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History of the Southeast Fisheries Science Center Miami Laboratory

ALEX CHESTER* AND ALBERT C. JONES

The Miami Laboratory of the Southeast Fisheries Science Center (SEFSC) is part of the National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Commerce. It is situated on Virginia Key, 3 miles east of Miami and north of Key Biscayne, Florida.

The Bureau of Commercial Fisheries (BCF) of the U.S. Fish and Wildlife Service established the facility in 1965 as the Tropical Atlantic Biological Laboratory. It was built on 5 acres conveyed to the federal government by Dade County (now Miami-Dade County) across the Rickenbacker Causeway from the marine campus of the University of Miami. The county stipulated “the land shall be used for public purposes, primarily for research on the living resources of the sea or their environment.” A brochure for the opening ceremony stated, “This Dedication marks the emergence of Miami as a major oceanographic center. It celebrates two events: the twenty-first anniversary of the founding of the [University of Miami’s] Institute of Marine Science and the establishment of an important new Federal laboratory for the study of the tropical Atlantic. This heralds the new age of inner space, the age in which man will turn more and more to the sea for food and mineral resources, for transportation and for defense.”

Two other BCF units were in Miami at the time: the Statistics Office that collected and processed commercial fishery landing and value data for publication, and a unit named the Miami Field Station of the Galveston Biological Laboratory that conducted studies of pink shrimp in the Dry Tortugas fishery. Both were provided space in the new facility. The three-story structure provided 46,300 square feet of working space with modern offices, research laboratories, a library, two walk-in refrigerators, a seminar room, X-ray and darkrooms, a radiation biology laboratory, a fire-proof records vault, two controlled environment rooms, and a large room with aquarium tanks (Figs. 1–4). There was also a small boat dock behind the facility on a tidal inlet that opened to Bear Cut, an inlet connecting Biscayne Bay with the Atlantic Ocean. Seawater pumped from the cut was contained

in a 200,000-gallon outdoor settling tank and subsequently pumped to a holding tank on the roof of the main building where gravity delivered it to the wet laboratories below.

Virginia Key was viewed as a growing center for marine research. That vision has become a reality with three major laboratories on the island encouraging cooperative research and the exchange of information and ideas: the University of Miami’s Rosenstiel School of Marine and Atmospheric Science (formerly the Institute of Marine Science) for academic studies of the oceans; NOAA’s Southeast Fisheries Science Center for federal studies of living marine resources (formerly the BCF Tropical Atlantic Biological Laboratory); and NOAA’s Atlantic Oceanographic and Meteorological Laboratory for federal studies of oceanography and meteorology.

The Tropical Atlantic Biological Laboratory was established to conduct “surveys of the distribution and abundance of surface schools of tuna in the tropical Atlantic and adjacent seas, and of their availability to live-bait and purse-seine fishing methods (Fig. 5).” Scientists also studied physical, chemical, and biological factors associated with tuna abundance and surface schooling. Although the U.S. tuna industry was headquartered in Southern California, it looked to the Atlantic Ocean for expansion, particularly off tropical West Africa. The BCF first provided supporting research from its Honolulu, HI, Biological Laboratory, then from its Washington, DC, Biological Laboratory, and finally from its new facility in Miami, which was built for that purpose. The initial staff was drawn from the Washington Biological Laboratory, The Miami Field Station of the Galveston Laboratory, the Statistics Office, and the BCF fish systematics laboratory in Brunswick, GA. To accommodate the latter, including their synoptic collection of fish, a one-story annex of 2,500 square feet, still in use, was constructed in 1966 behind the main laboratory building, next to Bear Cut.

Two 143-foot fishery research vessels were assigned: the FWS *Geronimo* and FWS *Undaunted*. The *Geronimo* conducted two cruises before it was transferred to the Galveston Biological Laboratory in 1966 (Fig. 6). The *Undaunted* conducted cruises to the eastern Atlantic Ocean

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Fig. 1. Marine aquarium.

off Africa, the western Atlantic off South America, and the Caribbean Sea (Figs. 7–12). These usually lasted about 120 d and consisted of three 30-d sampling sessions with about 15 d of running time at the beginning and the end of each cruise. After seining for baitfish, the vessel normally followed a station-to-station track to collect oceanographic data, including temperature, salinity, and oxygen levels. Chlorophyll measurements were recorded, and zooplankton and fish larvae were collected with plankton and neuston nets. A visual search was

made during daylight hours for sea birds or other signs of surface-schooling tuna. When a school was spotted, crew members (mostly former commercial fishermen) lowered fishing racks at the stern of the vessel and baited one-, two-, or three-pole rigs, depending on the size of fish in the school. Hooked fish were landed on deck where biologists took measurements and collected biological samples.

Initial efforts by the industry off Africa proved commercially disappointing, and interest turned to the Caribbean Sea. There, crews on Pacific vessels, which passed through the Panama Canal to land their catch at Puerto Rican canneries, had observed schools of tuna that they thought might support a commercial fishery. Accordingly, by the end of 1971 the Tropical Atlantic Biological Laboratory shifted its research focus from the eastern Atlantic to the western central North Atlantic and Caribbean Sea.

The laboratory published 147 research reports in the late 1960s, primarily on tuna biology and fishery oceanography. Identification of larval fish stages to species was also productive. Researchers collected, hatched, and reared over 55 immature species through a series of growth stages until positively identified. Rearing of a species of tuna from the egg to an identifiable stage was a notable accomplishment; it preceded Japanese efforts by about 6 mo.

Fig. 2. Northwest view of newly constructed Tropical Atlantic Biological Laboratory.

Fig. 3. Southeast view of newly constructed Tropical Atlantic Biological Laboratory.

In the 1960s, BCF was criticized for being too focused on commercial fisheries, primarily large industrial fisheries, and there was a growing interest in establishing a national program for marine resources and the environment. Congress responded in 1970 by creating NOAA to consolidate most federal nonmilitary organizations that routinely conducted research on the oceans and atmosphere. The new agency, placed under the Department of Commerce, would provide a broad spectrum of research to help protect the nation from natural hazards, acquire

an ecosystem-level understanding of the environment, and make better use of marine resources.

Within NOAA, the former BCF and the marine laboratories of the Bureau of Sport Fisheries and Wildlife became the National Marine Fisheries Service (NMFS). The Southeast Region of NMFS was defined as extending from North Carolina to Texas, including Puerto Rico, the U.S. Virgin Islands, and Navassa Island in the Caribbean. There are two organizational divisions: a unit named the Southeast Regional Office, headquartered in St. Petersburg, FL, which responds to issues of fishery management and regulation; and a network of laboratories named the Southeast Fisheries Science Center (SEFSC), which responds to issues of science. The SEFSC is headquartered in facilities of the former Tropical Atlantic Biological Laboratory, which was renamed the Miami Laboratory under NOAA. The SEFSC is composed of five major laboratories (Beaufort, NC; Miami, FL; Panama City, FL; Pascagoula, MS; and Galveston, TX) and two smaller research facilities (Bay St. Louis, MS, and Lafayette, LA). There are also port agent and observer offices throughout the region with personnel to collect fishery data in cooperation with agents of the southeastern states and territories.

By the time NOAA was formed, many coastal nations had extended or were considering

Fig. 4. Autopsy laboratory.

Fig. 5. Hooked yellowfin tuna.

Fig. 6. Crew of FWS *Geronimo* and first laboratory director, Dr. Thomas S. Austin (wheelchair) ca. 1964.

Fig. 7. Wet laboratory.

extensions of their jurisdictional limits into the high seas. Their objective was to regulate foreign fishery exploitation above their continental shelf areas. This threatened to exclude U.S. fishermen from traditional fishing grounds off Mexico, Brazil, and the Guianas, and in certain areas of the Caribbean Sea. In response, the U.S. State Department negotiated to keep these areas open to U.S. fleets. Settlements usually required U.S. vessels to document their catch in foreign waters, and some required the United States to cooperate in international fishery research. In response, Miami scientists provided support by maintaining vessel logbook systems for documenting foreign catches by U.S. flag vessels. They also participated in a variety of cooperative research activities with the International Commission for the Conservation of Atlantic Tunas (ICCAT), a compact of over 40 nations interested in management and exploitation of tunas, billfish, sharks, and other highly migratory species; the International Oceanographic Commission's Sub-Commission for the Caribbean and Adjacent Regions (IOCARIBE); the Cooperative Investigations of the Caribbean and Adjacent Regions (CICAR); and the MEXUS-Gulf cooperative program for fishery research between Mexico and the United States.

The mission of the Miami Laboratory shifted significantly in 1977 with passage of the Magnuson Fishery Conservation and Management Act, later renamed the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). The United States extended its jurisdictional limits beyond the territorial limits of the states, to 200 nautical miles offshore. This region would become the federal Exclusive Economic Zone (EEZ) in which commercial and recreational fishing would be regulated through a series of fishery management councils. There are three in the southeast: the South Atlantic Fishery Management Council, the Gulf of Mexico Fishery Management

Fig. 8. Bathythermograph slide replacement.

Council, and the Caribbean Fishery Management Council. MSFCMA mandated that regulatory actions invoked by the councils should be based on the best available scientific information to achieve optimum sustainable yield from the fishable stocks. This required an assimilation of regional fishery data, life-history studies, and virtual population modeling. The councils looked to the SEFSC to provide these data; the SEFSC looked to greatly expand its infrastructure to meet the growing demand to collect, analyze, and model information for the numerous fishable stocks in the region. Stock assessment science became the predominant activity in Miami—a trend that continues today.

Besides MSFCMA, two other landmark environmental legislative acts in the 1970s broadened the range of research at the Miami Laboratory: the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973. Sea turtles (six species in the southeast) and marine mammals (principally dolphins and whales) were considered species of concern and came under protective provisions of the new acts; this stimulated associated research programs in Miami.

By the 1990s, coral reef communities were also showing signs of decline. Interest was growing in establishing marine sanctuaries to provide ecologically mature areas that could contribute to the recruitment of fish and invertebrates into exploited, nonprotected areas. In addition, staghorn and elkhorn corals, the major reef-forming species in the Atlantic Ocean and Caribbean Sea, were under considerable stress; proliferating scientific literature made it apparent that the health and productivity of coral reefs were declining worldwide. Consequently, Presidential Executive Order 13089 for Coral Reef Protection

Fig. 9. Tuna live-bait fishing.

was signed in 1998, which provided necessary funding to greatly expand coral reef research in the United States and at the Miami Laboratory.

The Florida Everglades likewise became an ecological area of concern that received considerable national attention in the 1990s. In response, the federal government initiated a monumental environmental restoration effort to reestablish natural freshwater flows into the Everglades that had been artificially channeled in the early 20th century for mosquito control and land development. Miami researchers were called upon to evaluate the effects of runoff from the proposed alterations on nearshore marine ecosystems. (This project is discussed in more detail below, in the section “South Florida Ecosystem Investigations.”)

Biological implications of fishery regulation, however, are incomplete for management purposes without information on associated economic and social consequences. MSFCMA, therefore, requires that a fishery management plan include a Fishery Impact Statement to describe and evaluate the likely effects of regulation on participants in the fisheries being managed, fishing communities dependent on the fisheries, and participants in fisheries in adjacent areas. Miami researchers, therefore, were called upon to address these regional socioeconomic issues associated with fishery management.

In response to its growing portfolio of mandates, the Miami Laboratory evolved an organizational structure to address 1) regional fishery data collection, 2) highly migratory species stock

Fig. 10. FWS *Undaunted*.

Fig. 11. Temperature–depth recorder deployment.

Fig. 12. Skipjack tuna on deck.

assessments, 3) coastal species stock assessments, 4) sea turtle research and assessments, 5) marine mammal research, 6) coral reef and fish habitat investigations, 7) early life-history investigations, 8) South Florida ecosystem investigations, and 9) socioeconomic research.

REGIONAL FISHERY DATA COLLECTION

The Statistics Branch is a network of port agents throughout the region that cooperates with state agents to collect and archive fishery-dependent data for research. Until passage of MSFCMA, the primary mission was to collect landings and value data for national publication. On a voluntary basis, seafood dealers opened their office books to reveal weekly or monthly data for agents to record; vessel captains provided information on location of catch, gear used, and effort expended. Regional estimates were calculated and reported to the Statistics Headquarters Office in Washington, DC, for distribution in various publications.

MSFCMA, however, brought increasing demands on regional data collection in support of stock assessment modeling. Although decades of voluminous data had been archived, they were insufficient to adequately describe, monitor, and model the complex subtropical and tropical species and fisheries in the region. There was a need to increase the level of detail, quantity, and quality of data collected. Consequently, a number of initiatives were accomplished, including mandatory fishery reporting procedures, equitable data confidentiality regulations among the states consistent with those of the federal government, safeguards to prevent illegal dissemination of sensitive data, coordination between state and federal data collection efforts, and procurement of advanced data entry, data retrieval, and data archival methods.

HIGHLY MIGRATORY SPECIES ASSESSMENTS

The western Atlantic longline tuna fishery expanded in the 1970s and created concerns on both sides of the ocean that bluefin tuna and other highly migratory species might become severely overfished. Because such species are international in range and exploited by a number of nations and fisheries, they are managed cooperatively through ICCAT. Today, ICCAT addresses about 30 species, including Atlantic bluefin, yellowfin, albacore, and bigeye tuna; swordfish; billfish, such as white marlin, blue marlin, sailfish, and spearfish; and sharks. Moreover, the Atlantic Tunas Convention Act of 1965 authorized the Secretary of Commerce to

administer and enforce all provisions of ICCAT. In response, Miami scientists routinely participate in ICCAT data analyses, stock assessments, and assessment reviews.

Recreational fishing also expanded as offshore sport fishermen targeted marlin, sailfish, and tuna off the southern United States, the Bahamas, U.S. Virgin Islands, Puerto Rico, and other locations in the Caribbean. To gather information on this sector, personnel were sent to international sport fishing tournaments to survey fishermen and collect data and biological samples from specimens landed. In addition, a voluntary billfish tagging program (begun years earlier at the Woods Hole Oceanographic Institution) was adopted that provided big-game fishermen with tagging equipment to tag, record, and release their catch. Fishermen were asked to return information on tagged fish that they captured. This developed into the Atlantic-wide Cooperative Tagging Center in Miami that maintains decades of archival tagging records for billfish, tuna, and swordfish. From data and information collected, scientists have documented reproductive patterns, identified essential habitat, and discerned the transatlantic movement of blue marlin and bluefin tuna. They have also discerned the seasonal movement of white marlin from winter grounds off Venezuela to summer grounds in the Gulf of Mexico and off the mid-Atlantic states.

COASTAL SPECIES STOCK ASSESSMENTS

MSFCMA required the application of stock assessment science to EEZ species. To meet this challenge, Miami scientists began studies of selected southeastern species to estimate total catch, age composition in the catch, fishing and natural mortality rates, indices of abundance, age and growth characteristics, fecundity rates, release mortality, and other variables for mathematically modeling stocks to determine whether they were under- or over-exploited. The objective was to provide science-based stock assessment information that the councils could use in managing living marine resources for the best interest of the nation.

In the 1990s, interest grew in developing a process that would broaden assessment contributions, discussion, and debate among scientists in the SEFSC, fishery management councils, Southeast Regional Office, states, universities, and nongovernmental organizations. In 2002, the establishment of the Southeast Data, Assessment, and Review (SEDAR) process fulfilled that need. SEDAR involves scientists from multiple organizations throughout the region and con-

sists of three workshops for each assessment: a data workshop to gather, organize, and review data from diverse sources; an assessment workshop to apply assessment methods; and a review workshop to independently review the data, methods, and results of the previous workshops. Stocks assessed through SEDAR include red porgy, black sea bass, vermilion snapper, red snapper, yellowtail snapper, mutton snapper, goliath grouper, gag grouper, red grouper, hogfish, gray triggerfish, greater amberjack, king mackerel, and various shark species.

SEA TURTLE RESEARCH AND ASSESSMENT

The ESA mandated research and protection for sea turtles. A Sea Turtle Stranding and Salvage Network (STSSN) was initiated in 1980 with cooperating staff from federal and state agencies, universities, nongovernment organizations, and private citizen volunteers. By 2007, STSSN had documented more than 65,000 marine turtles that were beach stranded as dead, sick, or injured. A Cooperative Marine Turtle Tagging Program (CMTTP) was also initiated to provide researchers with tags and a central archive for sea turtle tagging data from the western North Atlantic Ocean. CMTTP has issued more than 188,000 tags and has received reports of more than 13,000 recaptures. Researchers have also flown aerial surveys in areas of the Gulf of Mexico and Atlantic Ocean to estimate the occurrence of sea turtles. These data, along with data from ground surveys, led to estimates of nesting female loggerhead sea turtles—identifying this region as the second largest nesting assemblage of loggerheads in the world.

Turtle Expert Working Group (TEWG) workshops of scientists from governmental agencies, academia, industry, and nongovernmental groups were convened to conduct stock assessments for loggerhead, Kemp's ridley, and leatherback sea turtles. TEWG workshops also determined that a significant problem existed in that larger loggerhead turtles were disproportionately killed in shrimp trawls. Many were simply too big to easily fit through the release mechanism of a turtle excluder device (TED). This led to a 2003 regulation that required larger-opening TEDs in the shrimp fishery.

Researchers also looked into incidental captures of sea turtles in the longline fisheries. They discovered that turtle mortality could be reduced without significantly reducing the catch of target species by changing longline bait from squid to mackerel and by using circle hooks in place of the industry standard "J" hooks. These findings,

along with new release technologies, resulted in a reopening of the Grand Banks and the Hawaii-based swordfish fisheries, both of which had been closed due to high incidental catches of turtles.

MARINE MAMMAL RESEARCH AND ASSESSMENTS

Both MMPA and ESA mandated marine mammal protection and research. Initially, Miami scientists, in collaboration with scientists at other SEFSC laboratories, estimated the abundance and spatial distribution of bottlenose dolphins in coastal and estuarine waters. Today, scientists continue to cooperate in conducting annual marine mammal assessment surveys aboard NOAA research vessels and airplanes on a rotational basis in the U.S. Gulf of Mexico, Atlantic Ocean, and Caribbean Sea on a number of species. Data collection includes visual line transect surveys, passive acoustic monitoring and detection techniques, and physical oceanographic sampling. Biopsies produce tissue samples for genetic studies to help identify population structures in marine mammal stocks, phylogenetic studies of cetacean taxonomy, and environmental contaminants.

In 1980, the Southeastern Marine Mammal Stranding Network of affiliated agencies was organized to collect information on stranded dead, injured, or otherwise beached marine mammals. This included an extensive bottlenose dolphin die-off in 1987–88. The prolonged event led marine mammal scientists to investigate the causes and impacts of the die-off and the status of the species, which was declared "depleted."

Research on North Atlantic right whales began in the early 1990s to support conservation and recovery. An initial project was satellite tagging of calving right whales along the southeastern coast of Florida in 1994 and 1995. Since then, Miami scientists have participated in annual aerial surveys along the mid-Atlantic and southeastern coasts to identify right whale habitats and migration patterns. The objective is to produce advice on right whale critical habitat for developing management strategies to reduce accidental vessel strikes.

CORAL REEF AND FISH HABITAT INVESTIGATIONS

Coral reef research at Miami initially analyzed trends in fishery landings of reef fish species, spiny lobster, and stone crab. Later, it initiated field studies of reef fish ecology, fish traps, artificial reefs, and the development of nondestructive, visual reef fish survey methods. Accomplishments included an analysis of the effects of

spear-fishing on reef fish community structure, a comprehensive review of artificial reef literature, and development of a diver-based, circular plot census technique for assessing reef fish community composition, abundance, and size. It also provided analyses of historical data and information for planning the Florida Keys National Marine Sanctuary—the first no-take marine reserve network in North America.

A new research emphasis since the turn of the century is the application of ecosystem-based approaches to resource management. Associated research includes extensive evaluations of coral reef habitat, efforts to elucidate mechanisms involved in coral decline, and region-wide analyses to expand reef fish ecosystem monitoring to better understand regional ecosystem dynamics. Additionally, the listing of staghorn and elkhorn corals as threatened under the ESA in 2006 has driven researchers to investigate the major causes of decline and hopes for recovery.

EARLY LIFE-HISTORY INVESTIGATIONS

Research at the Miami Laboratory on early life history originally consisted of larval fish investigations to understand biodiversity, systematics, and ecology of fishery populations in the Gulf of Mexico and Caribbean Sea. Studies have documented the biodiversity of the Florida current and shown the influence of the loop current and local eddies and countercurrents in dispersing and repopulating populations of reef fishes and spiny lobster. Studies of research cruise data have examined oceanographic biological connectivity between southern Florida coral reefs and areas in the Mesoamerican reef along the Yucatan–Quintana Roo coast of Mexico. Significant accomplishments include the production of a comprehensive guide to the larval fishes of the western central North Atlantic Ocean that includes 2,221 fish species in 218 families,¹ the monitoring of larval bluefin tuna population trends and ecology, and research showing local differences in otolith microchemistry as a potential marker of juvenile habitat.

SOUTH FLORIDA ECOSYSTEM INVESTIGATIONS

Since the 1990s, laboratory scientists have participated in the Comprehensive Florida Everglades Restoration Program, which is modifying

extensive South Florida wetlands to reestablish more natural freshwater flows from channeled drainage systems installed in the early to mid-20th century. Miami's research aims to understand and model the effects and effectiveness of restoration efforts on aquatic species in Florida Bay, Biscayne Bay, and other southern Florida coastal ecosystems. Research emphasis is directed at assessing and modeling performance indicators, such as habitat distribution and quality, and determining population conditions of key indicator species, such as pink shrimp, including the ultimate downstream ecosystem: coral reefs.

SOCIOECONOMIC RESEARCH

MSFCMA and other legislation require federal fishery managers to take into account the impacts of fishery regulation on affected individuals and communities. At the SEFSC, therefore, economists, sociologists, and anthropologists conduct research and provide information and economic models to help managers evaluate and make decisions during the regulatory process. They also collaborate with personnel in the Southeast Regional Office to assist in providing products for fishery management plans, regulatory amendments, and other required documents.

CONCLUSION

Miami Laboratory's organizational structure, role, and mission have shifted in four decades with associated shifts in the needs and interests of society. Underlying these changes is a consistent fundamental adherence to the idea that objective, peer-reviewed science should form the basis of sound resource management. SEFSC's scientists and directors have adhered to this philosophy and continue to work to produce scientific products that are of high quality and caliber and are responsive to the needs of managers responsible for the health and sustainable use of living marine resources.

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¹W. J. Richards (ed.). 2005. Early stages of Atlantic fishes: an identification guide for the western central north Atlantic, 2 vols. CRC Press, Taylor & Francis Group, Boca Raton, FL.