 figures. $5. **TAMU–SG–86–201.**

Texas ranks third in blue crab production within the Gulf of Mexico region. Two occurences which have directly affected the Texas blue crab industry began in 1975, an increase in involvement of Northeastern interest in the processing industry and an influx of Indochinese pickers and crabbers. These developments resulted in increased production due to more efficient harvesting and processing and an increase in the export of whole crabs and crabmeat to East coast markets. This report describes the Texas blue crab industry and identifies market development opportunities within Texas and the surrounding regions. The typical crab consumer is described as a middle-aged, white collar worker in the middle-income range. Demographic projections indicate that this socioeconomic group will increase, resulting in a growing market for crab. If a larger regional market should develop, according to the authors, prices rise and greater interest develops in commercial harvest, the resource may come under greater pressure. This suggests that greater emphasis be placed on more refined public management, including licensing of commerical crabbers.

Effects of Seismic Sounds on Marine Organisms: An Annotated Bibliography and Literature Review. T.L. Linton, N. Hall, D. LaBomascus and A.M. Landry. October 1985. 67 pages, 10 figures, 2 tables, 5 appendices. $3. **TAMU–SG–86–604. NTIS–PB–86–13–598/AS.**

Techniques of geophysical exploration are constantly changing, spurred by concerns for speed, efficiency and environmental protection. This project collects and reviews published studies relating to the effects of devices used for sound wave generation in geophysical exploration upon important marine organisms of the Texas coastal waters, including bays and estuaries. Researchers report that high-velocity explosives burn rapidly and produce a very fast buildup in pressure which kills fishes. The degree of lethality is directly related to charge size and distance from detonation site. Low-velocity explosives generate a moderate pressure buildup and relatively low peak pressure, producing relatively no lethal effects to aquatic organisms. Non-explosive sound sources such as air guns have a moderate pressure rise-time similar to that produces by low-velocity explosives. Although few studies have been conducted with air guns, they appear to have little adverse effect upon aquatic organisms.

Benthos Structure and Function in a South Texas Estuary. Flint. *Contributions in Marine Science* (1985) Vol. 28: 33-5. $1. **TAMU–SG–86-801.**

The Corpus Christi Bay estuary in the northwestern Gulf of Mexico was investigated for spatial and temporal variation of benthos community structure and function. Four stations were sampled quarterly for 2.5 years to investigate for macroinfaunal species assemblage changes as well as changes in benthic metabolism and nutrient regeneration. Cluster analysis of species assemblages illustrated that community structure changed from the riverine-influenced end of the estuary to the oceanic-influenced end. Taxa number increased away from the fluvial source while total abundance decreased. Maximum biomass was observed in the middle estuary region. Although spatial patterns were evident, no consistent seasonal patterns were observed for community structure characteristics from one site to the next. Community functional processes were not significantly different between sites. Metabolism did not show consistent temporal patterns but sediment nutrient flux always exhibited peak rates during the summer at all sites. Sediment texture differences as well as variability in salinity between sites were thought to influence benthos structure and function in this estuary. Multivariate discriminant analysis differentiated communities according to 1) those that inhabited a less variable environment (salinity) and supported more benthic taxa, and 2) those that inhabited a significantly different kind of sediment, supported fewer taxa, and exhibited much greater faunal biomass with corresponding larger metabolic rates. A comparison with other estuaries indicated that Corpus Christi Bay benthic metabolic rates were intermediate and that nutrient regeneration rates were high in those estuaries where similar data were available.

Pineal Gland and Melanton in Sea Turtles. Owens and Gern. *Current Trends in Comparative Endocrinology* (1985). pp. 645-648. $1. **TAMU–SG–86-805.**

Sea turtles possess unusually large pineal complexes which are highly vascularized and glandular in appearance. Histologically, secretory rudimentary photoreceptors and neurological supportive cells are distinguishable. However, there is no evidence of pineal innervation or typical photoreceptors in immature specimens of either the green (*Chelonia mydas*) or the loggerhead (*Caretta caretta*) sea turtles. Ralph has hypothesized a positive correlation between pineal complex devel-

opment (importance?) and increasing latitude. This relationship has been supported in lizards and certain rodents. Sea turtles, which are primarily tropical and subtropical, do not fit this pattern. Using a melatonin radioimmunoassay, we have conducted several physiological experiments to try to determine the role of the pineal gland and melatonin in these species. Even though at one time it was thought that melatonin might be a unique pineal product, it is now clear that this indoleamide occurs in several other tissues including the retina where it is probably synthesized. Melatonin has also been found in the blood of pinealectomized rats, sheep and rainbow trout. In the course of two experiments in which pinealectomy was performed on *C. mydas*, we have been able to examine melatonin titers post-operatively.

Comparative Endocrinology of Sea Turtles. Owens and Morris. *Copeia*, 1985 (3), pp. 723-735. $1. TAMU–SG–86–807.

In recent years, an effort has been made to begin to understand the endocrine regulation systems of endangered sea turtles. The purpose of the present paper is to review this area. The glycoproteins follicle stimulating hormone (FSH), luteinizing hormone (LH), and the thyroid stimulating hormone (TSH) have been purified from pituitaries of *Chelonia mydas*. A homologous radioimmunoassay for LH has been used to document a clear relationship between LH, ovulation and a pronounced progesterone peak which occurs as albumin is being secreted in the oviduct. A distinct role for FSH has yet to be proven, although, because estrogens seem to be out of phase with LH and progersteone, FSH may regulate estrogen. A complication with this suggestion, however, is that the reptiles which have been studied seem unique among tetrapods in not having LH and FSH receptor specificity. Circulating estrogens are at very low titers (20-50 pg/ml), with peaks in spring that may correlate with migration and ovarian maturation as well as during the internesting interval when subsequent follicular size classes are maturing. Testosterone is elevated slightly in female *C. mydas* during mating receptivity, but is much lower than early spring samples from mating males. The two species in the genus *Lepidochelys* hold mature eggs in their oviducts, apparently to ensure adequate recruitment of nesters for their unique mass nesting (arribada) system. Environmental temperature appears to directly affect some sea turtle endocrine systems. The unusually elaborate pineal complex in marine turtles produces the hormone melatonin which is reduced in the circulation and cerebrospinal fluid by the animal's exposure to light. Temperature, photoperiod and nutritional history appear capable of regulating reproductive cycling in these multiannual nesters. Much less is now known about males than females. Growth hormone (GH) and to a lesser degree prolactin are somatotrophic in marine turtles. GH also appears to synergize with gonadotropin in inducing final testicular spermiation. TSH from sea turtles or mammals did not stimulate the sea turtle thyroid in two separate assays, an observation which is both unexpected and unexplained. The ACTH-interrenal-stress axis in sea turtles is similar to other vertebrates with the glucocorticoid corticosterone demonstrating peaks at hatching, entry into the ocean and during induced stress situations.

Diel Periodicity of Spawning in Sciaenids. C.R. Arnold, S.A. Holt, G.J. Holt. *Marine Ecology - Progress Series*. Vol. 27: 1-7, 1985. $1. TAMU–SG–86–812.

Time of day was determined for spawning of several species of sciaenid fishes by examining development stages of eggs collected in estuarine and near-shore plankton samples. Estuarine samples were taken at different times of day and night but newly spawned *Cynoscion nebulosus* and *Bairdiella chrysoura* eggs were taken only during a period from just before to 3 or 4 hours after sunset. *Sciaenops ocellatus* and *Mentichirrhus* sp. Eggs from near-shore Gulf of Mexico samples, taken during the morning, all contained tail-bud stage embryos, indicating evening spawning in these species. It is proposed that evening spawning reduces predation on sciaenid eggs by allowing dispersal of eggs during the night when planktivores may be less active. Overnight dispersal reduced *C. nebulosus* egg density from 100 m^{-3} during evening spawning to 1 m^{-3} the next afternoon. Lower egg densities during the day would reduce egg mortality due to predation. Egg predation experiments showed that predation rates increased with increasing egg density but no difference was found in predation rates between trials run in light and total darkness.

Effects upon Selected Marine Organisms of Explosive used for Sound Production in Geophysical Exploration. T.L. Linton, A.M. Landry, J.E. Buckner and R.L. Berry. *The Texas Journal of Science*, XXXVII (4):pp. 341-353 (1985). $1. TAMU–SG–86–832.

Survival rate and extent and nature of injury were monitored for red drum (*Sciaenops ocellatus*), black drum (*Pogonias cromis*), blue crab (*Callinectes sapidus*), white shrimp (*Penaeus setiferus*), and American oyster (*Crassostrea virginica*) held in cages at logarithmic distances (one to 46 meters) from where a strand of commercially available explosive (Primacord with 100 grams of powder per 33 centimeters), commonly used to produce sound waves for seismic exploration, was detonated in a shallow water environment. Survival of test organisms varied with species, depth of cage, and distance from detonation site. Fish held at the surface exhibited low mortality, whereas those in bottom cages closest to site of detonation (one and 23 meters away) exhibited mortality rates between 40 and 100 percent. The swimbladder, kidney, and peritoneum were all most frequently damaged organs in fish. Shrimp exhibited modest mortality rates at all stations and water depths. Survival of shrimp did not appear to be related to distance from detonation. Blue crab survival appeared to be directly related to distance from detonation site. Survival of oysters was high at all stations and inversely proportional to distance from sound source. Varying results among test organisms were attributed to pressure wave characteristics associated with charge detonation. Comparable testing is needed during summer months to determine effects under "worst case" conditions when greater numbers and life stages of organisms are present and ambient conditions more stressful in these shallow water environments.

Biological Enhancement of Estuarine Benthic Community Structure. Flint and Kaike. *Marine Ecology - Progress Services*, Vol. 31: 23-33, 1986. $1. TAMU–SG–86–833.

Benthos in south Texas estuaries are normally concentrated in the top 3 to 4 cm where the sediment is well-oxygenated and less compact. Where larger infauna such as enteropneusts, ophiuroids, or echiurans occur in the sediments bioturbation by these infauna oxygenates and redistributes normally uninhabitated deeper sediments. A natural disturbance to Corpus Christi Bay benthos by these larger infauna could increase density and expansion of infaunal populations into deeper regions of the sediments, as well as enhance colonization by new infaunal species. During a 3.5 yr study of infaunal benthos there was a change in community structure associated with colonization of the soft-bottom habitat by the enteropneust *Schizocardium n.* sp. that resulted in a species composition atypical for a middle estuary habitat. After 2 yr the enteropneust population disappeared and the

diverse and productive soft-bottom community regressed to pre-enteropneust population disappeared and the diverse and productive soft-bottom community regressed to pre-enteropneust characteristics. Increased aerobic sediments during enteropneust presence may have diminished predicted competition and encouraged development of a more diverse community than would have otherwise existed.

Niche Characterization of Dominant Estuarine Benthic Species. Flint and Kaike. *Estuarine, Coastal & Shelf Science* (1986), 22- 657-674. $1. TAMU–SG–86-836.

Benthic macroinfaunal species in a south Texas estuarine environment were studied over a 2-5 year period to characterize their distributions and ecology. The 13 dominant taxa chosen for investigation exhibited distinct habitat usage differences as judged both by the use of discriminant analysis and the differentiation of behavioral characteristics. Species coexistence in the estuarine benthic community of Corpus Christi Bay was examined with respect to resource partitioning for such parameters as food and space. Utilization of these resources by the dominant taxa differed in both temporal and spatial dimensions, with the spatial dimension consisting of horizontal and vertical attributes. Benthic species were separated according to 1) occurrences in certain sediment types with varying organic content, 2) presence in estuarine regions characterized by different phytoplankton productivity rates, 3) different periods of annual occurrence, and 4) occurrence in different sediment microhabitats characterized by varying sediment depth and relation to depth of oxygenated sediments. Superimposed upon differences in habitat usage of these species were behavioral traits, such as feeding differences, which further discriminated how benthic species obtained resources. Based upon species occurrence in a certain characteristic environment, we speculated on the structural division of the benthic habitat by various taxa often classified as common members of the same species' assemblages in the past. Although other investigators have demonstrated interactions among co-occurring benthic infaunal species, the information presented here illustrated how these species could minimize interactions in order to maintain their populations.

1986-87

Age and Growth of Four Carcharhinid Sharks Common to the Gulf of Mexico; a Summary Paper. S. Branstetter and J.D. McEachran. *Indo-Pacific Fish Biology: Proceedings of the Second International Conference on Indo-Pacific Fishes.* 1986. pp. 361-371, Ichthyological Society of Japan, Tokyo. $1. TAMU–SG–87-801.

Age and growth information is presented for four shark species: *Carcharhinus limbatus, C. falciformis, Galeocerdo cuvieri,* and *Rhizoprionodon terraenovae.* Ages were estimated from vertebral centrum ring structure. Results were verified through back calculations and marginal increments, and validated through grow-out studies on live sharks injected with a marker, tetracycline. Age at recruitment to a developing fishery is similar for all four species at 3-4 year of age, however they enter the fishery at different stages of their life histories. The species are taken in various combinations during fishing efforts, therefore fishery management at the group level is desirable, but due to differences in their life histories, may prove to be difficult.

Bay and Offshore Fishing in the Galveston Bay Area; a Comparative Study of Fishing Patterns, Fishermen Characteristics. Graefe and Ditton. *North American Journal of Fisheries Management* (1986), 6: 192-199. $1. TAMU–SG–87-803.

Saltwater boat fishing patterns as well as fishermen characteristics and expenditures near Houston and Galveston, Texas, were investigated through a 1979 mail survey of registered boat owners who fished the Galveston Bay area. Bay and offshore fishermen were similar in most respects (income was an exception) but their economic impact varied greatly. Offshore fishing parties spent nearly twice as much money per day on the average as bay parties, but the contributed only about one-fifth as much to the regional economy because they were fewer in number and made fewer fishing trips. Offshore fishing parties were more likely than bay parties to buy snack foods and beverages, restaurant meals, tackle and equipment, and gas and oil for their boat in the coastal community. The findings presented here point to important differences in participation, spending and economic impact that need to be examined further elsewhere. The approach and findings should be of use to fishery managers and local officials when they allocate resources based on economic impact perspectives.

Utilization of Salt Marsh Plants by Postlarval Brown Shrimp; Carbon Assimilation Rates & Food Preferences. Gleason. *Marine Ecology - Progress Series* (1986). Vol. 31: 151-158. $1. TAMU-SG–87–804.

Changes in stable carbon isotope ratios were monitored at 4 d intervals for postlarval *Penaeus aztecus* Ives reared on plant foods representative of those found within a *Spartina alterniflora* Loisel salt marsh. Plant materials fed to shrimp, individually and in combination, included *Skeletonema costatum* (Greville) Cleve, *Isochrysis* sp., *Spartina* detritus, and epiphytes that grow on *Spartina.* Results of carbon isotope analyses indicated that the most rapid changes in tissue values occurred when shrimp were fed *S. costatum* alone or all foods combined. In both of these treatments the half-life of tissue carbon was reached before the first doubling of weight. Although shrimp fed epiphytes showed growth, significant assimilation of diet carbon was not detected. Food preferences were assessed with those materials which promoted growth (i.e. *S. costatum* and epiphytes) and, although there was no preference for *S. costatum* and epiphytes together compared to epiphytes alone, selection for both of these materials was greater than for *S. costatum* alone. Results indicate that (i) certain plants common in *Spartina* salt marshes such as the diatom *S. costatum*, can be important for metabolic maintenance in postlarval *P. aztecus* and (ii) postlarval brown shrimp may have substrate preferences that are not related to plant food value.

User-Resource Planning Framework for Offshore Recreational Artificial Reefs. Gordon & Ditton. *Coastal Zone Management Journal,* Vol. 13, No. 3/4. pp. 369-395. 1986. $1. TAMU–SG–87-811.

Artificial reefs have been used extensively in coastal waters to attract and enhance recreational fishery resources. In the United States, they have been traditionally built from "materials of opportunity" using limited budgets. This paper explores some past planning philosophies and presents a recent artificial reef deployment case that demonstrates a lack of sensitivity to local and regional recreational demand. A systems framework is developed to guide future planning efforts in artificial reef development. The framework is intended to integrate previously fragmented knowledge and to demonstrate the interdisciplinary nature of artificial reef planning. Emphasis is given to advance planning, user dimensions, and the integral issue of reef access.

Effect of Carbon Dioxide on Growth-rates of Selected Microorganisms Isolated from Black Drum (*Pogonias cromis*).

Michel Lannelongue and Gunnar Finne. In *Journal of Food Protection* 49(10): 806-810 (1986). $1. TAMU-SG-87-831.

The effect of carbon dioxide (25-100%)-enriched atmospheres on growth rates of a coryneform bacterium, *Micrococcus varians*, a *Vibrio* sp., a *Moraxella* sp. *and Pseudomonas fluorescens* growing on trypticase soy agar at 4 and 25°C was investigated. Growth rates were determined by measuring the rate of increase in the diameter of colonies on plates packed in laminated plastic pouches containing the CO_2-enriched environments. Carbon dioxide caused a significant decrease in the growth rates of all the organisms and the inhibitory effect was greatly enhanced by low temperatures. At 25°C, the gram-positive organisms were more resistant to CO_2 than the gram-negative organisms, while at 4°C none of the organisms grew in 25% CO_2, the lowest concentration tested. When exposed to air after being incubated in CO_2-enriched environments, the organisms in most instances grew at normal rates indicating limited residual effect of CO_2. The effect of temperature on relative CO_2 inhibition was investigated in detail for the *Moraxella* sp. and *P. fluorescens*. In an atmosphere containing 25% CO_2 in air at 20°C both organisms showed approximately 25% inhibition as compared to growth in air at the same temperature, while at 10°C *P. fluorescens* was completely inhibited and the *Moraxella* sp. showed 95% inhibition.

Chemoreception in the Homing and Orientation Behavior of Amphibians and Reptiles, with Special Reference to Sea Turtles. David Owens, Diana Crowell Comuzzie, and Mark Grassman. In *Chemical Signals in Vertebrates 4*. Ed. by David Duvall, Dietland Muller-Schwarze and Robert M. Silverstein. pp. 341-355. Plenum Publishing Corporation, 1986. $1. TAMU-SG-87-832.

The importance of chemoreception in the life history of amphibians and reptiles has been reviewed on several occasions. Our task is considerably more specific as our interest in the chemosensory components of orientation and homing. As in the far better documented avian and mammallian classes, it appears to be a gross over-simplication to think that an amphibian or reptile would rely on a single sensory system for homing or orientation. In fact a major difficulty that researchers appear to have had is the experimental dissection of the separate sensory modes in preparing protocols using the various animal models. It is very tricky to test just for chemoreception for example. Even though other senses surely must be important, we have attempted to avoid digressions into visual, tactile or other sensory systems. In actuality, evolution is acting to integrate all these systems in animals that have developed unusually keen orientation and homing abilities.

Abundance, Age Distributions and Growth of the Texas Hard Clam, Mercenaria mercenaria texana in Texas Bays. M. Alison Craig and Thomas J. Bright. In *Contributions in Marine Science* 29:59-72 (1986). $1. TAMU-SG-87-840.

The hard clam *Mercenaria mercenaria* (Linne) has been well studied; however little information is available on *Mercenaria mercenaria texana*, the subspecies found in Texas bays. Age and growth of *Mercenaria mercenaria texana* in Christmas Bay, Texas were determined by sectioning the shell and examining annual growth bands. Christmas Bay harbors a sparse population of older clams with few under five years old. Substrate type plays an important role in the distribution and growth of the bivalve. Christmas Bay clams exhibited poorer recruitment and slower first year growth than did clams from Texas bays further south. *Mercenaria mercenaria texana* shows a pattern of growth similar to that reported in the literature for hybrids of *Mercenaria mercenaria* (Linne) and *Mercenaria campechiensis* (Gmelin).

1987-88

Explanation of "Red Oysters." January 1988. Single copies free. TAMU-SG-88-504.

Following an occurrence of red-hued oysters off the Texas coast, this fact sheet was prepared to describe the phenomena and to reinforce the public's confidence in the oyster harvest. A relatively simple test whereby packers could determine if a frozen oyster might turn red was also included.

Hangs and Bottom Obstructions of the Texas/Louisiana Gulf. Gary L. Graham. July 1988. 141 pages. $15. TAMU-SG-88-508.

Fifteen years of reports from more than 150 Texas captains have been compiled into a book that will help others avoid trouble spots in the Gulf of Mexico. The 1988 edition of the "Hangs" book is an accumulation of LORAN C coordinates for known shipwrecks, rockpiles and thousands of other seabed hazards that threaten shrimp nets from the Mississippi River to the Rio Grande. It also serves as a guide for recreational fishermen looking for the places fish feed and hide. In addition to new and revised readings, the 1988 edition has an expanded format that makes the coordinates more legible and allows for greater distinction between close-set hangs.

Texas Parks and Wildlife Sets Regulations to Prevent Depletion of Finfish Species. 2 pages. No charge. TAMU-SG-88-509.

New size limits and bag and possession limits were approved by the Texas Parks & Wildlife Commission at its July 1988 meeting for red drum, black drum, flounder and sheepshead and became effective September 1 (1988). In addition, gill nets, trammel nets and drag seines were prohibited in state coastal waters beginning September 1. The new regulations are briefly detailed here.

1988-89

Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. C.W. Caillouet and A.M. Landry, compilers. 260 pages. $20.00. TAMU-SG-89-105.

These proceedings contain papers and abstracts based on presentations made at the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management in Galveston, Tex., October 1985. Most papers have been updated by the respective authors to reflect 1989 data. The proceedings includes 33 papers and five abstracts, as well as transcripts of question and answer sessions and a concluding panel discussion.

1989-90

Adaptive Coloration in Invertebrates. M. Wicksten., compiler, August 1990. 144 pages. $15. TAMU-SG-90-106.

This publication is based on papers presented at an adaptive coloration symposium sponsored by the Divisions of Animal Behavior and Invertebrate Zoology of the American Society of Zoologists in 1987. The collection provides a variety of aspects of adaptive coloration in diverse taxa, with the goal of presenting summaries for review as well as stimulation for further research. Biologists tend to specialize according to taxa or disciplines, and interdisciplinary comparisons can be difficult yet rewarding. Studies on adaptive coloration among invertebrates could show important differences in protective mechanisms between and within taxa as well as

between land, freshwater and marine habitats. Following an introduction by the compiler, the book includes the following papers: "The Evolution of Animal Coloration: Adaptive Aspects from Bioenergetics to Demography," Ward B. Watt; "Industrial Melanism in Moths; A Review and Reassessment," Theodore D. Sargent; "Relationships Between Visual Characteristics of Rainforest Butterflies and Responses of a Specialized Insectivouous Bird," Peng Chai; A Kaleidoscope of Cryptic Colors;Polymorphic Caterpillars and Camouflaged Adults on a Multi-colored Host Plant," Justin O. Schmidt; "Adaptive Coloration of Pontoniine Shrimps (Crustacea: Decapoda: Caridea)," Deborah L. Zmarzly; "Aposematism and Bioluminescence in Coastal Marine Communities," Matthew S. Grober; "Analyzing Color Pattern as Complex Trait: Wing Melanization in Pierine Butterflies," Joel G. Kingsolver and Diance C. Wiernasz; "Photoprotective Pigmentation of Freshwater Aooplankton: A Phenomenon of Extreme Environments," Chris Luecke and W. John O'Brien; "Adaptive Coloration in Texas Fiddler Crabs (*Uca*)," Carl L. Thurman II; "Special Resemblance, Aposematic Coloration and Mimicry in Opisthobranch Gastropods," Terrence M. Gosliner and David W. Behrens.

The Effect of the Ectoparasitic Pyramidellid Snail, *Boonea impressa*, on the Growth and Health of Oysters, *Crassostrea virginica*, under Field Conditions. Elizabeth A. Wilson, Eric N. Powell and Sammy M. Ray. 1988. *Fishery Bulletin.* 86 (3): 553-566. **TAMU-SG-90-819.**

Boonea (=Odostomia) impressa are contagiously distributed on oyster reefs so that some oysters are parasitized more than others. The parasite's mobility and the ability of oysters to recover from snail parasitism may be important in assessing the impact of parasitism on oyster populations. During a four-week exposure period in the field, *B. impressa* reduced American oyster, *Crassostrea virginica*, growth rate and increased the intensity of infection by the protozoan, *Perkinsus (= Dermocystidium) marinus*, but produced few changes in the oyster's biochemical composition because, although net productivity was reduced, the oysters retained a net positive energy balance (assimilation > respiration). During a four-week recovery period, growth rate returned to normal (control) levels, but infection by *P. marinus* continued to intensify in previously parasitized oysters kept *B. impressa*-free. Most changes in biochemical composition during recovery, including increased lipid and glycogen contents, could be attributed to the continuing increase in infection intensity of *P. marinus*. Consequently, the temporal stability and size of snail patches, particularly as they regulate infection by *P. marinus*, may be the most important factors influencing the impact of *B. impressa* on oyster reefs.

Control of Gonadotropin Release in the Atlantic Croaker (*Micropogonias undulatus*): Evidence for Lack of Dopaminergic Inhibition. Paul A. Copeland and Peter Thomas. 1989. *General and Comparative Endocrinology*. 74: 474-483. **TAMU-SG-90-823.**

Gonadotropin (GTH) secretion is known to be under inhibitory dopaminergic control in several species of fish. To investigate whether this is also the case in the Atlantic croaker (*Micropogonias undulatus*), juvenile and adult croaker were treated with a gonadotropin-releasing hormone analog (des-Gly1^0 D-Ala^6 Pro^9 n ethylamide luteinizing hormone-releasing hormone (LHRHa), 1-100 ng/g body wt) in combination with various dopaminergic drugs (1-20 mg/kg body wt). None of the dopamine antagonists tested, metoclopramide, pimozide, haloperidol and domperidone, were able to increase plasma GTH levels above those induced by treatment with LHRHa alone and in some cases the gonadotropin response to LHRHa was reduced. The dopamine agonists bromocryptine and apomorphine either had no effect on the noral response to LHRHa or increased it. None of the drugs tested had any detectable effect on GTH levels in the absense of LHRHa. These results provide evidence for a lack of dopaminergic inhibition in the control of GTH secretion in the Atlantic croaker.

The Spatial Distribution of *Perkinsus marinus*, a Protozoan Parasite, in Relation to its Oyster Host (*Crassostrea virginica*) and an Ectoparastic Gastropod (*Boonea impressa*). M.E. White, E.N. Powell, E.A. Wilson and S.M. Ray. 1989. *J. Mar. Biol. Ass. U.K.* 69: 703-717. **TAMU-SG-90-828.**

The endoparasitic protozoan *Perkinsus (=Dermocystidium) marinus* is a major cause of oyster mortality in the Gulf of Mexico. The small-scale spatial distribution of *P. marinus*, its oyster host, and a second oyster parasite, the ectoparasitic snail *Boonea impressa*, was examined on two oyster reefs in Aransas Bay, Texas. Large oysters (>5 cm long) were infected 3 to 4 times as frequently by *P. marinus* as smaller oysters on both reefs. In both cases, infected oysters were less contagiously distributed (lower variance/mean) than the entire oyster population, being most similar to the distribution of large oysters where most infections were found. In both cases the spatial distribution of infected oysters, when different, was more nearly random than the distributions of the oyster or snail populations. The distribution of large *Boonea impressa* explained the distribution of infected oysters better than any other parameter measured. *B. impressa* transmits *P. marinus* and feeding by *B. impressa* increases infection intensity in infected oysters. Hence the influence of snail parasitism on *P. marinus* prevalence and infection intensity, in large measure, determined the distribution of *P. marinus* on these reefs. Since *P. marinus* is estimated to be responsible for over half of all mortality in market-sized oysters, the distribution of snail patches may play an important role in the distribution of mortality in some oyster populations.

1990-91

Tidal Stream Transport of Larval Fishes into Non-stratified Estuaries. S.A. Holt, G.J. Holt, and C.R. Arnold. 1989. In *Rapp. P.-v. Reun. Cons. int. Explor. Mer*, 191: 100-104. **TAMU-SG-91-801.**

Larvae and juveniles of several fish species utilize tidal flow as a mechanism for migration. Reliance on the differences in direction of the net non-tidal flow between surface and bottom appears to be a major strategy for transport and retention of fish larvae in partially-stratified estuaries. Vertical movement by fish up into the current stream, when the flow is in the "desired" direction of travel, and movement down to the bottom, out of the current stream, when the flow is in the opposite direction (a process termed "selective tidal stream transport") facilitates the migration of juveniles and adults of several species. Tidal stream transport has been demonstrated in the larval transport into estuaries has not been established. Towed ichthyoplankton samples were taken on flood tide and the subsequent ebb tide at surface and bottom at five stations on a transect across Aransas Pass tidal inlet, Texas, to test the hypothesis that larval red drum (*Sciaenops ocellatus*) moved to the edges and/or moved to the bottom on ebb tide and, in both cases, moved into the water column on flood tide to take advantage of the reduced currents at the boundaries. There was no evidence of horizontal movement but larval red drum did appear to move vertically in response to tidal direction. Larval red drum were more abundant on the bottom than on the surface on both flood and

ebb but the difference was much greater on the ebb flow. The response to tidal direction was weak compared to dramatic differences seen in some other species. There was little difference in density of larvae between flood and ebb tide but the mean size was larger on flood than ebb, suggesting that only the larger individuals are leaving the tidal plume and being retained in the estuary.

Reproduction, Movements, and Apparent Population Dynamics of the Atlantic Threadfin *Polydactylus octonemus* in the Gulf of Mexico. M.W. Dentzau and M.E. Chittenden, Jr. 1990. *Fishery Bulletin, U.S.* 88:439-462. **TAMU-SG-91-802.**

Trawl collections were made for Atlantic threadfin *Polydactylus octonemus* from 5 to 100 m in the Gulf of Mexico along a cross-shelf transect off Texas during October 1977-August1981. Threadfin generally mature at 165-210 mm TL as they approach 7-9 months of age. Spawning primarily occurs in one period, mid-December-mid March, and spans 45-120 days overall; 90 percent of successful spawning may occur in only 59 percent of that period. Threadfin in the northwestern Gulf range from <5 to 27 m depths in the demersal stage but are most abundant at <5 to 16 m. Young-of-the-year recruit in waters <5-16 m when 2-4 months old. Fish begin to disperse to deeper waters in early summer and form a positive size gradient from the estuaries seaward. Threadfin in the demersal phase are not abundant in the northwestern Gulf after 9-11 months of age and reach only 15 months there. Observed mean and predicted sizes were 135-165 mm TL at 6 months, 165-215 mm at 9 months, and 180-205 mm at 12 months. Fitted von Bertalanffy parameters were 2.17-2.92 (K, annual, 195-230(L_∞),and -0.03-0.08 years (t_0). Maximum size in the demersal phase is 230 mm TL in the northwestern Gulf, but more typically only 200-205 mm. Typical maximum life span (t_L) is about 1 year but may exceed that if individuals survive in a pelagic stage after spawning. Apparent mean time and cohort-specific total annual mortality rates are 97-100% in the northwestern Gulf. Population dynamics parameters presented are termed apparent because of the unknown effects of recruitment, movements, random variation, gear selectivity, etc. Spawning grounds seemingly lie along the Outer Continental Shelf, slope, or further offshore, and currents of the cyclonic shelf gyre off Texas and western Louisiana transport the young to estuarine and inshore nurseries.

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

Preference responses of zebra fish to 10^{-3}, 10^{-4} and 10^{-5} M alanine (Ala) were concentration-dependent. Behavioural responses to copper (Cu) and Cu + Ala mixtures were also assessed. Zebrafish avoided 100 and 10 µg Cu l^{-1}, but not 1 µg l^{-1}. Mixtures of 10^{-3}M Ala + 100 µg Cu l^{-1} and 10^{-4} M Ala = 1 µg Cu l^{-1} did not differ statistically from controls (no detectable preference or avoidance). These results demonstrate, firstly, that a concentration of a pollutant avoided by itself (10 µg Cu l^{-1}) may not be avoided when encountered with an attractant chemical stimulus (Ala) and may supress the preference for an attractant stimulus, and secondly, that a concentration of a pollutant not avoided by itself and not considered deleterious (1µg Cu l^{-1}) suppresses attraction to Ala (an important constituent of prey odours for many fishes).

A Quantitative Analysis of Courtship Behavior in Captive Green Sea Turtles (*Chelonia Mydas*). D.K. C. Comuzzie and D.W. Owens. In *Herpetologica*, 46(2). 1990, 195-202. **TAMU-SG-91-804.**

Reproductive behavior of captive green sea turtles (*Chelonia mydas*) was observed at the Cayman Turtle Farm, British West Indies. Observed components of courtship behavior included gular rubbing, biting, cloacal checking, circling and biting, chasing, following, attempted mounting, mounting, and escorting. Data analysis indicated that in each of the observed components, reproductively attractive females were the target of the behavior significantly more often than reproductively non attractive females. Cloacal checks may be used by both males and females to assess reproductive condition of females. Males may escort mounted pairs to disrupt copulation attempts by rivals and increase their own reproductive success; females may act as escorts to enhance later mate availability. In general, females appear to signal approaching reproductive receptivity to males, but females may exercise mate selectivity by avoiding mounting.

Isolation and Identification of a New Cembranoid Diterpene from the Tunicate *Sytela Plicata*. J.M. Wasylyk and M. Alam. In *Journal of Natural Products*.. Vol. 52, No 6, PP. 1360-1362, Nov-Dec 1989. **TAMU-SG-91-805.**

We report the isolation of a novel cembrane, diterpene styelolide (1), from the tunicate *Styela Plicata*. The structure of the new diterpene was determined by utilizing 2D nmr techniques.

Isolation, Synthesis, and Evaluation of a Series of Indencarbazates as Hypotensive Agents. T.L. Lemke, R. Sanduja, M.M. Mroue, S. Iyer, M. Alam, M.B. Hossain, and D. van der Helm. In *Journal of Pharmaceutical Sciences*, Vol. 79, No. 9, September 1990. **TAMU-SG-91-806.**

Two idencarbazates, **1** and **2**, were isolated from the sponge *Cliona caribboea*. These compounds were found to possess mild hypotensive activity. A series of analogues of **1** was synthesized in order to study the structure-activity relationship of this unique class of compounds. A variety of structural changes did not result in a consistent pattern of biological activity.

Ultrasound Imaging of Reproductive Organs and Eggs in Galapagos Tortoises, *Geochelone elephkantopus* spp. T.R. Robeck, D.C. Rostal, P.M. Burchfield, D.W. Owens, and D. C. Kraemer. In *Zoo Biology* 9:349-359 (1990). **TAMUG-SG-91-810.**

This study demonstrates the efficacy of using ultrasound to determine the presence of ovarian developing, preovulatory, and atretic follicular structures and oviductal eggs in the Galapagos tortoise, *Geochelone elephantopus* spp. Ultrasound was effective in locating both right and left ovarian structures in 92 percent (n = 100 ovaries) of the trials. Developing and preovulatory follicles and oviductal eggs were echogenically visualized and had measurements ranging from 18 to 44 mm (n = 93) and 55 to 68 mm (n = 9), respectively. Atretic follicles ranged in size from 10 to 38 mm (n = 10). In one trial with four G. *elephantopus*, ultrasound observations were validated with the use of laparoscopy. All procedures were accomplished without general anesthesia on a specifically designed restraining table. Ultrasound provides an effective, safe modality for determining the reproductive status of adult female tortoises.

1991-92

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. 1991. *Journal of Fish Biology*. 38: 553-564. **TAMU-SG-92-801.**

Previous studies have examined the effects of grouping on the locating (search) phase of foraging and feeding behaviour

in fishes. Few studies have examined whether schooling in fishes may facilitate individual foraging by enhancing a group's responsiveness to food odours. The purpose of the current study was to assess the effect of increasing group size on the responsiveness of zebrafish, *Brachydanio rerio*, to L-alanine, an amino acid which is an important constituent of prey odours for many fishes. Based on the results of previous studies, either an increasing or decreasing linear relationship or a unimodal (convex or concave) relationship between responsiveness and group size was expected; the results, however, were bimodal. Groups of four fish were most responsive to alanine, as determined by the mean percentage of occurrences of fish in the area of a behavioural arena (an octagonal fluviarium) into which alanine was infused (at 10^{-3}, 10^{-4}, or 10^{-5} M). Groups of two, six and eight fish were significantly less responsive ($P<0.05$) than either groups of four fish or individual fish. The responses of groups of two, six and eight fish were not significantly different from each other.

Soft Plastra of Adult Male Sea Turtles: An Apparent Secondary Sexual Characteristic. Thane Wibbels, David W. Owens and David Rostal. 1991. *Herp Review*. 22(2): 47-49. **TAMU-SG-92-803.**

In contrast to many turtle species, chelonid sea turtles do not exhibit sexual size dimorphism. However, chelonid sea turtles do have several sexual dimorphisms that appear to facilitate successful mating. Collectively, these morphological characteristics enhance a male's ability to successfully mount a female. These secondary sexual characteristics also provide a means by which investigators can sex adult chelonid turtles and thus, are of importance to population studies.

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

Viruses may be major structuring elements of phytoplankton communities and hence important regulators of nutrient and energy fluxes in aquatic environments. In order to ascertain whether viruses are potentially important in distating phytoplankton community structure, it is essential to determine the extent to which representative phytoplankton taxa are susceptible to viral infection. We used a spiral ultrafiltration cartridge to concentrate viruses from seawater at efficiencies approaching 100 percent. Natural virus communities were concentrated from stations in the Gulf of Mexico, a barrier island pass, and a hypersaline lagoon (Laguna Madre) and added to cultures of potential phytoplankton hosts. By following changes in *in vivo* fluorescence over time, it was possible to isolate several viruses that were pathogens to a variety of marine phytoplankton, including a prasinophyte (*Micromonas pusilla*), a pennate diatom (likely a *Navicula* sp.), a centric diatom (of unknown taxa), and a chroococcoid cyanobacterium (a *Synechoccus* sp.). As well, we observed changes in fluorescence in cultures of a cryptophyte and a chlorophyte which were consistent with the presence of viral pathogens. Although pathogens were isolated from all stations, all the pathogens were not isolated from every station. Filterability studies on the viruses infecting *M. pusilla* and the *Navicula* sp. showed that the viruses were consistently infective after filtration through polycarbonate and glass-fiber filters but were affected by most other filter types. Establishment of phytoplankton-pathogen systems will be important in elucidating the effect that viruses have on primary producers in aquatic systems.

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

Collections were made for gulf butterfish *Peprilus burti* along a cross-shelf transect at depths of 5-100 m in the Gulf of Mexico off Texas from October 1977 to July 1980. Butterfish mature at 100-160 mm fork length as they approach age I. Spawning occurs primarily from September through May, but length frequencies indicate it concentrates, or is most successful, in distinct "Winter" (late January-mid-May) and "Fall" (early September-late October) periods that coincide with downcoast, alongshore currents (toward Mexico). Gonad data and persistence of small fish indicate spawning in winter, but at a low level. Spawning probably occurs offshore and upcoast toward the northcentral Gulf. Surface currents of the cyclonic shelf gyre probable transport eggs/larvae inshore and downcoast to recruit to the bottom in water 5-27 m deep, used as nurseries by butterfish when they are 2-5 months old. Butterfish disperse offshore as they mature and congregate in 36-100 m depths when they are 9-12 months old. They average 130-146 mm in fork length at age I in the northwestern Gulf, but 120-124 mm at age I and about 170 mm at age II in the northcentral Gulf. Somatic growth ceases as spawning approaches in the northwestern Gulf, but fish from the northcentral Gulf show large annual size increments. Butterfish reach about 200 mm in fork length, the largest ones occurring in the northcentral Gulf. Apparent maximum ages are 1-1.5 years in the northwestern Gulf and 2-2.5 years in the northcentral Gulf. Differences in population attributes suggest complete mortality at age I in the northwestern Gulf or some unknown combination of an offshore and permanent contranatant spawning or postspawning emigration of adults to the northcentral Gulf.

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

Eleven different allelic variants at the adenosine deaminase (ADA) locus have been detected using vertical starch-gel electrophoresis among 474 individuals of the marine fish *Sciaenops ocellatus* (L.). Thirty-five of the 66 possible genotypes were observed, and the heterozygosity level at ADA was estimated to be 70.3 percent. The extensive polymorphism at ADA may prove useful in terms of providing genetic markers for stocking programs using hatchery-raised fish.

Restriction Site Heteroplasmy in the Mitochondrial DNA of the Marine Fish *Sciaenops ocellatus* (L.). J.R. Gold and L.R. Richardson. 1990. *Animal Genetics*. 21: 313-316. **TAMU-SG-92-811.**

Restriction site heteroplasmy involving the enzymes *Nco*I and *Xba*I was detected in the mitochondrial DNAs of two individuals of the marine fish *Sciaenops ocellatus*. This represents only the sixth documented example of mitochondrial DNA restriction site heteroplasmy in animals. Two heteroplasmic individuals were found in a survey of nearly 750 individuals, suggesting that in most studies the incidence of mitochondrial DNA site heteroplasmy may be too low to be routinely detected.

Genetic Studies in Marine Fishes: II. A protein electrophoretic analysis of population structure in the red drum *Sciaenops ocellatus*. D.A. Bohlmeyer and J.R. Gold. 1991. *Marine Biology*. 108: 197-206. **TAMU-SG-92-812.**

Nine polymorphic loci were found among 42 presumptive

protein-coding gene loci surveyed among 474 red drum (*Sciaenops ocellatus*) sampled in 1987 from 13 nearshore and 1 offshore localities from the Atlantic coast of the southeastern USA and the northern Gulf of Mexico. The mean number of alleles over the polymorphic loci was 3.8, and the average heterozygosity over all loci examined was estimated as 0.0047. These data indicate that red drum have "normal" levels of genetic variability. Wright's F_{ST} values (the standardized variance of allele frequencies between samples) over all polymorphic loci ranged from 0.009 to 0.027 (mean F_{ST} = 0.019), and estimates of the effective number of migrants (N_em) per generation using Wright's island model ranged from 9.0 to 27.5. High levels of gene flow among the red drum samples were also indicated by Slatkin's qualitative analysis using conditional average allele frequencies. Nei's estimates of genetic distance between pairs of samples ranged from 0.000 to 0.009, indicating a high degree of nuclear gene similarity among all samples. Highly significant heterogeneity in allel frequencies at the locus for adenosine deaminase was detected between red drum sampled from the Atlantic and those sampled from the Gulf and among red drum sampled from the Gulf.

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. 1991. *Fisheries Research*. 12(1991): 213-241. **TAMU-SG-92-813.**

Variation in mitochondrial DNA (mtDNA) was examined among 397 individuals representing 13 geographic samples of red drum (*Sciaenops ocellatus*). Five of the samples were from the Atlantic coast of the southeastern United States, and eight were from the northern Gulf of Mexico. Seventy-six mtDNA haplotypes were found: eight haplotypes were found in 13 or more individuals, ten were found in four to 12 individuals, 22 were found in two or three individuals, and 36 were found in only one individual each. Mitochondrial DNA nucleon diversity values within samples ranged from 0.850 to 1.000; the value over all fish surveyed was 0.943. These data indicate that red drum have at least "normal" levels of genetic variability. Estimates of the percentage nucleotide sequence divergence among the 76 mtDNA haplotypes ranged from 0.137 to 1.962, with a mean (±SE) of 0.803 ±0.006. Heterogeneity in the frequencies of four haplotypes was detected between pooled samples from the Atlantic vs. pooled samples from the Gulf. No heterogeneity was detected among samples from the Atlantic or among samples from the Gulf. Collectively, these data indicate that the red drum population is weakly subdivided, with semi-isolated subpopulations occurring along the southeastern Atlantic coast and in the northern Gulf of Mexico. The large number of rare or unique mtDNA haplotypes found in the study may prove useful in evaluating the success of red drum stocking programs.

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

Polyclonal antiserum was produced from *Perkinsus marinus* hypnospores harvested from oyster tissue cultivated in fluid thioglycollate medium. The specificity of the antiserum for hypnospores was tested using indirect sandwich ELISA with alkaline phosphatase-conjugated goat anti-rabbit IgG and indirect immunofluorescence. As little as 20 ng of hypnospore protein could be detected by ELISA. Immunofluorescence assays suggested that the antigenic material was a component of the spore cell wall. Cross reactivity of the antiserum to other life stages of *P. marinus* present in oyster tissues could not be demonstrated by ELISA or immunofluorescence indicating that a substantial change in the antigenic properties of the cell wall occurs during spore formation. Hypnospore formation was also induced by placing *P. marinus*-infected oyster tissues into an anaerobic chamber rather than fluid thioglycollate. Spores were positively identified by ELISA, however little spore enlargement occurred suggesting that the triggering mechanisms for spore formation is not the same as that for enlargement.

Oceanography

1971–72

Electrical Resistivity Logging in Unconsolidated Sediments. William E. Sweet, Jr. August 1972. 142 pages. $3. TAMU–SG–72–205.

Electrical resistivity instruments and logging techniques have been developed for use in unconsolidated aquatic sediments. Sedimentary units have been correlated by these techniques, and *in situ* logs have been corrected with core logs from the same area. Electrical resistivity has been related to various geological and geotechnical properties of sediments, and found to vary directly with percentage of sand and the foundation factor; inversely with water content, void ration porosity, percentage of day and median X size diameter. Development in industry and present state of the art are discussed.

1972–73

Foraminiferal Evidence of Late Quaternary Sea Level Fluctuations from the West Flower Garden Bank. Bruce Robert Sidner and C. Wylie Poaq. December 1973. 124 pages. $4. TAMU–SG–73–213. NTIS–COM–74–10195.

Foraminiferal assemblages were analyzed in 8 piston cores and 22 surface samples from the West Flower Garden Bank in the northwest Gulf of Mexico in an attempt to determine accurately late Quaternary paleoclimatic and geologic events. The faunas are divided into environmental facies based on the planktonic and benthonic foraminifers.

1983–84

Whales and Dolphins off the Texas Coast (poster). February 1984. 36" x 24". $3. TAMU–SG–84–505.

This full-color reproduction of a specially commissioned work by artist Lori Grassman depicts the five species of marine mammals most frequently stranded off the Texas coast. The Atlantic bottlenosed dolphin, spotted dolphin, pygmy sperm whale, beaked whale and great sperm whale are included. All are painted to scale and a brief description of each species is printed on the back of the poster.

1985-86

Are Molluscan Maximum Life Spans Determined by Long-Term Cycles in Benthic Communities. Powell, Cummins. *Oecologia* (1985) 67: 177-182. $1. TAMU-SG-86-808.

A review of the maximum longevity of bivalves and gastropods indicates that a greater than average number of life spans coincide with the periods of long-term cycles in marine communities. Apparently, long-term cycles exert an important influence on marine communities by affecting the life spans of constituent species. Gastropods and bivalves are affected differently, longevities being determined by some cycles more than others in each group. Overall, molluscan longevities tend to be slightly longer than the corresponding cycle suggesting that there is selection pressure for life spans slightly longer than the cycle controlling recruitment success and generational replacement.

Recreation

1971–72

Proceedings of the Recreational Boating Seminar. Kathryn M. Delaune (comp.). January 1972. 80 pages. $3. TAMU–SG–72–103. NTIS–COM–72–10374.

The recreational boating seminar sponsored jointly by Texas A&M University's Industrial Economics Research Division and the Sea Grant Program was held December 17, 1971, in Galveston, Texas as part of the effort to provide technical information and assistance to marine-related industries and agencies involved in recreational activities. included in the Proceedings are the following presentations: "The Sea Grant Program," "Marine Insurance," "Marketing Trends and Dry Storage," "Maintenance, Repairs and Wet Storage," "Boating Safety" and "U.S. Coast Guard."

Proceedings of the Marina Management and Operation Seminar. Kathryn M. Delaune (comp.). May 1972. 78 pages. $3. TAMU–SG–72–105. NTIS–COM–73–10068.

Held on March 28, 1972, in Arlington, Texas, this conference is a part of the efforts to bring specialized and current information in the areas of management and operation of boat facilities to the marine operator. Marine insurance, facilities, sanitation, safety, anti-pollution laws and regulations were the subjects presented.

1973–74

Water-Related Recreational Complexes Seminar. Kathryn M. Delaune. February 1974. 2 pages. TAMU–SG–74–505.

This bulletin announces the April 23-24, 1974, seminar and outlines selected facts from a position paper on recreational boating and the fuel shortage, published by the National Association of Engine and Boat Manufacturers. Also, the dates of the March hearings for regulations proposed by Texas Water Quality Board on requiring toilets on large boats are listed.

1975–76

A Feasibility, Management and Economic Study of Marinas on the Texas Gulf Coast. L. Crompton and R.B. Ditton. 51 pages. $2. TAMU–SG–76–201. NTIS–PB–247–571/AS.

Four-month study to identify problems facing marinas on the Texas coast. Interviews were conducted with 29 marina operators in the Brownsville, Corpus Christi, Aransas, Galveston Bay and Port Arthur areas. Discussion includes effect of restricted supply of slips, profitability of a marina, real estate, interest and construction costs, storage/pricing strategies, labor/management constraints, role of public agencies and economic impact.

1976–77

Protection for Small Craft Marinas. John B. Herbich and Jack Y.K. Lou. May 1977. 4 pages. TAMU–SG–77–505.

The use of breakwaters for small marina application is briefly discussed in this advisory bulletin. Emphasis is on the physical factors surrounding the location of the breakwaters.

1978–79

Barrier Islands on the Texas Coast: Existing and Future Recreational Use and Development. R.B. Ditton, C.E. Alling, D.D. Beardsley, J.M. Falk, D.W. Pybas. August 1979. 129 pages. $5. TAMU–SG–79–203.

This report focuses on the recreational use and development of the five major barrier islands along the Texas coast: Galveston, Matagorda, St. Joseph, Mustang and Padre Islands. It is of interest to state and local planners, and to private investors. Because human actions frequently influence what takes place beyond natural boundaries of the islands, a regional approach is used. Regions are formed on the basis of prevailing social, economic, and institutional influences which are discussed extensively in this report. Six regions are identified: Galveston Island, Matagorda Island, St. Joseph Island, Mustang-North Padre Island, Padre Island National Seashore, and South Padre Island. Examination and analysis of current recreational use and development, along with the factors that enhanced or inhibited this use and development is undertaken for each of the identified regions. This is accomplished through an extensive literature search, personal interviews and on-site reconnaissance through 1977. Changes in the 1977-79 period are discussed in a section titled Update of Recent Developments. Summary statements are included for each region which categorize its relative intensity level of recreational use and development as high, medium or low based upon identified criteria. Lastly, a scenario for each region is given to examine possible recreational conditions in the future.

Fishing the Texas Surf. Tony Fedler. November 1978. 24 pages. TAMU–SG–79–605.

This booklet provides a brief discussion of Texas surf fishing techniques, including sections on the selection of rods, reels and terminal tackle and natural and artificial baits. One section is devoted to text and illustrations of 20 of the common fish varieties caught by surf, wade or pier fishing techniques.

1979–80

Access to and Usage of Offshore Liberty Ship Reefs in Texas. R.B. Ditton, A.R. Graefe, A.J. Fedler and J.D. Swartz. In *Marine Fisheries Review*, September 1979, pp. 25-31. 3 photographs, 5 figures, 4 tables. $1. TAMU–SG–80–803.

This study is to identify the extent to which Texas Liberty ship reefs are used by recreational fishermen. Two independent surveys were used to address the two principal means of gaining access to Liberty ship reefs. One study focused on the Texas charter and party boat fleet and the other on private boat fishermen residing in the Houston-Galveston metropolitan area. The Liberty ship reefs were found to attract a substantial number of private boat and charter/party boat fishermen, especially when the extent to use is compared with other site-specific artificial or natural offshore attractions. Nearly all use of the Liberty ship reefs originated from the closest access point. Use of a particular reef site appeared to be related to availability of alternative fishing grounds and ability to travel great distances offshore.

1980–81

Predicting Marine Recreational Fishing Patterns from Boat Characteristics and Equipment. Robert B. Ditton, Alan R. Graefe and Anthony J. Fedler. In *Transactions of the American Fisheries Society* 109(1980). pp. 644-648, 1 figure, 4 tables. $1. TAMU–SG–81–814. NTIS–PB–81–197–782.

An approach for predicting general marine fishing locations and distances traveled off shore for fishing is reported from boat equipment data. Discriminant analysis indicated that bay and offshore fishing boats could be distinguished with 80 percent classification accuracy from data on horse-

power, fuel capacity and boat length. Multiple regression analyses verified that fuel capacity and presence of radios and long-range navigation (LORAN) were significant predictors of offshore fishing distances.

1982–83

A Statewide Survey of Boatowners in Texas and Their Saltwater Fishing Activity. R. Ditton and A. Fedler. June 1983. 65 pages, 15 tables, 3 figures, 4 appendices. $2. **TAMU–SG–83–205. NTIS–PB–83–236–547.**

Data on saltwater fishing patterns of Texas pleasure boatowners were gathered through a survey of registered boatowners in the state. Sample findings were extrapolated to the statewide population of boatowners. More than 60 percent of the registered boatowners in Texas used their boats for fishing during the study year. However, only 14 percent of all Texas boatowners (approximately 529,000) fished salt water (bays or offshore). Approximately three percent (16,000) of Texas boatowners accounted for more than 120,000 fishing trips in the U.S. Territorial Sea and the Fishery Conservation Zone. The Galveston Bay area, with almost one-half of all bay boat fishing activity and more than one-third of all offshore fishing activity, was identified as the state's center of marine recreational boatfishing. Port Aransas was the second leading offshore recreational fishing port, with almost 25 percent of all offshore trips.

Keep That Bait Alive! William Younger and Russell Miget. July 1983. 12 panel brochure, 6 illustrations, 2 charts. **TAMU–SG–83–506.**

Coastal fishermen have found that keeping bait alive is one of the keys to successful saltwater bait fishing. This publication describes the physical needs of saltwater baits and explains conditions to avoid. The brochure opens into a poster depicting bait systems that can be purchased or constructed including flow-through buckets, sprayers, aerators and live bait wells. Advantages and disadvantages of each are listed. A brief guide to handling and hooking is included along with a chart of commonly used live saltwater baits.

1983–84

Understanding Involved Fishermen: A Survey of Members of the Gulf Coast Conservation Association. Robert Ditton and Stephen Holland. June 1984. 78 pages. $2. **TAMU–SG–84–623.**

The Gulf Coast Conservation Association is a group of about 10,000 individuals, most of whom live in Texas. They have concerned themselves with fishery conservation issues in general and in protecting the interests of recreational fishermen in particular. This is a report of the results of a mail survey of 559 randomly-selected members in the Houston-Galveston area. Most of the respondents were male, middle-aged fishermen who held professional-technical occupations and had family incomes of more than $40,000 per year. Virtually all were active fishermen who fished an average of 37 days a year. When asked their reasons for fishing, members reported that "the opportunity to escape the daily routine by relaxing outdoors" and "to seek the challenge and sport of fishing" were paramount. Members exhibited a pattern of enhanced involvement in fishing through magazines, club membership, tournament participation, boat ownership and high self-reported skill and catch levels. In addition, a majority supported a variety of fishery conservation options, even if it required self-sacrifice in the form of reduced catch or increased fees.

Information and Data Needs for Marine Recreational Fisheries Development in the Caribbean. Robert Ditton. In *Proceedings of the Gulf and Caribbean Fisheries Institute 35th Annual Session*, November 1982. pp. 144-151, 2 figures. $1. **TAMU–SG–84–808.**

This paper defines marine recreational fisheries development, discusses its objectives and enumerates data and information needs for achieving these objectives in a systematic fashion in the Caribbean. In addition to an integrated knowledge of technical information, a case is made for a catalyst or "middle man" to stimulate development activities. This catalyst should have a good understanding of how government works if information and data are to be used in support of public and private marine recreational fisheries development efforts.

1984–85

1983 Texas International Fishing Tournament: An Analysis of Participants' Characteristics, Attitudes and Expenditures. Robert B. Ditton and David K. Loomis. April 1985. 62 pages, 36 tables, 2 figures, 4 appendices. $3. **TAMU–SG–85–202. NTIS–PB–85–220–259/AS.**

This report represents the first economic impact study of a saltwater fishing tournament in Texas. It identifies the expenditures and economic impacts resulting from the 1983 Texas International Fishing Tournament (TIFT) and describes the socio-economic characteristics of tournament fishermen. The 45th TIFT, held August 3-7, at South Padre Island, Texas, attracted 446 competitors and produced significant impacts for the South Padre Island area and Cameron County.

1985-86

1984 Deep Sea Roundup: An Analysis of Participants' Characteristics, Attitudes and Expenditures. Robert B. Ditton and Lynn A. Arneson. January 1986. 107 pages, 3 figures, 75 tables. $5. **TAMU-SG-86-203.**

The 49th Annual Deep Sea Roundup was July 9-13, 1984, at Port Aransas, Texas, and attracted 451 fishermen. A mail survey was conducted following the tournament to assess the event's impact on the local economy. Results indicate that the tournament was economically successful in that it produced substantial impacts, primarily in Nueces County, but also, to a lesser degree, statewide. Non-residents spent more than $285,000, resulting in an economic impact of about $333,750. Additional impacts can be seen if one also considers that the majority of the $20,980 collected as registration fees was spent locally for entertainment, advertising and printing services.

12-Pound Test: One Dozen Checkpoints for Avoiding Snags in Your Fishing Tournament. Willie Younger. 2 pages. **TAMU-SG-86-502.**

Whether it is the club's annual fishing tournament, or one organized from scratch, proper planning and preparation on the director's part will make for a well-run event that provides hours of excitement and enjoyment for sponsors as well as participants. This checklist alerts tournament directors to critical areas of organization, and helps them avoid problems that could quickly ruin the tournament's reputation.

Keeping Fish "Tournament Fresh." Mel Russell. 2 pages. **TAMU-SG-86-504.**

A marine advisory bulletin primarily intended for tournament fishermen, this publication outlines the best ways to keep fish fresh aboard a boat when offshore for several days. Because many tournaments now require entry fish to be in a fresh, edible condition, this fact sheet includes compliance techniques and explains how freshness tests are administered. It also lists the properties of freshness typically sought by tournament judges.

Measuring the Impact of the Ixtoc I Oil Spill on Visitation at Three Texas Public Coastal Parks. Freeman, Hollin, Ditton. *Coastal Zone Management Journal* Vol. 13, No. 2: 177-201, 1985. $1. TAMU-SG-86-810.

In August 1979, tar balls and oil slicks from the world's largest oil spill (Ixtoc I) washed ashore on the lower Texas coast. Data on public visitation to three beach parks (Padre Island National Seashore, Padre Balli County Park, and Port Aransas County Park) from 1977 to 1982 were examined using time series intervention analysis. For each of the three sites, three events (gas price, gas availability, and the Ixtoc I oil spill) were modeled, entered into the time series analysis, and tested for their effect. When the oil spill model was tested with the visitation data, no significant decrease in visitation was demonstrated at any of the three sites. No long-term (nine months) impact on visitation was evident either. Reduced gas availability was associated with a significant decrease in visitation at Padre Island and Padre Balli parks.

Examining the Business Turnover in the Texas Charter Boat Fishing Industry. Ditton, Loomis. *Marine Fisheries Review*, 47 (1), 1985. pp. 43-47. $1. TAMU-SG-86-811.

This paper used data collected at two points in time to address the extent of turnover in the Texas charter boat industry between 1975 and 1980. If it is assumed that the best predictor of the future is the recent past, then a knowledge of trends cannot only lead to a better understanding of the phenomena, but also provide managerially useful information.

Framework for Understanding the Consumptive Orientation of Recreational Fishermen. Fedler, Ditton. *Environmental Management*, Vol. 10, No. 2, pp. 221-227, 1986. $1. TAMU-SG-86-818.

Fishermen were aggregated into high-, mid-, and low-consumptive groups according to the importance they placed on catching fish. Analysis of variance indicated that each consumptive group was unique in the importance it placed on other fish-related variables. Low-consumptive fishermen rated most other aspects of the fishing experience, such as interacting with nature, relaxation, and escaping the daily routine, more important than did high-consumptive fishermen. Low-consumptive fishermen also fished more frequently and were generally more satisfied with their most recent fishing trip than were high-consumptive-oriented fishermen. The three groups can be viewed as different fishing constituencies. By understanding their characteristics, we can gain additional insights into the impacts of management decisions on recreational fishermen and their experiences.

1987-88

1985 Hall of Fame Fishing Tournament: An Analysis of the Participants Characteristics, Attitudes, and Expenditures. Robert B. Ditton and David K. Loomis. 58 pages. $5.TAMU-SG-88-201.

The 13th annual Hall of Fame Saltwater Fishing Tournament was held May 18 through May 26, 1985, in Galveston, Tex., and attracted 261 participants. A mail survey was conducted following the tournament to assess the event's impact on the local economy. The survey's overall response rate was 73.7 percent. Total direct purchases associated with the tournament were estimated at $76,000, excluding tournament fees(an additional $6,600). Because there was only one out-of-state participant, no meaningful statewide economic benefits were realized. Approximately $21,600 was spent by out-of-county Texas residents, resulting a local economic impact of $43,000 for Galveston County. Unlike other tournaments, the benefits were dispersed across a number of economic sectors. A comparison with other studies of Texas tournaments showed the Hall of Fame to be relatively small with limited daily expenditures, and that it produced minimal economic impacts for the local economy.

Sport Shrimp Trawling . Gary Graham. November 1987. 5 pages. Single copies free. TAMU-SG-88-503.

Sport shrimp trawling has long been an important recreational activity along the Texas Coast. Besides furnishing fresh shrimp for the table or lively bait, sport shrimping can provide numerous hours of recreation. For a fisherman who owns a boat, sport shrimping is not expensive. A shrimp trawl that meets legal specifications can be purchased at many net shops or commercial fishing supply house and at some sporting goods stores. The cost of the trawl, otter doors and tow lines ranges from $150 to $250, depending on the size of the trawl. This pamphlet offers advice on rigging, modifying and setting the trawl, adjusting the door, and repairing the net.

Tackling Tournaments: The Saltwater Tournament Director's Guide. Rhonda Snider and Mel Russell, co-editors. 1987 162 pages. $15. TAMU-SG-603.

About 600 saltwater fishing tournaments are held annually; although not without detractors, they have become increasingly important to local economies. There is room for improvement in even the best-run existing tournaments, and lots to consider for those planning to start a tournament. This book should be of benefit in both situations. Individual chapters address setting objectives, types of tournaments, organization concerns, financing promotion, management, and follow-up evaluation.

Analysis of Motive and Participation Differences Between Saltwater Sport and Tournament Fishermen. D.K. Loomis and R.B. Ditton. 1987. In *North American Journal of Fisheries Management*, 7: 482-487. TAMU-SG-88-810.

Numerous descriptive studies of fishermen have been conducted. Motives, attitudes, and behavior of fishermen have been examined. These studies have confirmed the nonexistence of the "average" fisherman. They disclosed, instead, considerable diversity between and among fishermen and their activities. Few studies, however, have focused on this diversity, despite an emerging literature indicating fisherman diversity to be an important concern for fishery managers in allocating resources among competing interests. We empirically tested for and examined differences in motivation between Texas saltwater sport anglers and saltwater tournament fishermen, particularly those differences in measures of catch-related and non-catch motivation. Tournament fishermen rated the importance of catch-related motives significantly higher than did sport fishermen. Both groups rated equally high the importance attached to non-catch motives as reasons for fishing. Tournament fishermen considered themselves more skilled, believed they caught more fish, put more of their effort into fishing for a particular species and fished more frequently than sport fishermen. This distinction between the two groups of fishermen has implications for fisheries managers because tournament fishermen and sport fishermen likely will respond differently to various policy changes, particularly those changes related to a reduction in permissible catch.

1990-91

Demographics, Participation, Attitudes, Expenditures, and Management Preferences of Texas Saltwater Anglers, 1986. R.B. Ditton, D.K. Loomis, A.D. Risenhoover, S. Choi, M.F. Osborn, J. Clark, R. Riechers, and G.C. Matlock. Texas Parks

and Wildlife Department *Management Data Series*, No. 18, 1990. TAMU-SG-91-807.

Anglers who purchased a Texas saltwater fishing stamp during its first year of issuance between January 1 and July 31, 1986, were sent a mail survey inquiring about their general demographics, attitudes toward management tools, fishing motivations, species preferences and annual expenditures. Two-thirds of Texas saltwater anglers responding were residents of Texas coastal counties. Nearly 45 percent have been fishing in saltwater for over 20 years. Most (44 percent) fished in saltwater 13 or fewer days the previous year. About 15 percent of anglers reported fishing outside of Texas. Anglers were supportive of stocking fish in saltwater and minimum size limits as management tools and were most opposed to "slot limits" and the prohibition of certain types of bait. "For relaxation," "To be outdoors," and "To get away from the regular routine" were ranked as the most important reasons for fishing; "Obtaining a trophy fish" and winning a trophy were ranked as least important. Anglers agreed with the phrases "I usually eat the fish I catch" and "I like to fish where there are several kinds of fish to catch" and disagreed most with "I want to keep all the fish I catch" and "I usually give away the fish I catch." Spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), and flounder (*Paralichthys lethostigma* or *P. albiqutta*) were the most sought fishes by Texas saltwater anglers. Most saltwater fishing items bought by respondents were purchased in Texas and used predominantly for saltwater fishing. On average, Texas anglers spent approximately $1,500/year in Texas for saltwater fishing gear and equipment.

1991-92

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

Degree of homogeneity within a target population has been suggested as one criterion for determining the need for follow-up efforts in a mail survey. Previous studies of respondent group differences are insufficient for making generalizations regarding population homogeneity. Each study deals with a different population, activity or set of variables. Replicated data from three mail surveys of anglers were used to investigate the homogeneity of that population and to provide further support for generalizations. Significant differences were found across three respondent groups on most of the 11 variables studied. These included angler motivations, attitudes, information sources, management preferences, years of fishing experience, fishing frequency, perceived fishing ability, annual expenditure for tackle and age. Angler survey respondent groups were generally homogeneous with respect to gender and income. In addition to providing support for using follow-up procedures in statewide surveys of recreation fishing participants, results provide some empirical clues to understanding the conditions under which population homogeneity exists.

Recreation Specialization: Re-conceptualization from a Social Worlds Perspective. Robert B. Ditton, David K. Loomis and Seungdam Choi. 1992. *Journal of Leisure Research*. 24(1): 33-51. TAMU-SG-92-816.

This paper initiated development of a theory of recreation specialization from a social worlds perspective and provided empirical testing for some of the stated propositions. Recreation specialization was re-conceptualized as 1) a process by which recreation social worlds and subworlds segment and intersect into new recreation subworlds and 2) the subsequent ordered arrangement of these subworlds and their members along a continuum. At one end of the continuum is the least specialized subworld and its members and at the other end is the most specialized subworld and its members. A series of eight propositions which linked specialization with elements of social worlds and the previous work of Bryan (1977) were stated. Empirical hypothesis tests regarding group differences in resource dependency, level of mediated interaction and importance attached to activity-specific and non activity-specific elements of the recreation experience provided strong support for three of the propositions of the conceptual framework. Although initial efforts at theory development were supported, much conceptual and empirical work remains. This paper provides a starting point for a focused line of recreation specialization research.

References

1973–74

A Bibliography of Offshore Pipeline Literature. N.W. Lai, S.J. Campbell, R.F. Dominguez and W.A. Dunlap. June 1973. 127 pages. $3. **TAMU–SG–74–206. NTIS–COM–74–11387/AS.**

This bibliography is an up-to-date collection of available literature pertaining to offshore pipelines. Articles are listed by subject matter in the key-word index and under names of authors in the author index. A general index also is included where articles' sources can be found.

1974–75

Bibliography of Maritime and Naval History Periodical Articles Published 1972–73. Charles R. Schultz. August 1974. 56 pages. $3. **TAMU–SG–75–601. NTIS–COM–75–11775/AS.**

This bibliography lists articles that appeared in 1972-73 and a few entries from 1971. Items are arranged by subject into 17 categories including exploration, navigation, cartography, merchant shipping, inland navigation, ship-building, maritime law, small craft, fisheries, naval history, marine art and pleasure boating. Author, subject and vessel indices are provided.

1978–79

Bibliography of Maritime and Naval History Periodical Articles Published 1976–77. Charles R. Schultz. February 1979. 90 pages. $4. **TAMU–SG–79–607. NTIS–PB–295–539/AS.**

This compilation is based on holdings at Texas A&M University and a search of two historical data bases - *America: History and Life* and *Historical Abstracts*. The bibliography lists articles published in 1976-77. The items are arranged by subject into 17 categories, including navigation, shipbuilding, maritime law, small craft, fisheries, naval history, marine art and pleasure boating. Author, subject and vessel indices are provided.

1982–83

Bibliography of Maritime and Naval History Periodical Articles Published 1978-79 with Cumulative Indices for 1970–79. Charles R. Schultz (comp.). September 1982. 238 pages. $5. **TAMU–SG–83–602. NTIS–PB–83–119–123.**

This compilation is the sixth published, completing the first decade of the bibliography. Listings are arranged by subject into 17 categories, including exploration, navigation, cartography, merchant shipping, inland navigation, ship building, maritime law, small craft, fisheries, naval history, marine art and pleasure boating. Author, subject and vessel indices are provided. As an indicator of the end of a decade, this volume also includes cumulative author, vessel and subject indices for 1970-79. The entries have been compiled from holdings of the Texas A&M University Library, and from computer searches of *America: History and Life* and *Historical Abstracts.*

Computer-Accessible Annotated Bibliography of the Corpus Christi Bay Estuary. R. Warren Flint. April 1983. 280 pages. $5. **TAMU–SG–83–605. NTIS–PB–83–204–842.**

The Corpus Christi Bay system is one of Texas' major estuaries, with a surface area of almost 600 square kilometers of water, grass beds, tidal flats and salt marshes. Unlike most U.S. estuaries, the Corpus Christi system is located in a semi-arid climate, one that receives less than 70 cm of rain annually. Evaporation exceeds precipitation, causing the water to be hypersaline. Droughts, floods and hurricanes cause continual environmental variation, and the estuary is compartmentalized into several bodies of water with different hydrological and sedimentary regimes. Recent changes have been associated with human activity in the area, such as dredging, shipping, sewage disposal, filling of wetlands, and energy exploration. This annotated bibliography compiles citations of publications relating to the physics, chemistry, biology and sociology of the Bay system, information that will be useful to those who study the ecology and dynamics of the Bay and the effects of development on the system and the area. A list of key words directs the user to citations by subject area.

1987-88

Galveston Bay: Issues, Resources, Status, and Management. 1989. U.S. Department of Commerce National Oceanic and Atmospheric Administration Estuary-of-the-Month Seminar Proceedings. 114 pages. **TAMU-SG-88-115.**

A seminar on Galveston Bay, held March 14, 1988, at the U.S. Department of Commerce in Washington, D.C., is reproduced. The National Oceanic and Atmospheric Administration sponsored the seminar as a part of its continuing series of "Estuary-of-the-Month" Seminars, held with the objective of bringing to public attention important research and management issues of the nation's estuaries. The papers include historical and scientific overviews of the bay area, followed by an examination of management issues by scientists and research managers involved in Galveston Bay.

1991-92

Gulf of Mexico Oyster Bibliography. Thomas M. Soniat, James D. Simons and Eric N. Powell. 1992. Texas A&M University Sea Grant College Program. 59 p. $5. **TAMU-SG-92-602.**

This bibliography assembles, documents, records and organizes the extensive oyster literature from the Gulf of Mexico. The publication is restricted to work on *Crassostrea virginica* conducted on the Gulf coast of the United States. It developed from a project funded by the Galveston Bay Foundation to assemble the oyster literature of Galveston Bay. It is intended for fisheries managers, resource economists, government regulators, oyster biologists and oystermen. The titles are arranged alphabetically and indexed geographically (by state) and by subject matter.

Resource Management

1970–71

Coastal Land Resources Conference Proceedings. September 1970. 111 pages. TAMU-SG-71-101. NTIS-COM-71-00726.

This proceedings is an overview by scientists and government specialists of activities, problems and opportunities associated with the Texas coastal areas. It includes reports on coastal land utilization, shrimp mariculture, waterfowl management and harvesting, coastal mosquito control, coastal industrial development, beef cattle production along the Gulf coast, economic impact of recreation, coastal water quality, the Coastal Resources Management Program of Texas, the coastal interface, catfish culture and the role of the Sea Grant Program in coastal development.

The Estuarine Zone: Uses and Concerns. Johnie H. Crance. December 1971. 14 pages. TAMU–SG–71–108. NTIS–COM–72–10110.

Texas' 1,000 miles of estuarine zone shoreline are examined for their uses and concerns. Biological characteristics are described, as well as problems affecting estuarine zones. A selected bibliography on estuaries is also included.

1972–73

Recent Federal Legislation Significant in Environmental Planning Programs of the State of Texas. Reginald Hirsch, Carl Everett and Carol Dinkins. February 1973. 19 pages. $2. TAMU–SG–73–602. NTIS–COM–73–10617.

Provisions and effects of important recently enacted federal statutes affecting Texas' environmental plans and programs are summarized in this handbook. Subjects of 1972 acts discussed included ports and waterway safety, water pollution control, environmental pesticide control, marine protection, research and sanctuaries, noise control and coastal zone management.

1973–74

Resource Evaluation Studies on the Matagorda Bay Area, Texas. Wayne Ahr, James Daubenspeck, Harold W. Harry, Barry Holliday, Thomas C. Littleton, John Miloy and Larry Vetter. September 1973. 161 pages. $3. TAMU–SG–74–204. NTIS–COM–74–11706/AS.

Investigations by four research teams designed to help develop an information base for coastal zone management decisions are described in this report. Areas investigated are: bay circulation, chlorinated hydrocarbons in bay sediments, skeletal remains of microfossils as environmental indicators and economic analysis of the Matagorda Bay region.

1980–81

Survey of the Steamboat *Black Cloud*. Robert M. Adams et al. October 1980. 47 pages, 15 figures, 4 photographs. $3. TAMU–SG–81–201. NTIS–PB–81–140–998.

A survey of the submerged steamboat *Black Cloud* was conducted by the students and staff of the nautical archeology program at Texas A&M University in response to efforts and suggestions by historians and citizens of Liberty, Texas. The sidewheel steamboat, which had been abandoned in 1873 in the Trinity River, Texas, was rediscovered in 1965. The purpose of the survey was to give students field experience in locating and defining the limits of wreckage and plotting their findings on a map. This report contains a historical review of the *Black Cloud*, descriptions and drawings of hull remains, and a reconstruction of the paddlewheel from artifact fragments. Also included is a catalog of artifacts recovered from the site, an analysis of their condition and conservation measures taken, and recommendations for further study.

The Law of the Sea Treaty and the United States. Elizabeth L. Carnahan and Lauriston R. King. 1981, revised 1983. 12 pages, 4 illustrations, 3 photographs. TAMU-SG-81-506.

This fact sheet traces the history of the international negotiations through the United States' decision not to ratify the Law of the Sea Treaty in December 1982. It reviews the key features of the treaty signed by 117 nations, the events leading to the U.S. rejection of the convention and several areas of uncertainty created by the United States' action.

The Coastal Upwelling Ecosystems Analysis Program as an Experience in International Cooperation. Lauriston R. King. In *Ocean Development and International Law Journal* 9:269-288. 1981. 20 pages, 4 figures. $1. TAMU–SG–81–823.

The Coastal Upwhelling Ecosystems Analysis (CUEA) Project, the major effort in the Living Resources part of the United States Program for the International Decade of Ocean Exploration (IDOE), included a variety of approaches to the international involvement. Escalating cost, expanded geographical scope, and increasing insistence on coastal state participation in research projects off foreign shores heighten the likelihood that similar large-scale, long-term research efforts will require particular attention to international cooperation and collaboration. A look at the international aspects of CUEA is timely and instructive. This discussion reviews the background to the upwhelling project, the nature of international involvement, and closes with some observations about the requirements for similar projects in the future.

1986-87

Proceedings of the National Conference on the States and the Extended Territorial Sea. Lauriston R. King and Amy Broussard (eds.) March 1987. 172 pages. $10. TAMU-SG-87-114.

One result of the long and intricate negotiations leading to the United Nations Law of the Sea Treaty in late 1982 was a growing international consensus on a 12-nautical mile territorial sea. The U.S. refused to sign the treaty and has held firm to its three-nautical mile territorial sea, the prospect of an expanded territorial sea was left open as a result of President Reagan's 1983 Proclamation of a 200-Mile Exclusive Economic Zone for the U.S. To explore this issue, the Texas A&M Sea Grant Program and the Sea Grant Legal Network convened a National Conference on the States and an Extended Territorial Sea in San Antonio, Texas, on Dec. 9-11, 1985. This volume provides the record of the presentations made at that Conference.

Science, Politics and the Sea Grant Program. Lauriston R. King. *Ocean Development and International Law*, Vol. 17, No. 1/2/3, 1986. pp. 37-57. $1. TAMU-SG-87-802.

During its eighteen-year history of research, education, and advisory activities, the National Sea Grant College Program has played a distinctive role in the nation's efforts to develop, use, and manage its marine resources. The partnership between Sea Grant universities, marine industries, and government agencies has resulted in demonstrable scientific and economic contributions. Despite these successes, the

Reagan Administration has proposed termination of the program and embroiled it in a lengthy political struggle for survival. Should Sea Grant survive, its future success will depend increasingly on its ability to support an expanded basic research program.

Ocean Resources and Intergovernmental Relations: The Record to 1980. Maynard Silva and Lauriston King. In *Ocean Resources and U.S. Intergovernmental Relations in the 1980s.* Edited by Maynard Silva. Chapter 3, 75-104. Westview Press, Boulder and London. 1986. $1. **TAMU-SG-87-833.**

It has only been since the late 1950s that issues concerning the development, use and management of marine and coastal resources have been perceived as deserving sustained national policy attention. Not surprisingly, the character of relations between and among state, federal and local governments was determined far more by a mix of political feasibility, perceptions of the authority needed to get the job done, and the desires of shifting coalitions of interest groups that by any comprehensive philosophical concern for the distribution of power, authority and competence in the federal system. This chapter briefly reviews the nature of these relationships by describing the key policies for fisheries, marine mammals, offshore hydrocarbons and minerals, marine pollution, and coastal resource management.

Marine Policy and the States. Lauriston R. King and Olson. *Coastal Zone '87,* WW Div./ASCE, Seattle, WA/May 26-29, 1987. pp. 793-803. $1. **TAMU-SG-87-841.**

Increased conflict between the states and federal government over offshore activities, cuts into federal support for ocean programs, and the New Federalism rhetoric of the Reagan administration appeared to spur expanded state interest in ocean policy. Based on a review of new items, journal articles, and conversations with state ocean policymakers, it appears that few states have actually made full-fledged efforts to grapple with marine policy issues raised by federal activities. Posing the issue in terms of federal/state relations, however, obscures another important change, namely the development of state institutions for dealing with marine issues. Although these institutions vary widely in their political influence and effectiveness within different states, they have the potential to enhance the ability of the states to adapt to marine issues within their own jurisdictions.

1989-90

Coastal State Capacity for Marine Resource Management. Lariston R. King and Steven G. Olson. 1988. *Coastal Management.* 16: 305-318. **TAMU-SG-90-810.**

Policies of the Reagan administration appear to have stimulated increased coastal state activities in marine resource management. This paper uses the notion of government capacity to explore changes within these states. Capacity refers to the institutional structure, expertise, and commitment of political elites to deal with complex policy issues. Following a brief review of institution-building within the states, North Carolina and Texas are used to illustrate contrasting approaches to the development of institutional capacity. Although most academic attention has been devoted to national ocean policy and intergovernmental relations, the states themselves are worthy subjects for systematic analysis and comparison. Among the variables which might be addressed are state maritime history; institutional frameworks for marine policy; attitudes and commitments of elites toward ocean resources; the role of scientific rationality in state decisionmaking; and the nature of state political leadership.

1990-91

Economic Development and Local Governance of Galveston Bay. P.F. Causey. Public Administration Program, Dept. of Political Science, Texas A&M University, College Station, Texas. September, 1989. **TAMU-SG-91-811.**

The Galveston Bay system, comprising Galveston, Trinity, East and West Bays and related estuaries, is the largest estuarine system on the Texas coast. In recent years, this system has become the latest focal point in the continuing battle over the uses and needs of various interests for fresh water, land, and other natural resources. As of December 7, 1987, there were over 600 local governing entities within the four counties surrounding Galveston Bay alone, not including school districts. The main purpose of this study is to focus attention on Galveston Bay area local governing entities and those duties and actions which may affect the Galveston Bay system, especially those referred to as 'economic development' and those primarily directed at enhancing or protecting the natural resources of the bay.

Interest Groups and the Governance of Galveston Bay. C.E. Hunt. Public Administration Program, Dept. of Political Science, Texas A&M University, College Station, Texas. September, 1989. **TAMU-SG-91-812.**

A large number of political interest groups-organizations of individuals which make demands upon governmental institutions for particular policies and programs-are involved in Galveston Bay issues and politics. Given their potential importance, an assessment of the role of these groups is essential if one is to develop an adequate understanding of how the bay is governed. The purpose of this paper is to describe and analyze the activities of interest groups as they attempt to influence public policy and management decisions which impact upon Galveston Bay. Specifically, attention is directed at delineation of the interest group population, the key tactics that interest groups employ in attempting to influence by related policy decisions, and an evaluation of interest group effectiveness.

Safety and Emergency Preparedness

1969–70

University Guide to Diving Safety. William W. Schroeder and William P. Fife. May 1970. 28 pages. $3. **TAMU–SG–70–602. NTIS–PB–102–343.**

This guide is the result of the need to establish guidelines for diving under the auspices of Texas A&M University. Much of the contents have been taken from the University of California's "Guide for Diving Safety". It has been done in order that reciprocity of diver certification might exist between the University of California System, the Texas A&M University System, and other universities and colleges that have similar programs.

1978–79

The Use of Non-Explosive Mixtures of Hydrogen and Oxygen for Diving. William P. Fife. January 1979. 96 pages. $5. **TAMU–SG–79–201. NTIS–PB–297–068.**

This report summarizes hydrogen-oxygen (hydrox) diving done to date, and contains a detailed description of the techniques which have been developed to conduct such diving in the Texas A&M University hyperbaric laboratory. The animal studies reported were supported by the Office of Naval Research, and the human studies by the Texas A&M University Sea Grant College Program.

The Woman Diver. K.C. Smith. In *NOAA Magazine*, October 1978. Vol. 8, No. 4. 6 pages. $1. **TAMU–SG–79–803. NTIS–PB–294–231.**

The growing number of female sport divers, scuba instructors, research and commercial divers in this country has brought to the fore questions and problems concerning their involvement that previously have not been considered. In addition to noting briefly the historic and present social context of female participation in the activity, this article pinpoints some of the pressing medical and physiological considerations facing women divers. It includes information about five recent or ongoing clinical and statistical studies—virtually all of the modern research—about social or physiological effects of diving on women.

1979–80

Hurricane Message Enhancement. Carlton E. Ruch and Larry B. Christensen. January 1981. 140 pages, 43 figures, 18 tables. $5. **TAMU–SG–80–202. NTIS–PG–82–219–338.**

Can people be stimulated to respond to hurricane information in ways that will maximize their safety? This report describes experiments conducted on Galveston Island to determine psychological responses in the subject areas of (1) Simulated hurricane variables; (2) Consequences of exposure to hurricane fury via television; (3) Influence of other residents, authority figures and events; (4) Response as a function of media presentation; (5) Response to fear, information and testimony in current hurricane material. Results are interpreted statistically and summarized in a hurricane response model. Recommendations are made.

Emergency First Aid/Primeros Auxilios: Emergencias. Russell J. Miget. March 1981. 16 pages, 49 illustrations. **TAMU–SG–80–503.**

In the event of an accident, there is often little time to read a first aid manual and follow its detailed narrative. A marine fisheries specialist at Texas A&M University has developed a flip chart with abbreviated step-by-step procedures for use in emergencies aboard vessels. Easy to read, accompanied by explanatory illustrations, and written in both English and Spanish, this publication is designed primarily for untrained personnel who might be called on to administer emergency attention to an accident victim until professional medical help can be obtained.

Hurricane Watch ... Hurricane Warning - Why Don't People Listen? Carlton Ruch and Larry Christensen. May 1980. 4 pages. **TAMU–SG–80–508.**

In an effort to learn why some people respond to hurricane warnings while others do not, psychological experiments were conducted with residents of Galveston, Texas, an island 75 miles southeast of Houston that last experienced a major hurricane in 1961. The experiments were grouped into five subject areas: (1) simulated hurricane variables, (2) consequences of exposure to hurricane fury via television; (3) influence of other residents, authority figures and events; (4) response as a function of media presentation; and (5) response to fear, information and testimony in current hurricane media. This Marine Advisory Bulletin summarizes the conclusions reached by the researchers. While some conclusions relate essentially to the uniqueness of Galveston, all are applicable to any coastal area which could experience a hurricane. The findings are particularly appropriate for those concerned with disaster or emergency plannings and for members of the news media.

1980–81

Guidelines for Establishing Open-Water Recreational Beach Standards: Proceedings of a Conference, April 16-18, 1980, Galveston, Texas. James M. McCloy and James A. Dodson (comp.). August 1981. $5. **TAMU–SG–81–116.**

Protecting the health and safety of visitors to beaches is a problem for any organization that manages or owns a recreational beach. This report is the proceedings of a conference that was the first nationwide attempt to formulate guidelines for use of national organizations that are developing standards for rescue services at open-water beaches. Participants convened in workshops and recommended guidelines in three areas: Personnel and training, management and supervision, and equipment and facilities. Among the problems addressed were liability and risk management, adequacy and uniformity of rescue services, lifeguard qualifications and in-service training and funding. Hosted by the Center for Marine Training and Safety of the Coastal Zone Laboratory of Texas A&M University at Galveston, the conference was co-sponsored by the American Camping Association and the Council for National Cooperation in Aquatics. It was funding in part by the Texas A&M Sea Grant College Program.

Have Fun! But Know the Dangers of the Beach (¡Diviértase! Pero Conozca los Peligros de la Playa). June 1981. 8 pages. **TAMU–SG–81–505.** (Revised June 1991)

Swimming is the number one recreational activity in Texas, but it also accounts for nearly half of the water-related deaths in the state each year. This 16-panel brochure details some of the precautions that apply in any water, beginning with the most obvious — learn to swim. The bilingual text also covers rip currents, sand bars and holes, and stings, bites, burns and cuts. Emergency medical telephone numbers are listed for each part of the Texas coast. The brochure is written in both English and Spanish.

Hurricane Relocation Planning for Brazoria, Galveston, Harris, Fort Bend and Chambers Counties (Texas). Carlton Ruch. June 1981. 183 pages, 21 tables, 17 figures. $5. **TAMU–SG–81–604. NTIS–PB–81–243–677.**

This study of five Texas coastal counties provides data for decision making leading to regional coordination of evacuation before hurricanes. The data can also be used in specific county or city evacuation plans. Three methodologies are developed that can be used in other coastal areas as well. SLOSH (*Sea, Lake and Overland Surges from Hurricanes*) is one such method. The following information is presented to help in deciding how soon evacuation must begin in certain areas to safely evacuate residents before routes are cut off by winds or storm surge that accompanies hurricanes: (a) possible surge penetration for hurricanes of varying intensities; (b) critical places in the study area to indicate road cutoff times by hurricane type for both surge penetration and wind intensity (given in hours plus or minus anticipated time of storm center landfall); (c) hurricane-prone areas that probably should evacuate for most storms (these areas are divided into evacuation zones by county); (d) areas subject to surge intrusion only in extremely severe hurricanes (these areas are divided into contingency zones by county); and (e) the number of hours required to evacuate the residents of evacuation zones who indicated that they would evacuate if advised to, and the number of hours required to evacuate all persons from evacuation and contingency zones if hurricane winds exceed 130 m.p.h. Data are also supplied for the Freeport and Texas City levee systems and for Galveston Island, and data on shelter needs are provided. Information and cautions in using this report are addressed to the media. In addition, hurricane categories and words associated with hurricanes are defined.

The Effect of Social Influence in Response to Hurricane Warnings. Larry Christensen and Carlton E. Ruch. In *Disasters*, Vol. 42 (2): 205-210 (1980). 10 figures, 3 tables. $1. **TAMU–SG–81–809. NTIS–PB–81–199–895.**

Two experiments are reported relating to an individual's conformity or lack of it in a simulated hurricane situation. In the first experiment, the influence of strangers' responses on one's own response was investigated. This study also examined the potential influence that surrounding events (e.g. industrial plant closings) and authority figures (e.g. an advisory from the National Weather Service) can have on response. This was considered an important addition since previous studies have shown that individuals attribute their behavior to the influence of such variables. In the second experiment, the influence of a spouse or friend's response on one's own response was investigated.

1982-83

Safety at Sea: A Guide for Fishing Vessel Owners and Operators. Dewayne Hollin (comp.). October 1982. 44 pages, 17 cartoons, 15 sample forms, 1 figure. **TAMU–SG–83–501.**

Fishing vessels with well-planned safety programs can save lives, prevent injuries and avoid costly damages and lost work time. This safety guide can help you design a safety program for your vessel. Illustrated with cartoons, it offers tips on a wide range of safety concerns: how to hire safer employees, how to make the work environment safer, how to train workers to think about safety. It also discusses emergency procedures and survival techniques. Checklists and sample forms that can be copied or modified and used during inspections or in reporting and investigating accidents and injuries are included.

Hurricane Relocation Planning for Aransas, Kenedy, Kleberg, Nueces, Refugio and San Patricio Counties. Carlton Ruch. June 1983. 211 pages, 25 figures, 23 tables, 2 maps. $5. **TAMU–SG–83–606. NTIS–PB–83–239–004.**

This study of six Texas coastal counties provides data for public officials to use in making decisions about when to recommend evacuation in the event of a threatening hurricane. Key information is presented to help in deciding how soon evacuation must begin in certain areas to evacuate residents safely before routes are cut off by winds or storm surges that accompany hurricanes.

1983–84

Texas Rips! (poster). February 1984. 11" x 17". **TAMU–SG–84–506.**

Another in Sea Grant's series of water safety materials, *Texas Rips!* delivers a warning message about the dangerous rip currents along the Texas coast. A high percentage of drownings occur each year in Texas when swimmers or waders are caught in rip currents adjacent to rock groins, jetties or piers. In addition to an illustration of a typical rip current hazard, the poster also includes information on how to escape should a person be caught.

Protecting Your Boat Against Severe Weather. D. Hollin and K. Pagans. October 1984. 8 pages. **TAMU–SG–84–511.**

The key to protecting boats from winter storms, hurricanes or any threatening weather is planning, preparation and timely action. This guide gives boatowners specific steps that they should follow, whether they plan to remove the boat from the storm area, secure it in the marina or take it to a hurricane hole. Included are diagrams of storms mooring techniques, an easy-to-read glossary of severe weather terms and tips on what to look for in a marina's severe weather preparedness plan.

Hurricane Relocation Planning for Hardin, Jasper, Jefferson, Newton and Orange Counties. Carlton Ruch. September 1983. 141 pages, 11 figures, 13 tables, 3 maps. $5. **TAMU–SG–84–620.**

This study of five Texas coastal counties provides data for decision making leading to regional coordination of evacuation before hurricanes. The data can also be used in specific county or city evacuation plans. Information includes possible surge penetration for hurricanes of varying intensities; critical places in the study area to indicate road cutoff times by hurricane type for both surge penetration and wind intensity (given in hours plus or minus anticipated time of storm center landfall); hurricane-prone areas that probably should evacuate for most storms; areas subject to surge intrusion only in extremely severe hurricanes; and the number of hours required to evacuate the residents to evacuation zones who indicated that they would evacuate if advised to, and the number of hours required to evacuate all persons from evacuation and contingency zones if hurricane winds exceed 130 m.p.h.

1985-86

Keys to Hurricane Safety (Puntos de Seguridad en Caso de Huracanes). September 1985. 8 pages, 1 map. **TAMU-SG-86-501.**

This bilingual version of TAMU-SG-83-503 presents hurricane awareness and preparedness information in both English and Spanish, in recognition of the intended audience along the Texas coast. The brochure itemizes the steps that should be taken before a hurricane threatens, when a watch or warning is issued, during and after a hurricane, and during

the recovery period. A simplified Texas map indicates all major evacuation routes away from the coastline. Common hurricane-related terms are defined.

Texas Coast Hurricanes. Amy Broussard and Norman Martin. May 1986. 24 pages. **TAMU-SG-86-505.**

This publication is designed to reduce the risks from severe coastal storms and hurricanes by describing what they are, how they work, the reasons why they can be so destructive, and the steps that individuals can take to protect themselves, their families and their property. It includes step-by-step instructions (in both English and Spanish) for hurricane preparation and evacuation plans, tracking charts, suggestions for recovery after a storm, and lists of additional publications on hurricanes and hurricane awareness.

Hurricane Relocation Planning for Cameron and Willacy Counties. Carlton Ruch. September 1985. 155 pages, 11 tables, 8 figures. $8. **TAMU-SG-86-601.**

This study of two Texas coastal counties provides data for public officials to use in making decisions about when to recommend evacuation in the event of a threatening hurricane. Key information is presented to help in deciding how soon evacuation must begin in certain areas to evacuate residents safely before routes are cut off by winds or storm surge that accompany hurricanes.

1986-87

Water, How Safe Are You? September 1987. **TAMU-SG-87-402.**

As the weather turns hot there is nothing so inviting as the thought of cool water and swimming, skiing, boating, fishing or just lazing away the afternoon. Below that placid surface is danger, however, and each year in Texas an average of 650 people get so involved in their activities that the end result is death by drowning. Drowning is the second leading cause of accidental death of Americans between the ages of 1 and 44. Since most victims are teenaged males between 15 and 19 years old, this bulletin points out some of the more obvious, but often forgotten, safety practices. Written primarily for a teenaged audience, it covers swimming, river recreation and boating. It includes a list of reference brochures, films, books and courses that can be used to supplement water safety instruction.

1987-88

Evacuation and Contingency Zones—Matagorda Area. Amy Broussard. November 1987. 4 pages. Single copies free. **TAMU-SG-88-502.**

This brochure gives specific evacuation information for persons living in the Matagorda Bay area, including Calhoun, Jackson, Matagorda and Victoria counties of Texas. Evacuation and contingency zones are shown on an accompanying map, which indicates those areas most susceptible to the effects of hurricanes of specified intensities. A summary of hurricane occurrence along the Texas coast is included. This brochure is designed to accompany Keys to Hurricane Safety, which includes general safety tips before, during and after a storm event.

1989-90

Gulf Coast Fishing Vessel Crewman's Handbook. D. Hollin. 1989. 32 pages. Single copies free. **TAMU-SG-90-502.**

It is the duty of every crew member to become familiar with basic procedures and systems that affect his safety, the safety of the other crewmen and the safety of the vessel. Accident prevention aboard fishing vessels in the Gulf of Mexico has long been a goal of both the National Council of Fishing Vessel Safety and Insurance and the fishing industry. An earlier safety manual has now been excerpted into a pocket-sized handbook for all crewmen. This handbook provides a general orientation to Gulf of Mexico fishing vessels and their operation, and offers basic safety tips for both the novice and the experienced crewman. The more each crewman knows about safety and seamanship, the better the odds that the vessel will be a success story rather than a casualty statistic.

Sea Grant

1969–70

Marine Affairs in Texas: A Report for 1968-69. December 1969. 17 pages. **TAMU–SG–70–103. NTIS–PB–188–955.**

Resume of progress made under the Sea Grant Program of Texas A&M University during its first year of operations. Describes project activities and funding levels for the program.

Report of Sea Grant Project Activities 1968-69. December 1969. 115 pages. **TAMU–SG–70–104. NTIS–PB–188–954.**

This is a report of the first year's activities for Texas A&M's Sea Grant institutional award. That year included 27 projects, involving 72 professionals and 58 graduate students. The initial projects were categorized into program development, education and technician services, extension and advisory services, and research projects.

1972–73

5th National Sea Grant Conference Proceedings. Texas A&M University. February 1973. 251 pages. $3. **TAMU–SG–73–101.**

The fifth annual meeting of the Association of Sea Grant Program Institutions (October 10-12, 1972, in Houston, Texas) was hosted by Texas A&M University. Proceedings include presentations in the areas of national marine programs, deepwater terminals, cooperation with industry and building an advisory network.

1977–78

Readership Study of *Sea Grant '70s*. Samuel M. Gillespie. November 1977. 117 pages. **TAMU–SG–78–205. NTIS–PB–280–038/AS.**

The results of a study initiated to develop a profile of the readership of *Sea Grant '70s* and to provide information on subscribers' attitudes and perceptions toward the magazine are reported. Sea Grant '70s, a monthly magazine published (at the time of the study) by the Texas A&M University Sea Grant College Program, disseminates information about publications and activities of the institutions supported by the National Sea Grant Program. Data about a randomly-chosen sample of the readership were gathered by a self-administered questionnaire. Information was obtained on the reader's states of residence, occupations and attitudes toward the publication as a whole and its various sections. A copy of the questionnaire is included as an appendix.

1981–82

Future Directions for Sea Grant Social Science Research. Lauriston R. King (ed.). February 1982. 32 pages. **TAMU–SG–82–108.**

On September 15-17, 1981, 35 social scientists from universities and state and federal agencies met at Texas A&M University to explore the future direction of social science research in the Sea Grant Program. The workshop was in response to a recommendation by the Sea Grant Association's Committee on Research that such a session be held to define, plan and develop the overall direction that social science might take in the national program. This report is a compilation of the statements developed by working groups and the workshop conclusions.

Sea Grant Is ... Jan. 1982. 8 pages. **TAMU–SG–82–111.**

This brochure offers a brief explanation of what the Sea Grant Program represents, both nationally and at Texas A&M University.

Sea Grant College Program Biennial Report 1979-80 and 1980-81. Amy Broussard (ed.). August 1982. 32 pages. **TAMU–SG–82–118.**

This report describes the diverse projects undertaken by the Texas Sea Grant Program during the years indicated. Divided into programs areas—advisory, education, mariculture, fisheries, ocean engineering, environmental quality, safety and information—each topic is presented in a feature article-type format. The report also includes a complete listing of research activities and principal investigators for the two years, and an overall review by the Sea Grant Director.

1982–83

Creating the College of the Sea: The Origin of the Sea Grant Program. John Miloy. February 1983. 64 pages, 6 photographs. $2. **TAMU–SG–83–604. NTIS–PB–83-204–057.**

Based on John Miloy's master's thesis written in 1976 at Texas A&M University, this book first discusses the "rediscovery" of the oceans and the increasing interest in oceanography after World War II. Government leaders proposed many solutions to the problem of coordination of federal oceanographic research. *Creating the College of the Sea* describes how one such solution, the Sea Grant College Program, came about. It is based on a review of personal papers and correspondence, particularly those of Dr. Athelstan Spilhaus, and recounts meetings, discussions and congressional debates that led to the passage of the Sea Grant Act of 1966. It includes that original legislation, the Sea Grant Program Improvement Act of 1976, and amendments passed in 1978 and 1980.

1983–84

Evaluation of Texas A&M Sea Grant Marine Education Materials. Valerie J. Gunter. June 1984. 47 pages, appendices. $2. **TAMU–SG–84–204.**

A random-sample survey was conducted in 1983 to determine who uses Texas A&M Sea Grant marine education materials, how they are used, and how dissemination occurs. This report presents the survey results. The findings indicate that the materials are being disseminated into the general population, but that two-thirds of the users live outside the state of Texas and only half are elementary or secondary teachers. The materials are used by a more diverse population than anticipated, and nearly half expressing extreme enthusiasm and most of the others being neither enthusiastic nor highly critical.

1985–86

Bienniel Report 1983-1985. Norman Martin, Rhonda Snider and Amy Broussard. September 1984. Special Issue of *Texas Shores*. **TAMU–SG–86–109.**

The research, management, extension and education activities of the Texas A&M University Sea Grant College Program for 1983-1985 are outlined in a series of lively, readable articles. Each section tells the Texas Sea Grant story by focusing on individual projects in the research areas of mariculture, fisheries, environment, coastal and engineering studies, as well as functions of the Marine Advisory Service, Marine Education Program and the Marine Information Service. In addition, the biennial report includes a financial

summary of program areas, three-dimensional funding graphs, project length statement and a list of publications from the biennium.

1987-88

Research Publication Policies and Opportunities. Amy Broussard, editor. 1987. 6 pages. **TAMU-SG-88-103.**

This brochure includes a description of the various types of publications produced by the Marine Information Service service, and outlines procedures to be followed by researchers in submitting manuscripts. The reports required of researchers and others supported by the Texas A&M Sea Grant Program are discussed, as are the services offered by MIS.

1991-92

Texas A&M University Sea Grant College Program Directory 1991-1992. Amy Broussard (ed.). 1992. Single copies free. **TAMU-SG-92-601.**

The research projects that comprise the 1991-1992 Sea Grant Program are annotated in this directory, which also includes the name, address and telephone number of each project investigator. Researchers in charge of Nutrient-Enhanced Coastal Ocean Productivity projects are also identified. In addition, the directory lists the staff of the Texas A&M Sea Grant Program, including members of the administration, Marine Information Service and Marine Advisory Service.

Texas Sea Grant Program 1968-1992 Publications. 1992. 104 pages. Texas A&M University Sea Grant College Program. **TAMU-SG-92-603.**

This is a bibliography of publications and videos produced by the Texas A&M Sea Grant Program since its inception in 1968 through mid-1992. Citations are listed by topics in chronological order in 17 categories. A brief abstract is included for each listing. Information is given for ordering those publications still in print as well as alternate sources for those no longer available through Sea Grant.

Catalog of Current Sea Grant Publications. 1992. 76 pages. Texas A&M University Sea Grant College Program. **TAMU-SG-92-604.**

This looseleaf catalog lists all publications and videos that are currently available from Texas A&M Sea Grant. The citations are listed by topic in chronological order, so more recent works are found toward the end of each section. A brief abstract is included for each listing.

Seafood Marketing

1972–73

Selling Seafood Successfully. Samuel M. Gillespie, Bill Schwartz and Mary Ann Stutts. July 1973. 4 pages. **TAMU–SG–73–505.** ***Revised April 1985.***

This bulletin discusses seafood merchandising. Topics include product assortment, dressing fish, pricing considerations, fundamentals of a seafood display, a model stock list of assorted seafood products and a description of marketing seafood forms.

1974–75

An Analysis of Seafood Consumption Patterns and Product Perceptions in Texas. Samuel M. Gillespie and Michael J. Houston. August 1975. 53 pages. $2. **TAMU–SG–75–216. NTIS–PB–248–115/AS.**

Attitudes toward seafood were examined by sampling 675 households in three Texas cities: Austin, Corpus Christi and Waco. Consumer consumption patterns are described and explained in terms of attitudes and perceptions toward seafood. Findings suggest that although consumption of seafood is appreciably lower than that of red meats and poultry, consumers do perceive seafood as a nutritious and relatively economical meat item. Major impediment to purchase was negative reaction to preparation and purchase. Results of a behavioral model developed to explain consumption patterns are reported. Seafood consumption patterns are analyzed on the basis of a number of socio-economic attributes. Includes questionnaire.

1979–80

Marketing Alternatives for Fishermen. John P. Nichols, et al. May 1980. 46 pages, 6 tables. $2. **TAMU–SG–80–204. NTIS–PB–80–223–381.**

Markets and market channels for seafood landed by American fishermen are as varied and diverse as the products which flow through them. From small, one-boat operations to highly industrialized fleets, there is a wide range of conditions and problems. Traditionally, however, most fishermen know very little about what happens to the fish beyond the dockside or point of first sale. To some extent, how well fishermen fare as the total fishing/seafood sector of the economy grows and expands depends on the way they are organized to market their product. This publication is intended for leaders at all levels of the seafood industry, marine advisory personnel and public policy-makers in related state and federal agencies. Its purpose is to foster discussion and development of a more informed view of the market problems facing fishermen and of the alternative approaches which may be available to them.

Seafood Preparation

1978–79

Ah-h-h! Texas Shrimp! Annette Reddell. June 1979. 6 pages. **TAMU–SG–79–504.**

Ah-h-h, Texas Shrimp! Shrimp, with its distinctive taste and tender, juicy meat, is the number one favorite seafood among Texans. And it's big business for the Texas fishing industry. This free brochure features a number of shrimp recipes developed in the seafood test kitchen at Texas A&M University. It includes tips on buying fresh shrimp and explains terms that might be confusing to the consumer.

1979–80

Shrimp In Microwave Cookery. Annette Reddell. March 1980. 40 pages. $2. **TAMU–SG–80–505.**

With so many people turning to time- and energy-saving devices, a cookbook for quick and easy seafood preparation is quite appropriate. This 8 1/2 x 11- inch paperback cookbook features 40 shrimp recipes in four categories for use in the microwave: hearty main dishes, accompaniment dishes, soups and chowders, and party foods. An experiment comparing microwave-cooked shrimp to those prepar-ed with conventional methods led to the development of this cookbook by personnel in the seafood test kitchen at Texas A&M University. Directions for converting conventional oven recipes to microwave use, as well as suggestions to keep in mind when cooking shrimp in the microwave are included.

Swordfish Fare. Barbara Rowland and Annette Reddell. June 1980. 6 pages. **TAMU–SG–80–510.**

Swordfish, a long-time favorite fish in other areas of the United States, is now gaining notable popularity in Texas. One of the more savory preparation methods for the firm flesh of the swordfish is smoking. This brochure, originally produced for the Texas Restaurant Association Convention held in June 1980, features four recipes utilizing smoked swordfish and two for delicious accompanying sauces. The information presented outlines the steps in proper smoking of swordfish. Included is a table which gives marinating and cooking times along with recommended cooking temperatures to ensure good results in smoking swordfish.

1981–82

Microwave Cooking with Shrimp. Annette Reddell Hegen. October 1981. 4 pages. **TAMU–SG–82–501.**

Energy conservation, convenience and speed are factors which have made the microwave oven so popular and tasty Texas shrimp is a good candidate for microwave cookery. This brochure offers recipes for microwave shrimp and gives helpful advice about the factors which influence microwave cooking time.

Cooking the Crab Catch. Annette Reddell Hegen. October 1981. 8 pages, 3 illustrations. **TAMU–SG–82–502.**

Taste-tantilizing "Crab Meat Stuffed Mushrooms" and "Blue Crab-Broccoli Bake" are just two of the delicious recipes offered in the brochure featuring Gulf Coast blue crab. The common market varieties of low-calorie, nutritious crab meat - usually found in the fresh cooked form - are described, and step-by-step procedures for preparing both soft- and hard-shell crabs are given. Also included are illustrations of the anatomy of the blue crab and a glossary of crab-related terminology.

The Opulent Oyster. Annette Reddell Hegen. May 1982. 6 pages. **TAMU–SG–82–504.**

Oysters, versatile, low in calories and rich in protein, are described in this brochure. The notion that these succulent mollusks can't be eaten in months without an 'r' in the spelling is disproved and eight tempting recipes are offered from elegant "Oysters Rockefeller" to an oyster and artichoke casserole.

1982–83

Cooking Seafood for a Crowd. Annette Reddell Hegen. October 1982. 4 pages. **TAMU–SG–83–502.**

Planning on running a food concession at the county fair or local festival? This pamphlet, aimed at helping groups prepare quantities of seafood for a public event, covers basic concerns: facility, menu, equipment, quality control, health and safety standards, work schedules and personnel. It includes a buying guide, listing quantities of seafood and other common menu items to serve 100, 500 and 1,000; recipes for 100 portions of Texas red sauce and quick tartar sauce; and a planning guide.

1983–84

Shrimp Treats from the Ladies of the Fleet. Annette Reddell Hegen. September 1983. 4 panels. **TAMU–SG–84–501.**

Seven delicious ways to fix Texas shrimp! These recipes were gathered from members of the Texas Shrimp Association Auxiliary, whose families have been in the shrimp industry for years. Included are recipes for: "Sea Surprise," a molded shrimp salad: "Shrimp and Eggplant Dressing;" "Shrimp and Buttery Pasta;" "Bar-B-Q Shrimp;" "Shrimp Ball Hors d'Oeuvres;" "Cantonese Shrimp;" and "Crispy Fried Shrimp" dipped in a batter of wheat cereal.

Bay Bounties. Annette Reddell Hegen. September 1984. 6 pages. **TAMU–SG–84–510.**

For a hearty breakfast, scrumptious appetizer or elegant main meal, this recipe collection provides eight new ways to fix the bountiful harvest of shrimp, crab, sheepshead and other seafood from Texas bays. Members of Families Involved in Seafood Harvest (FISH), whose goal is to maintain marine resources for present and future generations, have netted time-honored recipes from pioneering Gulf Coast families and fishermen. The brochure includes a quick and easy recipe for crab dip and shrimp dip, as well as more elaborate dinner spreads like stuffed crab, baked sheepshead, fish fillets simmered in a seasoned tomato sauce or fish fillets smothered in a spicy mushroom sauce and served over steaming rice. There's also an easy, one-skillet shrimp, bacon and eggs breakfast, or a gumbo of crab, shrimp and vegetables that tastes best after simmering several hours.

1984–85

Celebrate Today With Shrimp. Annette Reddell Hegen. June 1985. 6 panels. **TAMU–SG–85–504.**

You won't find fried shrimp in this medley of appetizers, sidelights and main dishes, but this brochure offers some innovative shrimp choices that are guaranteed to perk up your meal planning or get-togethers. Delicious, highly nutritious and reasonably priced, when you consider cost per serving, shrimp are versatile enough for any cooking style and most budgets. The eight dishes presented are "Cameron County Shrimp Dip," "Bacon-Wrapped Shrimp," "Creole

Shrimp Butter," "Shrimp-Stuffed Fillets," "Shrimp Baked in Garlicky Butter Sauce," "Shrimp and Wild Rice Stuffing," "Hot Shrimp Casserole" and "Cajun Shrimp Gumbo."

1985-86

Seafood Fixins for Your Holiday Cheer. Annette Reddell Hegen. October 1985. 8 panels. **TAMU-SG-86-503.**

This collection of seafood recipes uses crab, shrimp, oysters and fish fillets to create a variety of festive dishes. Try such party fare as the hot crab cocktail spread, shrimp party ball, smoked fish log, or hot oyster fritters. Recipes also are included for Holiday Fish Kiev, Christmas Cranberry Catch, Holiday Golden Oyster Stew, and a Shrimp Tree St. Nick that can double as a Yuletide centerpiece.

1986-87

Over the Coals. Annette Reddell Hegen. May 1987. 6 panels. **TAMU-SG-87-503.**

Smoking or grilling fish or shellfish on the outdoor grill is an easy and satisfying way to create delicious seafood meals. Smoking provides a unique flavor to seafood - unlike anything you can produce in the kitchen. Smoked seafoods are excellent right off the grill or they can be combined with other ingredients for impressive salads, dips, spreads or a variety of hearty entrees. From hibachis to covered units with motorized spits, Texas seafoods cooked over the coals offer a festive alternative to conventional cooking.

1987-88

Texas Fish-Light and Lean Recipes. Annette Reddell Hegen. March 1988. 2 pages. **TAMU-SG-88-506.**

Fish fillets are a market form of finfish that offer preparation versatility in creating a high-quality protein meal. Fillets are the boneless, lengthwise sections of flesh cut from the backbone. They are 100 percent edible and therefore economical since there is no waste. Offered here are a sampling of quick and easy recipes that are easy on both wallet and figure.

1988-89

The Seafood and Health Connection. Annette Reddell Hegen. September 1988. 6 pages. Single copies free. **TAMU-SG-89-501.**

Although seafood is popular for the taste and for ease and versatility of preparation, the nutritional benefits probably account for the current and steady increase in consumption. Recent studies have focused new attention on the comparative health benefits. This six-page fact sheet describes the new findings, includes tables on Omega-3 fatty acid content, and on cholesterol/calorie content of both finfish and shellfish, and offers new heart-healthy seafood recipes.

Keeping Seafood Safe at Home. Annette Reddell Hegen. January 1990. 2 pages. Single copies free. **TAMU-SG-89-503.**

This Texas Marine Advisory Service bulletin provides seafood consumers with important education on how and where to buy fish or shellfish, seafood contamination, storage and cooking the catch.

1989-90

Freezing Fish and Shellfish (replaces 77-503). R. Nickelson, II and Annette Redell Hegen. 1990. **TAMU-SG-90-503.**

The freezing of fish, shrimp, crabs and oysters is discussed in this illustrated booklet. Reasons for freezing, selection of the best products and steps in preparation for freezing are explained. Facts about thawing and refreezing are included.

Seafood-The Healthy Choice. Annette Reddell Hegen. 1990. 7 pages. No charge. **TAMU-SG-90-505.**

Seafood is a winning combination for your palate and health — flavorful and nutritious, yet low in calories. A four-ounce serving provides nearly half the daily protein needed. Seafoods are rich in vitamins and minerals, low in sodium, and are a unique source of omega-3 fatty acids, reported to be beneficial in maintaining a healthy heart. They can be prepared in a variety of ways and they cook quickly. This brochure contains several Texas recipes to keep your menu interesting and low in calories.

Seafood Technology

1971–72

Development of a Process for Preparing a Fish Protein Concentrate Which Can Be Reconstituted Into a Meat-Like Product. Kamaluddin Hyder and Bryant F. Cobb, III. March 1972. 92 pages. $3. **TAMU–SG–72–201.**

A process for preparing fish protein concentrate (FPC) with rehydration and emulsifying properties is described in this report. *Micropogon undulatus*, which is discarded during shrimping operations in the Gulf of Mexico, is used as a starting material for this process. Characteristics of the FPC produced are presented including its usefulness as a binder protein in sausage-like products. In addition to FPC, a partially refined fish oil is produced as a co-product.

Seafood Quality Control: Boats/Ebarcaciones. Ranzell Nickelson, II and Manuel Pina, Jr. April 1972. 8 pages. **TAMU–SG–72–508. NTIS–COM–72–11227.** ***Revised November 1983. (NTIS-PB–84-134-675)***

This publication is designed to familiarize the boat and fish house operator or employee of factors affecting seafood quality in daily operations. Since human illness from seafood is only 6.5 percent of the total illness reported, seafood sanitation is of greater concern as an economic impact on fishermen than as a health hazard. The author elaborates on the causes and remedies of seafood sanitation problems. Written in Spanish and English.

Seafood Quality Control: Processing Plants. R. Nickelson, II. June 1972. 8 pages. **TAMU–SG–72–511.** ***Revised November 1983 (NTIS-PB–84-134-659).***

Some problems associated with seafood processing operators and suggested solutions are presented in a non-technical matter. This publication should be of interest to anyone concerned with seafood quality control in processing plants.

1972–73

Seafood Quality Control: Processing Plant Personnel. Ranzell Nickelson, II and Manuel Pina, Jr. June 1973. 8 pages. **TAMU–SG–73–504. NTIS–COM-73–11524.** ***Revised November 1983 (NTIS-PB–84-134-667).***

This bilingual, illustrated manual clearly presents the harmful effects of bacteria on seafood and the proper seafood handling techniques to English- and Spanish-speaking workers.

1973–74

Role of Microorganisms in Shrimp Quality: A Research Summary. C. Vanderzant, B. Cobb and R. Nickelson, II. January 1974. 46 pages. $3. **TAMU–SG–74–201. NTIS–COM–74–10715.**

Described in this publication are research objectives, summaries of previous work and major research accomplishments for 1969-72 in the areas of (1) role of microorganisms in the quality deterioration of Gulf coast and pond-reared shrimp; (2) development of indicator tests to determine the potential shelf life of shrimp; (3) role of *Vibro parahaemolyticus* in Gulf coast seafoods, and (4) quality deterioration of microbial origin in frozen breaded raw shrimp.

1978–79

Ammonia-Producing Enzymes in White Shrimp Tails. Chia-Ping S. Yeh, Ranzell Nickelson, II and Gunnar Finne. In *Journal of Food Sciences*, Vol. 43, No. 5 (1978). pp. 1400-1401, 1404. 3 pages, 3 figures. $1. **TAMU–SG–79–802.**

Of many ammonia-producing enzymes tested, only adenosine deaminase and AMP deaminase were found in significant levels in white shrimp tails. Arginase was also shown to be present, and formation of ammonia from arginine can thus potentially take place through urea and bacterial urease. At every temperature tested, enzymatic ammonia production from shrimp tissue during initial postmortem storage accounted for more than half of total ammonia production. Optimum temperature for the enzymatic ammonia formation was shown to be 37°C, while the pH profile showed two distinct peaks: one near 6.0 and the other around 8.4. This study shows the importance of native shrimp tissue enzymes in affecting spoilage of iced shrimp.

Occurrence and Control of *Salmonella* in Freshwater Catfish. L.E. Wyatt, R. Nickelson, II and C. Vanderzant. In *Journal of Food Sciences*, Vol. 44 (1979). pp. 1067-1069, 1073. 4 pages, 2 figures, 2 tables. $1. **TAMU–SG–79–807.**

Incidence of *Salmonella* was determined in farm-raised catfish and in their environment. Effect of processing procedure on *Salmonella* contamination also was investigated. In addition, domestic and imported retail samples were examined for *Salmonella*. *Salmonella* was isolated from processed farm catfish and catfish pond water. Its source could not be established in that feed, cattle manure, frogs, turtles and crayfish from the ponds were *Salmonella*-negative. Detection of *Salmonella* in catfish and catfish pond water seemed to be enhanced by high stocking densities and water temperatures approaching 26°C. By changing the processing procedure, the incidence of *Salmonella* in the finished product was reduced from 48.6 to 0 percent. Retail samples showed a wide range of total plate and coliform counts with good correlation (0.86 farm-raised and 0.80 wild) between the two in fresh fish. This correlation was not noted in frozen imported fish (-0.10 for Mexican and -0.0047 for Brazilian). *Salmonella* was isolated from only 13 of 153 (8.4 percent) retail samples.

1979–80

***Edwardsiella tarda* in Freshwater Catfish and Their Environment.** Lawrence E. Wyatt, Ranzell Nickelson, II and Carl Vanderzant. In *Applied and Environmental Microbiology*, Vol. 38, No. 4, October 1979. pp. 710-714. 4 pages, 3 tables. $1. **TAMU–SG–80–802.**

Edwardsiella tarda was isolated from 47, 88, and 79 percent of skin, visceral, and dressed-fish samples, respectively. This species was also isolated from 30 percent of imported dressed fish, 75 percent of catfish pond water samples, 64 percent of catfish pond mud samples, and 100 percent of frogs, turtles, and crayfish from catfish ponds. The incidence of *Edwardsiella* increased during the summer months, as water temperatures increased. Of several isolation media evaluated, the most effective was selective enrichment in double-strength *Salmonella-shigella* broth and subsequent plating on single-strength *Salmonella-shigella* agar. The significance of the incidence of *Edwardsiella* in catfish, catfish disease, and public health could not be substantiated.

Stability of Adenosine Deaminase and Adenosine Monophosphate Deaminase During Ice Storage of Pink and Brown Shrimp from the Gulf of Mexico. Wai Lun Cheuk, Gunnar Finne and Ranzell Nickelson, II. In *Journal of Food Sciences*, 44 (6), 1979. pp. 1625-1628. 4 pages, 4 figures. $1. **TAMU–SG–80–807.**

Stability of adenosine deaminase and AMP deaminase from pink and brown shrimp muscle extracts was assayed during postmortem ice storage. AMP deaminase activity was lost rapidly during the early stage of ice storage, and no activity could be detected after (a) 10 days for pink shrimp and (b) 16 days for brown shrimp. Even though there was a gradual loss in activity, adenosine deaminase could be detected in both species through the entire storage period of 21 days. Stability of these two enzymes was also correlated with the traditional spoilage indicators: Total volatile nitrogen (TVN), total plate count (TPC) and organoleptic evaluations. During the lag-phase of bacterial growth, AMP deaminase lost 50 percent of its original activity while adenosine demainase remained active. During the log phase, bacterial counts and TVN values gradually increased to 108/g and 30 mg TVN-N/100g, respectively, while AMP deaminase lost its activity. Finally, during the stationary phase, adenosine deminase (with low activity) was the only ammonia-producing tissue enzyme that could be detected. The activity of adenosine deaminase and AMP deaminase could potentially be used as quality indices for fresh shrimp held on ice.

Fatty Acid Stability of Gulf of Mexico Brown Shrimp (*Penaeus aztecus*) Held on Ice and in Frozen Storage. Nestor R. Bottino, Martha L. Lilly and Gunnar Finne. In *Journal of Food Sciences*, 44 (6), 1979. 2 pages, 3 tables. $1. **TAMU–SG–80–808.**

Fatty acid composition of iced, frozen and frozen-glazed brown shrimp (*Penaeus aztecus*) was determined as a function of storage time. Iced shrimp were analyzed every third day for 18 days while both frozen sets were analyzed at regular intervals for 183 days. No significant changes in either iced, frozen, or frozen-glazed shrimp could be detected.

Presence, Growth and Survival of *Yersinia enterocolitica* In Oysters, Shrimp and Crab. S.S. Peixotto, G. Finne, M.O. Hanna and C. Vanderzant. In *Journal of Food Protection*, Vol. 42, No. 12. December 1979. pp. 1778-1779. 8 pages, 10 figures, 3 tables. $1. **TAMU–SG–80–809. NTIS–PB–80–174–659.**

Yersinia enterocolitica was recovered from 6 of 45 (13 percent) oyster, 2 of 50 (4 percent) shrimp and 12 of 58 (21 percent) blue crab samples. No single method of enrichment (cold mannitol broth or modified Rappaport broth for 7, 21 or 60 days) was most effective for the three types of shellfish examined. The effect of refrigerated storage on *Y. enterocolitica* depended upon the type of shellfish, condition (raw or boiled), strain of *Y. enterocolitica* and temperature and time of storage. In general, *Y. enterocolitica* counts increased in (a) raw oysters stored at 0-2° C for 14-21 days and at 5-7° C for 2-10 days, (b) in boiled shrimp stored for 3-5° C for 7-21 days and (c) in cooked crab meat stored at 5° C for 14 days. Freezing and heating of shrimp and crab meat caused extensive destruction of *Y. enterocolitica*. Biotypes capable of causing human illness (when inoculated into seafoods) survived and under certain conditions multiplied at refrigeration temperatures. Biochemical characteristics of the isolates from raw shellfish differed from those of clinically significant types.

Effects of Sampling Procedures on *Salmonella* Recovery from Fresh Water Catfish. Lawrence E. Wyatt, Ranzell Nickelson, II and Carl Vanderzant. In *Journal of Food Protection*, Vol. 43, No. 1, January 1980. pp. 974-981. 3 pages, 1 table. $1. **TAMU–SG–80–810.**

To determine the effectiveness of different sampling procedures, 200 frozen catfish known to be contaminated with *Salmonella* were divided into 350 samples. Variables in sampling included anterior and posterior portions of fish, blending, immersion, swabbing, rinsing and incubation at elevated temperatures. The composite of blended anterior and posterior samples incubated at 43° C and immersion of whole fish incubated at 35° C showed the highest number of positive samples, 50 percent and 42 percent, respectively. The contact method of swabbing (14 percent) and rinsing (14 percent) were the least effective of the methods examined. The anterior (visceral cavity area) portions of the fish seemed to be more highly contaminated (38 percent positive) than the posterior portion (26 percent positive). These data show that the sampling procedure can greatly affect recovery of *Salmonella* from fresh water catfish. Overall levels of *Salmonella* were low and the hazards of cross-contamination with other foods seem remote.

Shelf-Life Studies on Carbon Dioxide Packaged Finfish from the Gulf of Mexico. Harrel Banks, Ranzell Nickelson, II and Gunnar Finne. In *Journal of Food Sciences*, Vol. 45, No. 2, 1980. pp. 157-1625 pages, 13 figures. $1. **TAMU–SG–80–813. NTIS–PB–80–209–380.**

Modified atmosphere packaging using CO_2 was shown to be effective in retarding the growth of microorganisms during storage of fresh fish from the Gulf of Mexico. At 4°C, there was at least a log difference in bacterial counts at 2, 4, and 6 days between fish stored in CO_2 as compared to control fish stored without CO_2. While the CO_2 atmosphere was shown to inhibit the growth of common spoilage types of bacteria such as gram-negative rods (*Pseudomonas*), stimulation of gram-positive bacteria (such as *Lactobacillus*) also was demonstrated. Fish stored at 4°C for 2-8 days in a modified atmosphere containing CO_2 had lower total volatile nitrogen (TVN) values than fish stored at the same temperature without CO_2. The results indicate that the shelf-life of fresh fish can be extended by packaging and storing the fish in a CO_2 atmosphere.

1980–81

Minced Fish Flesh From Nontraditional Gulf of Mexico Finfish Species: Bacteriology. Ranzell Nickelson, II, Gunnar Finne, Mary O. Hanna and Carl Vanderzant. In *Journal of Food Sciences* 45(5), 1980. pp. 1321-1326. 6 pages, 9 tables. $1. **TAMU–SG–81–804. NTIS–PB–81–192–825.**

Fresh and frozen minced fish flesh was prepared from sheepshead, black drum, croaker, sand trout, tilapia, and mullet. Aerobic plate counts (APC, at 25°C) of fresh mince ranged from 1.2×10^5/g (sheepshead) to 2.6×10^8/g (tilapia, those of frozen mince (2 months at -20°C) from 7.9×10^3/g (sheepshead) to 7.9×10^6/g (tilapia). In most cases only minor changes in count occurred during scaling, heading, and evisceration. Counts usually increased during flesh/bone separation. Coliform counts of frozen minced flesh ranged from 11.2 to >1100/g. Fecal coliform bacteria were detected in the frozen mince of tilapia, croaker, and black drum (range 1.2-254.3/g), coagulase positive staphylococci in tilapia, sheepshead, and mullet product were similar to those present in the whole fish. *Moraxella-Acinetobacter* sp. were the most prevalent microbial types in the fish before, during, and after processing into minced fish flesh.

Minced Fish Flesh From Nontraditional Gulf of Mexico Finfish Species: Yield and Composition. Gunnar Finne, Ranzell Nickelson, II, Annette Quimby and Nina Connally. In *Journal of Food Sciences*, 45(5), 1980. pp. 1327-1329, 1340. 4 pages, 1 figure, 4 tables. $1. **TAMU–SG–81–806. NTIS–PB–81–189–920.**

Production yield, composition, and quality of minced (deboned) flesh from nontraditional finfish species from the Gulf of Mexico were investigated. The fish, which were

processed both as fresh and prefrozen, included: sheepshead, sandtrout, black drum, croaker, and mullet together with fresh-water tilapia. The yield of deboned flesh varied from a high of 31.3 percent for fresh croaker to a low of 20.0 percent for prefrozen round mullet. The proximate composition of deboned flesh from different species showed that the moisture content varied from 75.22 percent (black drum) to 81.96 percent (mullet); protein from 14.19 percent (mullet) tp 18.69 percent (sandtrout); and fat from 1.33 percent (mullet) to 5.83 percent (croaker). No substantial difference was observed between fresh and prefrozen fish regarding proximate composition. Croaker contained the highest degree of saturated fatty acids while sheepshead was highest with respect to unsaturated acids. Thiobarbituric acid (TBA) analysis showed the deboned flesh to be of good quality with regard to oxidation. However, in every case there was a marked increase in TBA number during four weeks frozen storage of the round fish. Total volatile nitrogen (TVN) analysis showed that nontraditional species available wholesale were of variable quality ranging from good to poor.

1981–82

Storage Characteristics of Finfish Fillets (*Archosargus probatocephalus*) Packaged in Modified Gas Atmospheres Containing Carbon Dioxide. M. Lannelongue, M.O. Hanna, G. Finne, R. Nickelson, II and C. Vanderzant. In *Journal of Food Protection* 45(5): pp. 440-444 (1981). 6 pages, 1 figure, 3 tables. **$1. TAMU–SG–82–821.**

Sheepshead *Archosargus probatocephalus* fillets were refrigerated at 4°C in air. Numbers and types of microorganisms and total volatile nitrogen (TVN) were determined at regular intervals during storage. Increases in aerobic plate counts were greater for fillets stored in other gas mixtures. Pure CO_2 and 40 percent CO_2: 60 percent N_2 most effectively limited bacterial growth. TVN values of samples stored in air and in 20 percent CO_2: 80 percent O_2 increased rates similar to those of fish held on ice. At larger CO_2 concentrations, however, TVN increased slowly, and the rate of TVN production was inversely proportional to CO_2 tension.

Storage Characteristics of Brown Shrimp (*Penaeus aztecus*) Stored in Retail Packages Containing CO_2-Enriched Atmospheres. M. Lannelongue, M.O. Hanna, G. Finne, R. Nickelson, II, and C. Vanderzant. In *Journal of Food Sciences* 47(3): pp. 911-913 and 923 (1982). 4 pages, 3 figures, 3 tables. **$1. TAMU–SG–82–823.**

Modified atmospheres containing CO_2 retarded microbial growth during refrigerated storage of retail packaged fresh brown shrimp (*Penaeus aztecus*). The inhibitory effect seemed proportional to the CO_2 tension. The surface pH of shrimp stored in air increased rapidly initially, but pH decreased in all samples stored in CO_2-enriched atmospheres. Shrimp stored in modified atmospheres also had significantly lower total volatile nitrogen (TVN) values than those stored in air. Head-space composition changed throughout storage in all atmospheres tested and were largest for shrimp stored in air.

1982–83

Microbiological and Chemical Changes During Storage of Swordfish (*Xiphas gladius*) Steaks in Retail Packages Containing CO_2-Enriched Atmospheres. M. Lanne-longue, M.O. Hanna, G. Finne, R. Nickelson, II, and C. Vanderzant. In *Journal of Food Protection*, 45(13): pp. 1197-1203 (1982). 8 pages, 6 figures, 3 tables. **$1. TAMU–SG–83–808.**

Swordfish (*Xiphias gladius*) steaks were held in retail packages containing 100 percent CO_2 and in mixtures of 40 percent and 70 percent CO_2 in combination with either oxygen or nitrogen. Controls were stored in air. Samples were removed for chemical and microbiological analyses after 2 to 22 days of storage at 3.5°C. The inhibitory effect of CO_2 on psychotropic, aerobic gram-negative spoilage bacteria was proportional to the CO2 tension in the packages. Maximum inhibition of growth was achieved with 100 percent CO_2. Swordfish steaks stored in CO_2-enriched atmospheres had lower total volatile nitrogen (TVN), trimethylamine (TMA) and total volatile (TVA) values than steaks stored in air. Oxidative rancidity was not a flavor problem of fish in any of the atmospheres after 20 days of refrigerated storage.

Storage Characteristics of Fresh Swordfish Steaks Stored in Carbon Dioxide-Enriched Controlled (Flow-Through) Atmospheres. V. Oberlender, M.O. Hanna, R. Miget, C. Vanderzant and G. Finne. In *Journal of Food Protection* 46(5): pp. 434-440 (1983). 7 pages, 2 tables, 4 figures. **$1. TAMU–SG–83–819.**

A flow-through controlled atmosphere packaging system using a number of different CO_2-enriched gaseous compositions effectively retarded growth of microorganisms on fresh swordfish steaks held at 2°C for 22 days. During the first 14 days of storage, *Pseudomonas* spp. either dominated or represented a major part of the microflora in all gaseous atmospheres tested. However, in atmospheres containing 70 percent CO_2 or pure CO_2, heterofermentative *Lactobacillus* spp. and *Brochothrix thermosphacta* were a major part of the microflora, particularly after Day 14 of storage. Both total volatile nitrogen and trimethylamine, often used as quality indicators for fresh seafoods, increased more slowly for swordfish stored in CO_2-enriched atmospheres than in air. A controlled atmosphere, flow-through system for storage of fresh seafoods is advantageous because (a) the gas mixture is stable, (b) individual portions can be removed from a master package without losing or disrupting the atmosphere, and (c) volatile off-odors accumulating during storage in sealed, CO_2-enriched atmospheres are carried off with the flow-through gas.

1984–85

Safety and Quality Aspects of Oysters, Mussels and Clams. Michael G. Haby. June 1985. 2 pages, 1 table. **TAMU–SG–85–503.**

Oysters, clams and mussels are enjoyed by seafood lovers nationwide, and often these shellfish are eaten whole and raw. This consumption pattern and the fact that these shellfish grow attached to bay bottoms create the potential for food-borne illnesses if these products are not purchased from certified, reputable sources and handled properly upon receipt. This advisory bulletin, designed for seafood retailers, discusses: Why oysters, clams and mussels can be victims of their environment; How the National Shellfish Sanitation Program (NSSP) works to ensure the harvesting, processing and distribution of safe shellfish; What techniques you can use to make sure that this "safety net" extends to your customers; How to assure customers of consistent high quality shellfish.

Video Productions

Educational

Texas Shores ... Saving What's Left. 26:39 VHS format. $20.

The Texas shoreline is retreating in the face of advancing waves of saltwater and the rate seems to be increasing. Travel the coast with us as we look at the price we all pay for erosion and the work aimed at finding a solution. The video includes a section on wave characteristics and the various activities that cause erosion, both natural and man-made. The production received the Grand Award at the 1991 CASE competition and was a Finalist in the 1991 Houston International Film Festival for documentary.

Balancing Act. 15:00 VHS format. $20.00

Scientists and private citizens have become an integral part in the creation of management plans for sensitive natural resources in Texas. This educational video outlines the biological significance of two coastal preserves in the Galveston Bay complex and the problems in creating a comprehensive management plan for both. Water quality problems are addressed, as well as the role private citizens can play in the process.

Saltwater Aquarium. 16:00 VHS format. $15.00.

An instructional video on the creation and care of a saltwater aquarium, the program covers curing the tank, water quality, testing procedures, and the do's and don'ts of home-based aquaculture.

Flower Garden Banks National Marine Sanctuary. 9:10 VHS format. $20.00.

The Flower Garden Banks, the northernmost coral reefs on the continental shelf of North America, became a National Marine Sanctuary in 1991. Located more than 100 miles off the coast of Texas and 50 feet below the sea's surface, the East and West Banks serve as a regional reservoir of shallow-water Caribbean reef fishes and invertebrates. This video, co-funded by NOAA's Sanctuaries and Reserve Division and Texas Sea Grant, highlights the location and problems observed at the Banks, and describes what is being done to protect the Santuary. A full-color informational brochure accompanies the video, and an educational poster is available.

Environmentality: Learning to Share Our World. 56:10 VHS format. $5.00.

An educational satellite uplink program produced by The Louisiana Educational Resource Network and co-sponsored by Texas Sea Grant, Walt Disney World's EPCOT Center, Sea World of Florida, Southern University, Save the Manatee Foundation and the Louisiana Systemic Initiative Project. The video uses the manatee to exemplify how the planet Earth is a fragile place.

Don't Mess with Texas Beaches. 20:00 VHS format. $15.00.

Litter on Texas beaches continues to be a problem, but the new enforcement procedures brought about by MARPOL Annex V and those anticipated from special designation are helping. This educational video also details the hazards debris presents for wildlife and Texas' tourist economy, and includes an explanation of abatement procedures currently being used.

Hooked on Seafood. 33:00 VHS format. $20.00.

This step-by-step guide reveals the secrets to buying and preparing quality fish and shellfish. The video features shrimp, crab, fish and oysters, with quick, easily prepared recipes demonstrated for each. Originally intended for home economics instruction, this handy reference has proven useful for the novice as well as the seasoned pro.

A Second Chance for South Bay. 14:55 VHS format. $20.00.

One of only three hypersaline bays in the world, South Bay was chosen as the first inductee to the Texas Coastal Preserve Program. This video describes the selection process and the criteria that will be used in future designations.

Advisory

Tournament Fresh. 20:00 VHS format. $10.00.

This instructional video explains freshness testing and how to detect a frozen fish in a tournament entry. Use of a torrymeter is covered as wll as the procedure for checking a blood sample under magnification.

Texas Sea Trials of the Turtle Excluder Device. VHS format. $20.00.

Texas Marine Advisory Service fisheries specialist Gary Graham evaluates several certified excluder designs for shrimp retention and ease of operation. The video covers the features, advantages and disadvantages uncovered by Graham and others during extensive testing off the Texas coast.

Texas Brown Shrimp. 10:20 VHS format. $15.00.

This marketing video for Texas brown shrimp covers the Texas offshore shrimp industry from capture to consumption. It includes details on a recent taste test that rated wild brown shrimp as superior to imports and outlines the product flexibility of Texas shrimp processing.

Texas Aquaculture. 26:40 VHS format. $7.00.

This full-length picture and music montage shows many of the different aspects of the Texas aquaculture industry.

Distributed by Texas Sea Grant

Hybrid Stripers. 15:30 VHS format. $15.00.

This is a technology-transfer video on the successful growout of hybrid striped bass. The program covers spawning, pond preparation and feeding. The video was produced by Dr. Thomas Linton and E.I. DuPont and is distributed through Texas Sea Grant.

Shrimp Boat Safety. 19:11 VHS format. $25.00. Specify English or Spanish.

This instructional video is on basic safety procedures involving the shrimping industry. It is available in both English and Spanish.

Handling the Catch. 22:00 VHS format. $25.00. Specify English or Spanish.

The program addresses on-board procedures that will result in the highest quality shrimp reaching the dock. It is available in both English and Spanish.

Cage Culture...Raising Fish in Ponds. 24:38 VHS format. $5.00.

This "how to" video shows various aquaculture techniques of raising fish in cages along with different cage designs. The video was produced by the University of Maryland Sea Grant College Program and is being distributed by Texas Sea Grant for the cost of the VHS tape.

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