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A History of the NMFS Laboratory at Galveston

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INTRODUCTION

The following account is a brief history of the federal fisheries laboratory at old Fort Crockett in Galveston, TX, from its beginnings in 1950 to the present in 2010. The history is a narrative by the current Director, Dr. Roger J. Zimmerman, drawing on information mainly derived from annual reports, publications, and recollections of retired staff, including Dr. Sammy Ray, Ms. Zoula Zein-Eldin, Mr. C. Timothy Fontaine, Dr. Charles Caillouet, Dr. Geoffrey Matthews, and Dr. Edward Klima.

I became Director of the National Marine Fisheries Service Galveston Laboratory following Dr. Ed Klima's retirement in January of 1994. When I first arrived as an Intergovernmental Personnel Agreement research scientist in 1981, the Laboratory was in a state of turbulent transition. Its world-class shrimp aquaculture program had been discontinued and the laboratory had just avoided closure. Had I known that it would take more than a decade for the situation to stabilize, I might not have stayed. But I am glad that I did. The very existence of the Galveston Laboratory today is a credit to the perseverance of its staff during that transition and a reflection of the prominence of its history.

OVERVIEW

The National Marine Fisheries Service (NMFS) Laboratory at Galveston is a part of the National Oceanic and Atmospheric Administration (NOAA) within the U.S. Department of Commerce. The facility is located at 4700 Avenue U, Galveston, TX, at the former site of the U.S Army's Fort Crockett. The laboratory incorporates seven of the oldest Ft. Crockett buildings, built in 1910 and recently restored (McKeen, 1994), into a NOAA campus. The NOAA elements at the facility include the NMFS Southeast Fisheries Science Center (SEFSC), the NMFS Southeast Region Office (SERO), and the National Ocean Service (NOS) Flower Gardens Banks National Marine Sanctuary (FGBNMS), as well as the NOS Physical Oceanographic Real-Time System (PORTS).

In 1950, federal marine fisheries investigations were accomplished through/as the U.S. Fish and Wildlife Service (USFWS) in the Department of Interior. In 1956, the Bureau of Commercial Fisheries (BCF) and the Bureau of Sport Fish and Wildlife (BSFW) were established within the USFWS to address federal commercial and sports fishing activities. The research station for federal fisheries in the Gulf of Mexico region was established in 1950 as the USFWS Galveston Biological Laboratory, Gulf Fishery Investigations, and it focused on the shrimp fishery in the Gulf of Mexico (GoM). The USFWS BCF Galveston Biological Laboratory became the Gulf Coastal Fisheries Center in the early 1970s shortly after incorporation into NOAA and the NMFS. The Gulf Coastal Fisheries Center had programs at several field stations around the Gulf, including Pascagoula, MS; Panama City, FL; St. Petersburg, FL; and Miami, FL, the latter of which became the headquarters for the NOAA's Southeast Fisheries Science Center (SEFSC). When the SEFSC was created, the Galveston facility was renamed the NOAA NMFS SEFSC Laboratory in Galveston (Fig. 1).

From its earliest days, activities at the Galveston Laboratory have revolved around the shrimp fishing industry. As a consequence, the laboratory has become the repository of knowledge of shrimp biology and ecology and shrimp fisheries in the Gulf of Mexico. Although various programs at the laboratory have come and gone, its foundation has remained: to study shrimp species life histories, to assess shrimp stocks, to report shrimp fishery landings, to evaluate shrimp fishery bycatch, and to determine shrimp habitats and the role of shrimp in ecosystems.

Today, in 2011, the NMFS SEFSC Galveston Laboratory has programs based on (1) observer monitoring of southeastern U.S. fisheries and stock assessments, (2) protected species monitoring and research, and (3) fish habitat and ecological research. All derive from its historical foundation, which is shrimp research. The protected species and fish research programs exist because sea turtles and fish are taken incidentally in the shrimp fishery. Its habitat and ecology programs exist because salt marshes, seagrasses, and mangroves serve as nurseries that are essential fish habitat (EFH) for species of shrimp. Importantly, in the recent move toward ecosystem-based fishery management (EBFM), shrimp species are recognized as vital components of GoM ecosystems and food webs.

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Fig. 1. NOAA Galveston Laboratory, 2010 (Photo by Ron Wooten).

Agency priorities have changed over time regarding fisheries, along with social attitudes, and the changes have driven the Galveston Laboratory's mission and research priorities. When the laboratory was established in the 1950s, it was to learn about life histories and distributions of shrimp species in order to exploit their fishery value. That mission was shared, even sidetracked, during its first decade by red tide research. This diversion came about because of a major red tide breakout in 1947 and public hysteria emanating from it (Rounsefell, 1963a). In the 1960s, the Laboratory added shrimp aquaculture (marine aquaculture) to its mission in response to the Agency's desire to expand the economic value of the resource to the nation. By the late 1970s, shrimp aquaculture research had peaked. With congressional enactment of the Fishery Conservation and Management Act (FCMA) of 1976, renamed the Magnuson Act, national interests changed from exploitation to sustainability of fisheries and conservation of protected species. This led to a major upheaval the laboratory's research during the late 1970s through the 1980s when conservation of sea turtles was incorporated into its mission. In the 1990s, assessment of fisheries bycatch, delineation of essential fish habitat, and multispecies stock assessments became mission priorities that continue today.

Fort Crockett Before Fisheries

Originally built as a U.S. Army Garrison during the Spanish-American War in 1897, the Fort Crockett Military Reservation was named in 1903 in honor of David Crockett, American pioneer and hero of the Alamo. The first permanent buildings of Ft. Crockett were constructed circa 1910 (Fig. 2). The facility expanded and served the U.S. Army through World War I and World War II. The facility was home to the Coast Artillery Corps starting in 1911 and the Third Attack Group in 1926. The fort housed troops during both world wars and also served as a prisoner-of-war camp during WWII. Having armed military bases on the coast was deemed necessary during WWII because of the threat of German submarines in the Gulf of Mexico. Under a veil of secrecy, the installation was fortified to meet this threat and was fully complete in 1943.

In 1946, with the end of WWII, the U.S. Government deactivated Ft. Crockett, and then for few years from 1948 through 1951, used it as a recreation center for the Fourth Army. In 1953, the Fort was declared surplus and in 1956 it was released to the GSA for disposal. Although present from 1950, the USFWS Bureau of Commercial Fisheries first gained title to part of the property in 1958. The BCF facility then

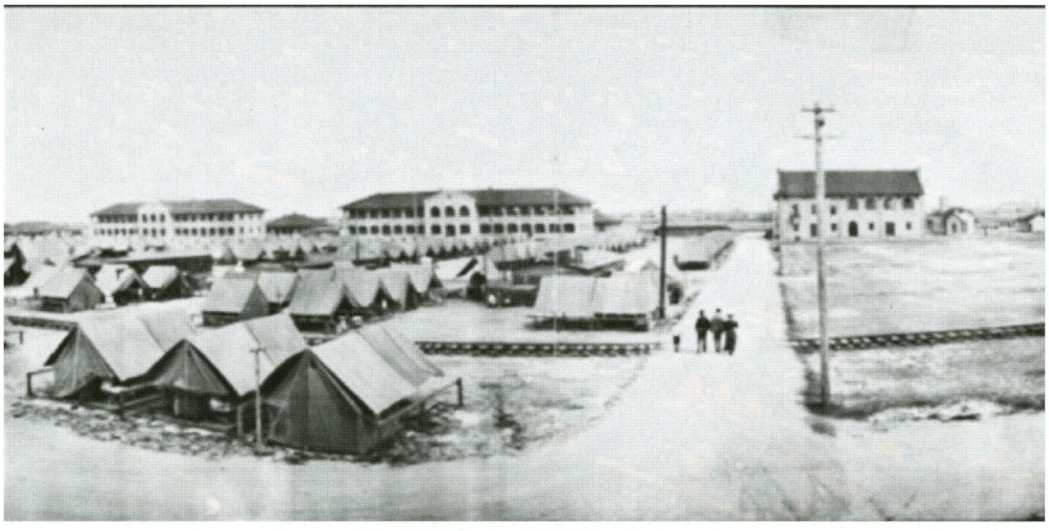

Fig. 2. U.S. Army Fort Crockett, 1918 (Photographer unknown).

consisted of Buildings 216, 302, 303, and 301, which were, respectively, the Post Exchange, a two-story barrack, a mess hall, and a latrine and showers with rooms for a barber and a tailor. The first renovation of the facility to meet its scientific mission began at that time.

The Fort has seen innumerable hurricanes, and its oldest buildings were first tested by the storm of 1915 shortly after the Galveston seawall was built. The city financed 3 mi of seawall with funds from Congress, specifically to protect Ft. Crockett. The seawall and the concrete buildings, currently occupied by NOAA, withstood and held.

The Beginning of the BCF Biological Laboratory in Galveston

Dr. William Anderson established the USFWS BCF Biological Laboratory as its first Director in 1950 at decommissioned Ft. Crockett in Galveston. Dr. Anderson was sent from the BCF headquarters in New Orleans and brought Mr. Albert Collier with him to assume the position of Laboratory Director following Anderson. Ms. Laura Hermann was the administrative assistant of the laboratory at that time. They first occupied the Post Theater building that stood directly east of the Post Exchange building, currently designated Building 216. The Post Theater was a stucco building smaller than the three-story Post Exchange, and it can be seen in some of the early photos of Ft. Crockett (Rounsefell, 1963a). The theater building was demolished years ago, and it is now the site of a strip shopping center east of the current facility. From 1950 to 1953, operations were mostly preparatory to assembling a research staff that came to occupy the post exchange, Building 216.

The move into the Post Exchange building was complete by 1954, and among others, Dr. Sammy Ray started work at the Galveston Laboratory in September 1954, following completion of graduate school at Rice University. Dr. Ray relates that he began as a GS-9 Fishery Biologist earning about $4,700 a year. At the time, Mr. Albert Collier had become the Laboratory Director and other new recruits were Mr. Ken Marvin (chemist), Dr. William Wilson (phytoplankton specialist), Ray Proctor (shrimp aquaculture biologist), and Ms. Zoula Zien-Eldin (shrimp physiologist). A small building then called the Chemistry Building was north of Building 216, which is where Ken Marvin and Ray Proctor were located. The smaller building no longer exists, but part of a wall still stands as evidence alongside Building 216. Dr. Ray worked with both Mr. Collier and Dr. Wilson on red tide research, which aside from shrimp research was the major endeavor at the beginning. His job was to develop *Gymnodinium brevis* (now *Karenia brevis*) in a bacteria-free culture.

An Emphasis on Red Tide

Dr. Ray remembers that development of bacteria-free *G. brevis* was an event of historical importance. This was a vital step needed to demonstrate that red tide toxin indeed came from *G. brevis*. Dr. William "Bill" Wilson was his supervisor and the first to culture a bacteria-free red tide "bug" at the Biological Laboratory. The

laboratory was in competition with the University of Miami to develop the pure culture, but Miami lost the race when Wilson beat them out (S. Ray, pers. comm.). It was believed that *G. brevis* emitted a toxin, but it could not be proven, and Selwyn J. Bein had published a paper that the toxin was from an associated pigmented bacteria. No one was able to separate the red tide dinoflagellate from the bacteria reliably. By chance, Bill Wilson had developed a culture grown without bacteria, but when attempts were made at replication, it was usually contaminated. At that time everyone thought soil extract was essential and that determining the correct culture media was the problem. Using what Bill developed, where 1 vial out of 10 to succeeded, and with advice from him, Sammy started autoclaving the glassware for final treatment. His success went to 8 out 10 vials of uncontaminated culture. It turned out that the test tubes were not sufficiently clean to begin with, so when sterilization was added to the procedure, repeatable results were achieved. From these cultures, it was shown that the toxin did indeed come from the red tide organism, and it was not from associated bacteria.

The laboratory was small in 1954, with nearly everyone in the Building 216. According to Dr. Ray, he got into trouble because he never came to work before 0900 hr and rumors circulated that he was not putting in his 8 hr a day. No one knew that he was staying past 1800 hr and would often leave and return at 2000 hr, working at night and on weekends. As a result of his diligence, Dr. Ray published his only, but very important, article on red tide. In 1957 he was promoted to a GS-11 earning $5,500 a year (S. Ray, pers. comm.). Today Dr. Ray is better known for his lifelong work on oysters.

Albert Collier left the laboratory in 1956 to go next door to start a marine laboratory for Texas A&M University (TAMU). Dr. George Rounsefell arrived in 1956, the year before Collier left, to address complaints that the Biological Laboratory was not publishing enough. Dr. Rounsefell subsequently became the Laboratory Director in 1957, with Joe Kutkuhn as the Assistant Director. Dr. Ray left to join Albert Collier at the TAMU Lab in July of 1957, and Bill Wilson joined them shortly afterward.

During 1956, while Bill Wilson was in Washington, DC, there was a fish kill on the west coast of Florida due to red tide. Bill told Sammy to go to Florida instead of going home for Christmas. Dr. Ray got to Miami at midnight and drove all night to the west coast near Sarasota. Red tide experts and others came, as well as Bill Wilson and Dr. Dave Aldrich, along with John Evans who was hired to do public relations for the news media. Red tide was a high-profile social and political worry that Rounsefell and others wanted credit for solving. Earlier, Albert Collier had proposed putting copper ore in passes of rivers on the West Coast of Florida to control red tide. According to Dr. Ray, George took some of Albert's ideas, not knowing anything about the science, and ordered a field test application of copper sulfate. He said "if the red tide goes away then we get credit for getting rid of it" (S. Ray, pers. comm.). So they spread 105 tons of copper sulfate with the use of crop-dusting planes in an inlet where the red tide occurred (Rounsefell, 1958) and left another inlet with red tide untreated. When sampled by Ray and Aldrich overnight, sure enough the red tide had disappeared from the samples in the treated inlet. Johnny Evans, the PR guy, quickly proclaimed, "We did it!", and he publicly pronounced success for Rounsefell. Wilson told Ray and Aldrich to double check the procedure, and they discovered that the Niskin bottles used to sample treatment waters were new and had not been properly conditioned in seawater beforehand. Killing of the red tide organism had been confounded by chemical contamination in the unconditioned Nisken bottles. But George didn't buy it and went ahead with the original pronouncement. The news media announced that red tide was no more. Nothing was ever said about the experiment's problem and a correction was never issued. The laboratory's annual report the following year describes the test as "moderately successful" but "too expensive to use for controlling large outbreaks" (Rounsefell, 1958).

By 1958, an easement had been obtained that led to acquisition of approximately 140 acres at East Lagoon along the east end of Galveston's sea wall. Title for the property was transferred to the USFWS BCF in 1959 from the U.S. Army Corps of Engineers (Ciufolo and Harter, 1984). One of the first uses of the lagoon was an experiment in dumping 20 tons of copper ore (sulphide with 1% copper) in its waters as a test to control red tide (Marvin et al., 1961). The study yielded no useful results and the ore remains there to this day. Red tide research at the Galveston Laboratory was phased out in 1962 (Rounsefell, 1963b).

Early Shrimp Research

Studies of shrimp and shrimp fisheries in the Gulf of Mexico originated at USFWS BCF headquarters in New Orleans during the 1930s but were interrupted in the 1940s by World War

Fig. 3. Bureau of Commercial Fisheries staff in Galveston, 1960 (Photo by Daniel Patlan).

II. Because the shrimp fishery was one of the most valuable fisheries in the United States, shrimp research was restarted in the 1950s as the Gulf Fisheries Investigations based at the newly established Biological Laboratory in Galveston. By the beginning of the 1960s, all of the staff were involved with shrimp in some way (Fig. 3).

The main focus of early shrimp research in the Gulf was on the life histories of the three prominent fishery species formerly in the genus *Penaeus,* white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), and pink shrimp (*Farfantepenaeus duorarum*). Field studies were undertaken to determine where they occurred, their growth characteristics, and their movements and abundance patterns. Larval and postlarval stages of white, brown, and pink shrimp were described as best possible from the wild. Life histories of white shrimp and brown shrimp postlarvae were shown to differ seasonally in peak immigration into Galveston Bay, which at the time was postulated to be an adaptation to reduce interspecific competition for nursery habitat (Rounsefell, 1958).

Comprehensive monitoring of the Gulf fishing industry first began in 1959. Landings in quantity and value of the fishery were reported not only for shrimp, but also for about 104 species of fish industrial "products used for canned pet food, fishmeal for stock and poultry feed, frozen mink feed, and fish oils" (Rounsefell, 1959). In 1960, landings of GoM fisheries were reported by the Lab at 1.14 billion pounds, including shrimp worth $64 million. Shrimp were then recognized as the nation's most valued in dollars (Rounsefell, 1960) and menhaden the most in tonnage (Rounsefell, 1961). Continuous records of all shrimp and menhaden landings, as well as estimates of fishing effort, have been kept since that time. Studies of insecticide toxicity on newly described white shrimp and brown shrimp postlarvae along with other selected estuarine species were initiated at the Laboratory in 1960 (Rounsefell, 1960). The early work on effects of pesticides was done both in Galveston and at the USFWS BCF in Gulf Breeze, FL (Rounsefell, 1963b), which today is a U.S. Environmental Protection Agency Laboratory.

Fig. 4. Bureau of Commercial Fisheries Aquaculture Lab at East Lagoon, 1958 (Photo by Daniel Patlan).

In 1960, the Galveston Laboratory added to its research capabilities through construction an elevated flow-through seawater building at East Lagoon (Fig. 4). This seawater facility was originally dedicated to study estuarine species under seminatural conditions (Rounsefell, 1961) but became a useful asset in development of shrimp aquaculture research later. Jimmy Wallet was the original caretaker at the East Lagoon site, where he lived in a trailer. Ted Williams became the live-in caretaker in the 1970s until Hurricane Alicia in 1983, after which the facility was no longer used. In the early 1980s, following the end of shrimp aquaculture research, Dr. Ray used the facility for oyster research. At that time, Texas A&M University was interested in buying the East Lagoon property for his research. But when Dr. Ray took Perry Atkinson, Chancellor of Texas A&M University, to see the facility, a barn owl flew out, hit Perry in the head, and the offer was withdrawn (S. Ray, pers. comm.).

Shrimp Populations, Migration and Prediction

From the beginning, the laboratory experimented with ways to mark shrimp so they could be identified and tracked, providing information on populations, movements, and distribution patterns in the Gulf of Mexico. In 1958, researchers at the lab tested biological dyes on shrimp that would stay after molting. Field trials were conducted on pink shrimp in the Tortugas that provided estimates on growth and mortality (Rounsefell, 1958). They followed with investigations to see if turning shrimp blue or orange or other unnatural colors made them more vulnerable to predators in their environments. In 1963, the lab advanced shrimp-marking techniques manifold by using fluorescent stains and thus increasing ability to conduct multiple studies of movements simultaneously (Lindner, 1964).

By 1962, after 3 yr of sampling postlarval shrimp abundance and catch per unit effort of resulting juvenile shrimp in Galveston Bay, a first attempt was made at predicting annual shrimp abundance for harvest (Rounsefell, 1963b). The belief that the annual shrimp crop could be predicted by counting abundance of immigrating postlarvae remained strong (Lindner, 1964) and was tested for years to come in the Shrimp Dynamics Program (Fig. 5). By 1967, it was realized that between the postlarval index and the juvenile index, the latter was better for prediction (Lindner, 1968). Dr. Goeffery (Jeff) Matthews first entered the program in 1965 as a summer intern and recalls sampling postlarval shrimp for Mr. Neal Baxter with a beam trawl at the Bolivar Roads shoreline and with a plankton net at Rollover Pass in East Bay. In 1987, Jeff

Fig. 5. Gilbert Zamora sampling shrimp postlarvae in Galveston Bay, 1958 (Photo by Daniel Patlan).

analyzed years of data and concluded that the variance in postlarval shrimp abundance was too great in samples to use as a forecaster of brown shrimp production, much to his and Neal Baxter's dismay (Geoffery Matthews, pers. comm.). However, Neal Baxter's juvenile index derived from a bait shrimp survey in Galveston Bay did succeed in predicting brown shrimp catch off of Texas. The Brown Shrimp Annual Catch Prediction issued each year by the Laboratory is largely based on the relationship that bears his name, the Galveston Bay Baxter Bait Index.

Habitat studies at the laboratory began with sampling in estuaries to determine where postlarval and juvenile shrimp were found. In 1957,

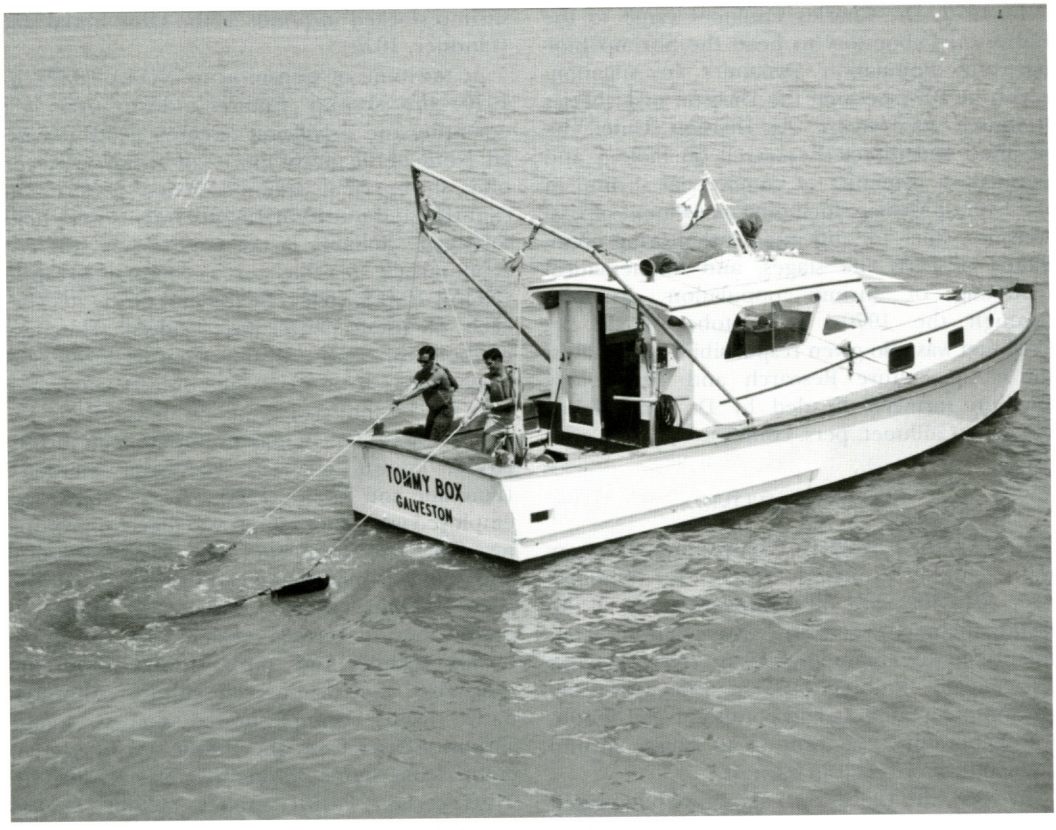

Fig. 6. Jack Pullen (left) and Gilbert Zamora (right) trawling for shrimp in the Houston Ship Channel, 1969 (Photo by Daniel Patlan).

first attempts were made to evaluate habitat differences between brown, white, and pink shrimp in West Bay of the Galveston Bay system, but the study was foreshortened because of uncontrolled dredging in the area (Rounsefell, 1963b). Studies in years beyond those initial attempts were expanded to evaluate the use of seagrasses, marshes, and shorelines as nurseries for shrimp, crabs, and fishes. The negative effects of dredging and the reduction of freshwater inflows was recognized at that time (Rounsefell, 1963b). With the ability to culture early life stages of shrimp, differences in the effects of salinity and temperature on species were tested experimentally in the laboratory and compared to conditions in the field (Lindner, 1964).

Field surveys by the Laboratory were expanded to offshore environments in the early and mid 1960s to determine distributions of shrimp life stages and habitats in the northwestern Gulf (Fig. 6). Transects across the continental shelf were sampled from Brownsville, TX to Mobile, AL with the use of the GUS III, a chartered 85-ft shrimp trawler. The monthly cruises were largely devoted to plankton sampling in search of shrimp larvae and postlarvae and to bottom trawling in search of spawning adult shrimp (Rounsefell, 1963b; Lindner, 1964, 1965, 1966). After 4 yr of intensive shelf surveys, in water depths ranging from 7 to 110 m, the program was discontinued in December of 1965 (Lindner, 1966). The cruises provided the most complete information available then and today on distributions of planktonic stages of shrimp in the northwestern Gulf of Mexico.

The mark and recapture studies of shrimp, begun by techniques developed earlier, was continued by the laboratory throughout 1960s. The research was conducted both in the northwestern Gulf and the Tortugas shrimp grounds, and its purpose was to provide direct estimates of growth and migration and indirect estimates of mortality rates. The objectives even now pursued were: (1) to determine mortality rates between life stages, (2) to measure effects of environment on growth and survival, (3) to follow movements in offshore waters, and (4) to identify individual populations and their relationships between offshore spawning grounds and inshore nurseries (Lindner, 1968).

In 1972, Dr. Charles Cailluoet came to the Galveston Laboratory to head the Shrimp Biology and Population Dynamics Investigation, which in 1974 became the Division of Fisheries Resource Assessment. As Division Chief, he planned and directed research on biology and population dynamics of commercial shrimp in the Gulf of Mexico, including assessment of vital statistics, stock identification, monitoring abundance of early life stages, and mathematical modeling of shrimp population dynamics through the 1970s. In October 1981, Dr. Caillouet was also given responsibility for Galveston's Aquaculture Research and Technology Division formerly headed by Dr. Jim McVey (Charles Cailluoet, pers. comm.).

Shrimp Aquaculture

In 1958, the USFWS BCF Galveston Laboratory was expanded to include Ft. Crocket Buildings 216, 301, 302, and 303. Improvements at the facility included a seawater system flowing from the beach with a pump house and redwood tanks adjacent to Building 301. In 1960, with the addition of a building and ponds at East Lagoon, the Laboratory was primed to begin shrimp aquaculture research in earnest.

By 1963, the Galveston Laboratory had reared two species, pink shrimp and rock shrimp, from egg to postlarvae (Lindner, 1964). Not only did this enable researchers to identify and differentiate very early stages of shrimp species, but it also set the stage to understand population dynamics of shrimp in the wild. Having the ability to rear and experiment with shrimp in the laboratory led to understanding of differences between species and their life stages in feeding, growth, survival under effects of salinity, temperature, and human-induced influences, starting with pesticides. With completion of life cycles in the lab, research on shrimp hatchery and pond culture methodologies became a priority at the Galveston Laboratory that continued another 13 years.

Pond culture of brown shrimp at East Lagoon was attempted in 1966 with the use of postlarvae collected from the entrance into Galveston Bay. The growth and survival rates of brown shrimp were poor and highly dependent on water circulation and fertilization of plankton in the ponds. By contrast, a few white shrimp accidentally placed in an adjacent stagnant pond had growth rates that were described as spectacular by comparison (Lindner, 1967). A prototype shrimp hatchery was established in 1968 and brown shrimp post larvae were first produced at a mass scale (Lindner, 1969). But a year later white shrimp again grew twice as large as brown shrimp stocked in ponds at the same initial size (Lindner, 1970).

At the time of transition to NOAA NMFS in 1970, the shrimp culture industry was still emerging and significant research needs persisted. None of the native species of brown, white, or pink shrimp had attained sexual maturity in captivity, and nutritional requirements were held to blame. Reliable larvae culture was still not economically feasible on a commercial scale (NOAA NMFS, 1972). By the end of the decade, each of these issues was resolved. Hatchery methods for rearing shrimp from fertilized eggs to postlarvae from spawning adult females came into use by industry. A practical technique for producing rotifers in mass culture to feed shrimp larvae, known as "The Galveston Method" (Fontaine and Revera, 1980; Treece, 2000a) was employed worldwide. Improved diets for growing juveniles were formulated that were economical and could be mass produced in pelletized form. White shrimp were economically grown in ponds, but it became evident that needs of brown shrimp and pink shrimp were too specialized for commercial culture. Although native white shrimp showed success, exotic shrimp species from the Pacific were easier to culture and more productive (Treece, 2000b). Thus certain Pacific species, mainly *Penaeus vanamei*, became the standards for commercial shrimp farms in the United States and elsewhere.

In the late 1970s, NMFS decided that shrimp aquaculture research was no longer within its mission and the program at the Galveston Laboratory was terminated. This left the Galveston Laboratory with aquaculture research in limbo and without purpose. Some staff left, but most stayed and were integrated into other programs. Ed Klima recalls that at the time that shrimp culture research was dying he was contacted by Jack Woody of the USFWS about possible sea turtle work. The result was a project which began in 1978 and that switched the Lab's aquaculture program to research with live sea turtles (Ed Klima, pers. comm.).

Sea Turtle Research

In the late 1940s, it was discovered that the Kemp's ridley (*Lepidochelys kempi*) sea turtle nested primarily on one beach at Rancho Nuevo, Tamaulipas, Mexico. At that time, there were approximately 40,000 females nesting on this beach. By the mid-1970s, it was estimated that no more than 500 females were nesting there and the species was on the verge of extinction. In 1977, the USFWS and the National Park Service presented a plan of action for restoring and

enhancing the Kemp's ridley turtle to representatives of Texas Parks and Wildlife, NMFS, and the Instituto Nacional de Pesca in Mexico. Agency officials and scientists agreed to a plan to enhance the turtle's nesting success and survival at Rancho Nuevo, to establish a second nesting site at the Padre Island National Seashore (PINS) in Texas, and to begin an experiment in headstarting sea turtles at Galveston (Klima and McVey, 1981).

With the cessation of the shrimp aquaculture program, aquaculture facilities at the Galveston Laboratory were quickly and easily adapted to raising sea turtle hatchlings. Aquaculture specialists and other scientists at the Laboratory changed their research to the challenge of raising and studying marine turtles. Sea turtles are charismatic megafauna, and local nongovernment organizations (NGOs) had great interest in helping this program succeed. Leading the way was Help Endangered Animals Ridley Turtles (HEART), established in 1982 by Ms. Carole Allen of Houston, TX (www.ridleyturtles.org/). HEART merged with the Sea Turtle Restoration Project in August of 2002 (www.seaturtles.org/). Ms. Allen worked tirelessly for more than a decade in support of the Kemp's ridley Headstart program (Ed Klima, pers. comm.). HEART organized schools, teachers, and children to buy turtle food for approximately 2,000 Kemp's hatchlings each year grown in captivity to 1 yr of age by the laboratory. Eggs were taken from nesting turtles at Rancho Nuevo, placed in PINS sand, and taken from Mexico to Texas, where they were reburied in protected areas on the beach at PINS and hatched. The hatchlings were allowed to crawl to the surf in hopes of imprinting on seawater characteristics at PINS. Then they were scooped up and taken to the Galveston Laboratory to be reared for a year before returning them to the Gulf, this time in Texas waters. More than the experiment to enhance the Kemp's ridley population, perhaps the greatest value of the Head Start Program was in knowledge gained about sea turtle biology in general. The captive sea turtles provided unparalleled access for research by government and university scientists. Development of effective archival tags that last the lifetime of a sea turtle was made possible, as well as an understanding of growth rates, longevity, and nutritional requirements. Size and age to sexual maturity was determined, technology for tracking movements in the wild with underwater sonic and satellite transmitters was developed (Fig. 7), and perhaps most importantly, development and testing of turtle excluder devices (TEDs) in fishing trawls progressed because of captive rearing.

In 1977, an international agreement was signed between the Departmento de Pesca, Instituto Nacional de Pesca (INP) in Mexico and the NMFS SEFSC to cooperate on fisheries and living marine resources research in the Gulf of Mexico. The initial MEXUS–Gulf working groups addressed shrimp, ichthyoplankton, demersal fish, coastal pelagic fish, pollution, hydroacoustics, and sea turtles (Richards and Juhl, 1987). The sea turtle working group focused on the Kemp's ridley and until recent years guided recovery of the species. Scientists at the Galveston Laboratory have been key participants in the MEXUS–Gulf shrimp and sea turtle working groups since the beginning.

In the late 1980s it was discovered that explosives used to sever the legs of offshore oil platforms during removal killed dolphins and sea turtles (Fig. 8). During an exploratory survey by the laboratory, Mr. Tim Fontaine was on an offshore oil rig when workers told him they had never seen turtles out there. About an hour later they saw one. Through a Biological Opinion from NMFS issued to the USGS and Minerals Management Service, an agreement was signed to use NMFS observers to assure that neither marine mammals nor sea turtles were present when explosives were set off. In 1987, Gregg Gitschlag and Maurice Renaud initiated Galveston's oil platform removal observer program that continues today (Gregg Gitschlag, pers. comm.).

Shrimp Fishery Management

Shrimp management research in Galveston gained momentum when the Texas Closure was established in 1981. The laboratory was instrumental in providing information that showed closing of the offshore brown shrimp fishery from mid-May through mid-July, prevented wastage of small-sized shrimp, and allowed larger more valuable sizes to be caught when the season opened (Klima, Baxter, and Patella, 1982). The state of Texas and the Gulf of Mexico Fishery Management Council adopted the closure as beneficial to both the shrimp population and the fishery. Management measures were not always popular, however. Later in the decade, resistance to the requirement in 1989 for TEDs by the shrimp fishery was immediate and threatening. Blockades by shrimp boats lined up across channels into Galveston and Corpus Christi Bays drew public attention and caused a media frenzy. Ed Klima, Director at that time, remembers, "passes were closed down, we were threatened to be bombed, I got threats at home, my wife got

Fig. 7. Maurice Renaud (left) and Jim Carpenter (right) placing a satellite tracking tag on a Kemp's ridley, 1994 (Photographer unknown).

Fig. 8. Offshore oil platform removal using explosives in the Gulf of Mexico, circa 1995 (Photographer unknown).

threats." The resulting animosity in the industry toward TEDs lingers still.

Fishery observer programs were instituted at the Galveston Laboratory in the late 1980s and early 1990s to obtain information directly from commercial fishing vessels. The programs arose from the need for data and research to evaluate the effectiveness of TEDs and consequent shrimp loss in shrimp trawls. The fishery observer programs drew upon the experiences gained in the offshore oil platform removal observer program. A special study, for instance, was conducted within the oil platform removal program to determine the effect of mortalities on red snapper populations caused by explosives used.

Galveston's observer programs expanded in the 1990s and into the new century to become the principal activity of the Fishery Management Branch (FMB) headed by Dr. James (Jim) M. Nance. Fishery observers are now mandatory on selected commercial red snapper and shrimp fishing vessels. The data collection by observers now include bycatch characterization of species caught incidentally other than those in the target fishery. The FMB also continues to perform stock assessments of brown, white, and pink shrimp populations, as well as to provide shrimp catch statistics analyses for management by the Gulf of Mexico Fishery Management Council.

The experience and established protocols of Galveston's observer programs became especially valued following Hurricane Katrina's devastation and the BP Deep Water Horizon oil spill incident. In 2005, Galveston's fishery observers were immediately available after Hurricane Katrina to sample shrimp, fish, water, and sediments to test for toxic contamination. In 2010, during the BP Deep Water Horizon oil spill fishery, observers were used aboard chartered and commercial fishing vessels to obtain fish and shrimp samples for seafood safety purposes. During the spill, oil platform removal observers, trained to make observations from the helicopters, were also immediately available to conduct aerial surveys of marine species in danger of being oiled. These surveys provided daily information on the impacts from the beginning to the end of the spill and facilitated the rescue of hundreds of sea turtles from the oil.

One of the FMB's more sought-after products is an Annual Brown Shrimp Catch Forecast that is released in June of each year prior to the onset of the shrimp season. The forecast originated in the 1960's using preseason abundance of brown shrimp in Texas and Louisiana estuarine nurseries to predict the size of catch offshore each year. The regression calculations used to estimate catch in recent decades also include environmental relationships. In concert, a new modeling approach is now being applied to Galveston's stock assessments of pink shrimp which incorporates environmental parameters. The approach will migrate to stock assessments of white shrimp and brown shrimp and it represents the evolution of fisheries management to Ecosystem-Based Fisheries Management (EBFM). Factors such as area of favorable nursery habitat, long considered relevant in annual recruitment in Louisiana's brown shrimp fishery, will be included.

Habitat and Ecology

Researchers at the Galveston Laboratory began estuarine habitat studies in the 1960s, but always as a footnote to shrimp population studies. In the early 1980s, the laboratory established an estuarine ecology program without dedicated funding, which eventually became the Fishery Ecology Branch (FEB). The FEB, currently led by Dr. Thomas (Tom) Minello, established Galveston's lead in fishery habitat research within the SEFSC and nationally. Formal recognition of the importance of habitats to fisheries appeared in the reauthorization of the now Magnuson-Stevens Act of 1997, with identification of essential fish habitat (EFH) as a legislated priority. The Laboratory began studying habitat relationships to juvenile shrimp distributions, growth, and predator–prey relationships in Galveston Bay in the 1980s (Minello and Zimmerman, 1983; Zimmerman, Minello, and Zamora, 1984; Fig. 9). Then habitat research expanded to estuaries throughout the Gulf of Mexico in the 1990s and through 2010 (Minello and Rozas, 2002; Rozas and Minello, 2010). As interest in habitats increased, FEB research expanded to include estuarine habitat restoration and spatial modeling of habitat-related secondary productivity. Laboratory scientists began teasing out details of processes and mechanisms that translate numbers of shrimp postlarvae entering an estuarine nursery into adult shrimp in the offshore fishery. The overall work on shrimp ecology in Galveston led to broader studies that currently include a cooperative Large Marine Ecosystem Project with Mexico and ecological research of coral reef fisheries in the Caribbean. Restoration and recreation of salt marshes in the northern GoM incorporate landscape design techniques originated by the FEB to sustain estuarine-dependent fishery production. Impacts of sea-level rise scenarios of marsh loss influences on fisheries in the northern GoM have been derived from the work.

Fig. 9. Tom Minello using a drop sampler in a salt marsh on Galveston Island, 2000 (Photo by Lawrence Rozas).

Fig. 10. NOAA Fisheries Galveston Laboratory Staff, October 22, 2010. First row (left to right): Andy Krauss, Tim Finn, Marissa Nuttall, Bill Kiene, Ryan Eckert, Alan Bunn, Heather Young, Chris Cotto, Tim Baumer, Shannon Batte, Guy Lagarde. Second row (left to right): Mike Harrelson, Tim Berk, Lyndsey Howell, Connie Thompson, Frances Garcia, James Randolph, Roger Zimmerman, Ronnie O'Toole, Donita McMahen, Tammi Barreras, Becky Smith. Third row (left to right): Craig Hayslip, Stephen Davies, Tom Holmes, Rick Hart, Rusty Swafford, John Embesi, Jennifer Morgan, Saket Waghmode, Amanda Loy, Lisa Pugh, Amy Mendoza, Zach Smith, Shelley DuPuy, Marc Weekley, Heather Seiler, Kelly Drinnen, Gina Richie, Elizabeth Scott-Denton, Nichole Zellner, Kira Engel. Fourth row, in between the railings (left to right): G.P. Schmahl, Robert Colton, Kris Benson. Left steps (left to right, from bottom to top), Pat Cryer, Juan Salas, Jeff Pulver, Ben Higgins, Shawn Hillen, Keith Roberts, Brian Koplin, Judy Gocke, John Regini, Jim Ditty. Right steps (front row, left to right): Tom Minello, Jim Nance, Geoffrey Matthews, Phil Caldwell, Megan Kesterson, Donna Kinsella (back row, left to right): Gregg Gitschlag, John Wilson (Photo by Manny Chan).

The Galveston Lab Now

Current activities at the SEFSC Galveston Laboratory revolve around research and monitoring in support of fishery management, fishery ecology, and protected species. The fishery management programs address science questions of the GMFMC and SERO concerned with shrimp and red snapper fisheries and stock assessments. Data from catch and bycatch in trawl and hook and line fisheries are collected by the laboratory's FEB through extensive use of fishery observers. Independent electronic monitoring devices for fishing vessels are currently under development and testing. The fishery ecology programs are concerned with determining habitat differences that affect production of fishery species and spatial and ecological modeling of relationships. Protected species programs at the laboratory are mainly focused on sea turtle issues related to fisheries. But the laboratory also supports both sea turtle stranding and marine mammal stranding monitoring and rehabilitation. The NOAA Texas Marine Mammal Stranding Network has a new facility that is located and supported at the laboratory. The NOAA National Ocean Service now shares the NMFS facility through its Flower Gardens Banks National Marine Sanctuary (FGBNMS) and the Physical Oceanographic Real Time Systems (PORTS). Staffs of both NMFS and NOS at Galveston (Fig. 10) have benefited through shared activities of scientific staff and especially as pertains to educational outreach to the local community and nearby partners, including Texas A&M University at Galveston, Texas Parks and Wildlife Department, the U.S. Coast Guard in Galveston, the Galveston District of the Army Corps of Engineers, the Texas Maritime Museum, the Galveston Historical Foundation, and the City of Galveston.

The NOAA Fisheries Service Laboratory at Galveston has been a mainstay of research in the Gulf of Mexico for 60 yr. During that time, the laboratory has delved into red tide, shrimp aquaculture, offshore oil platforms and their removals, endangered sea turtles, essential fish habitats, shrimp life cycles, fishery catch statistics, bycatch, salt-dome petroleum storage sites, and oil spills. The Galveston Laboratory has led the nation in shrimp research through the decades. With NOAA's increasing commitment to conserving protected species, reducing bycatch, establishing marine protected areas, and restoring coastal wetlands, the Galveston Laboratory continues to evolve with these new research priorities.

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