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**OCEAN REFLECTIONS**

# GULF COAST MARINE LABORATORIES PAST, PRESENT AND FUTURE

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**Abstract:** I spent my nearly 50–year career in marine science working at marine laboratories, most of that as a chief executive officer. So, it is appropriate that my reflections are about marine laboratories, rather than my own science. After relating my career course, I turn my attention to the history and development of marine laboratories along the U.S. coast of the Gulf of Mexico (GOM). Surprisingly, the region's first laboratory was actually constructed in 1903 at Cameron, LA, but operated less than a decade before closing. It was not until after World War II that the university–affiliated marine laboratories of today developed in each of the states and have contributed greatly to our understanding of coastal environments. They now have impressive facilities and operate the region's GOM research fleet, participate in the global advancement of science, educate and inform a broad spectrum of society, and are at the front line in debates over important public policies. Marine laboratories must strive to achieve excellence in scientific discovery, integration, application and life–long education, while overcoming challenges due to relative isolation from the universities or agencies with which they are affiliated and their vulnerability to coastal climatic events and changes. The GOM marine laboratories have an unprecedented opportunity to contribute to the rehabilitation of degraded ecosystems and recovery of their living resources. They also have a responsibility to assist coastal citizens transition the energy economy to limit climate change and adapt to the changes that do occur. More than ever, their science must be relevant, credible, salient and useful.

**Key words:** Gulf of Mexico, history, research fleet, ecosystem restoration, climate change

## My Course and Bearing

The course of this paper deviates from that followed by the distinguished senior scientists who have authored previous *Ocean Reflections*. They presented splendid accounts of career–long quests to understand seagrass ecosystems, salt marsh nurseries, deep–water fish biology or the design of marine protected areas, for example. The authors were driven by passion that sustained their focused research advances over many decades. My career path took an early and sharp deviation when I was appointed as the first Executive Director of the Louisiana Universities Marine Consortium (LUMCON, see list of initials in Table 1) when I was only 34 years old. From that point on, the priorities of my career were leadership and administration of institutions. Pursuit of my own research interests became secondary and writing scientific publications became something to pursue on nights and weekends.

In 1980, I was an Associate Professor at the Virginia Institute of Marine Science (VIMS), where I had built a research program in benthic ecology. Our research was evolving from multivariate analysis of data–rich observations to more experimental and process–oriented approaches. I was well on my way along a career–long evolution in benthic research. However, after I took on institutional responsibilities, my scientific engagements broadened to produce publications on wetlands, eutrophication, oil and gas development impacts,

***TABLE 1.*** *Abbreviations of entities used in this paper.*

| | | | |
|---|---|---|---|
| BCF | Bureau of Commercial Fisheries | MML | Mote Marine Laboratory |
| CBL | Chesapeake Biological Laboratory | NAML | National Association of Marine Laboratories |
| CZL | Chesapeake Zoological Laboratory, Johns Hopkins Univ. | NASEM | National Academies of Sciences, Engineering and Medicine |
| DISL | Dauphin Island Sea Lab | NOAA | National Oceanic and Atmospheric Administration |
| DUML | Duke University Marine Laboratory | NSF | National Science Foundation |
| EPA | U.S. Environmental Protection Agency | RCRV | Regional Class Research Vessel |
| EPSCoR | Experimental Program to Stimulate Competitive Research | SAML | Southern Association of Marine Laboratories |
| FSU | Florida State University | TAMU | Texas A&M University |
| FSUCML | Florida State University Coastal and Marine Laboratory | TAMUCC | Texas A&M University Corpus Christi |
| FWS | U.S. Fish and Wildlife Service | TAMUG | Texas A&M University Galveston |
| GBS | Gulf Biologic Station | UMBI | University of Maryland Biotechnology Institute |
| GCRL | Gulf Coast Research Laboratory | UMCES | University of Maryland Center for Environmental Science |
| GEMDD | Gulf Ecosystem Measurement and Modeling Division, EPA | UMCP | University of Maryland College Park |
| GOM | Gulf of Mexico | UNAM | Autonomous University of Mexico |
| GoMRI | Gulf of Mexico Research Initiative | UNOLS | University-National Oceanographic Laboratory System |
| GRP | Gulf Research Program, National Academies | UF | University of Florida |
| IPCC | Intergovernmental Panel on Climate Change | USF | University of South Florida |
| LUMCON | Louisiana Universities Marine Consortium | USF-CMS | University of South Florida College of Marine Science |
| LSU | Louisiana State University and A&M College | USM | University of Southern Mississippi |
| MBL | Marine Biological Laboratory, Woods Hole, Massachusetts | UTMSI | University of Texas Marine Science Institute |
| MESC | Marine and Environmental Science Consortium, Alabama | VIMS | Virginia Institute of Marine Science |

ecosystem management, and climate change. These were topics important to the institutions I led and to my responsibilities for putting science to use.

Knowing that I was born and raised in Louisiana, John Fleeger, a fellow benthic ecologist and then an Assistant Professor at the Louisiana State University (LSU), encouraged me to become a candidate for the LUMCON position and to take on the exceptional opportunity of building a marine laboratory in my home state. The 5 finalists for the position were interviewed all on the same day at Port Fourchon on the Louisiana coast by the Consortium's governing council. I went into the interview thinking that I had no chance—the other candidates were at least in their fifties—but also nothing to lose. Chalking the interview up to experience, I flew back to Virginia, only to receive a telephone call the next day offering me the position. Had I really thought this through?

I had earlier promised VIMS Director William Hargis that I would not accept another job offer before talking with him. I arranged an appointment, expecting that he would make me, one of the institute's top grant winners, a counter offer. Instead, after I described the job I was offered, Bill offered a congratulatory handshake. He explained how he, a Virginia native, had become the VIMS director at a young age. He counseled that few scientists ever have such an opportunity, I had to take it. Unwittingly, there seemed to be no other option.

This new career bearing resulted in my spending 37 years holding leadership responsibilities for marine laboratories, LUMCON for 10 years and subsequently heading the University of Maryland Center for Environmental Science (UMCES). In fact, except for a year—long Fulbright postdoctoral fellowship on the campus of the University of Queensland, I have spent my entire professional career, including graduate training, based at academic marine laboratories distant from a university campus. So, any expertise I possess is regarding marine laboratories.

Actually, I have been fascinated by marine laboratories even longer (Figure 1). I aspired to be a marine scientist since the tenth grade, when my biology teacher inspired me to think that I could actually build on my fascination with marine life and conduct science as an occupation. He encouraged me to apply for a summer program for high school kids at the Gulf Coast Research Laboratory (GCRL) in Ocean Springs, MS, not too far away from my New Orleans home. I was then only a mediocre student and was not accepted. Strange as life is, now, nearly 60 years later, I am writing this invited paper for that Laboratory's journal! Undaunted and afflicted with some attention deficit, I continued to daydream about working at a marine lab, doodling site plans with laboratory buildings, slips and docks. With persistence and good fortune, I was actually able to live my boyhood dream by building one new marine laboratory and expanding two others.

In this reflection, I will first provide my own experiences and then review the development and contributions of marine laboratories, with a particular emphasis on those along the coast of the U.S. Gulf of Mexico (GOM) and Caribbean region. Then, I will discuss the multiple functions these laboratories provide and the operational and financial challenges they face related to their governance, locations and community relationships. Finally, I will offer my perspectives on the future roles marine laboratories can play as virtually everything in our world changes, from the coastal environments where we work to higher education and the support and uses of science.

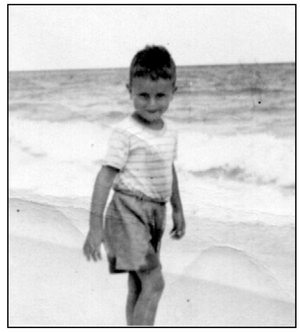

***FIGURE 1.*** *Don Boesch ca. 1949 planning his future as a marine laboratory director on the beach at Galveston, TX.*

## My Cruise Track

### Virginia Institute of Marine Science (VIMS)

The marine laboratories where I have worked have both significant similarities and differences in organization, mission and operations. I did my graduate training at VIMS and, after my postdoc in Australia, served on its faculty for 8 years. It was founded in 1940 as the Virginia Fisheries Laboratory by a professor at the College of William and Mary, essentially to replicate the Chesapeake Biological Laboratory (CBL) established in Maryland about 15 years earlier. VIMS became an independent agency of state government in 1962. However, it arranged with both William and Mary and the University of Virginia to supervise students earning graduate degrees, producing its first Ph.D. in 1968.

Under Bill Hargis's autocratic directorship there was no shared governance or even search committees, but he was able to grow the institution dramatically. However, its scientific results ruffled feathers of entrenched interests, particularly after finding widespread contamination by the pesticide kepone in the James River estuary emanating from the plant that manufactured it (Huggett and Bender 1980, Fincham 2014). Hargis defended the science: "Science came first and let the chips fall where they may." A state police investigation was launched that resulted in criminal charges against Hargis for stealing state property by giving a staff member an old marine diesel engine in exchange for overtime spent on the conversion of an old minesweeper into a research vessel. The judge threw out the charges and dismissed the jury, but fiscal irregularities uncovered were used to force the 1979 consolidation of VIMS under the College of William and Mary. Two years later Bill Hargis stepped down and "went back to the bench." I learned a lot from him: lead with a strong vision, stand up for the

truth, avoid administrative over—reach, and step down before they want you to.

VIMS has grown to perhaps the largest coastal marine science program in the nation, currently with a resident faculty of 55 and graduate student body of about 90. It has been relatively well supported by the Commonwealth of Virginia, particularly in terms of capital facilities, through its own appropriations line. Incidentally, of the 4 directors who followed Hargis, 3 did their graduate training on the U.S. Gulf Coast: Frank Perkins at Florida State University (FSU) and Donelson Wright and current director John Wells in coastal geology at LSU.

**Louisiana Universities Marine Consortium (LUMCON)**

When I left VIMS in 1980, I had one of its larger research groups, with graduate students, research assistants and post docs. Arriving at my new work station in a well—worn house trailer at Cocodrie, the site of the planned LUMCON Marine Center, I had a support staff of two. In his recollections of the Texas A&M University (TAMU) Project Nine investigation of the causes of oyster mortalities, Sewell Hopkins (1980) describes how in 1949–1950 he would take the train to Schriever and then a taxi to Houma and another for the 30—mile ride down Bayou Petit Caillou to Cocodrie. There he would be transported by crew boat to the basecamp in the Bay Sainte Elaine oil field. On learning that LUMCON was planning a marine laboratory at Cocodrie, Hopkins commented, "It is like that place Gertrude Stein complained about, there is no there there." Although Stein wrote that about Oakland, CA, there was still not much there in Cocodrie in 1980. Cocodrie probably has more real—estate value today than when I left in 1990, but I am told that it now has fewer than 10 fulltime residents. Hurricanes and FEMA have forced people to move north, while highly elevated and often luxuriant sportfishing camps sprang up.

The site of the LUMCON laboratory was determined before I arrived. The Gulf coast is not easily reachable from Louisiana's population centers or its universities. State—owned land at Cocodrie could provide access to estuaries of moderate salinity, coastal marshes as far as one can see, barrier islands, and vessels large enough to support research in the Gulf. Like Penn State is to Pennsylvania, Cocodrie is neither too far east nor west, but equally inconvenient to all parts of the state. The resident scientists who have since worked at the Marine Center, and most of the support staff, have mostly lived in Houma or as far as New Orleans or Baton Rouge.

At VIMS, scientists were "protected" from having to deal with higher—level university administrators. My new job required that I regularly interact with university presidents, regents, and elected and appointed officials, coupled with all of Louisiana's characteristic intrigue. Very quickly I realized that I had thrown myself into the deep end of a very idiosyncratic pool. While swimming in that pool over the next decade, I learned quite a lot about universities and their administration, politics, integrity, communication, perseverance, and myself.

LUMCON was then governed by a council representing the 4—year public universities, 3 higher education systems, and the Board of Regents that coordinates higher education. Council members ranged from university presidents to deans to assistant professors, all with different ideas about LUMCON. The driving force to build a laboratory and research vessels was Darryl Felder, a faculty member a bit younger than me at the University of Southwestern Louisiana, now the University of Louisiana, Lafayette. It was through his efforts, with the support of his university, that state legislation was passed to create the consortium and sufficient funding appropriated to begin the design of the Marine Center and 2 research vessels.

I was assured that full funding was committed. I just needed to work with the architects and contractors to make sure the projects moved forward. My career change did not seem very smart 3 months after my arrival. Governor Dave Treen, who had assumed office a few months earlier as the first Republican since Reconstruction, declined to include the needed funding in his capital budget. Treen was fiscally conservative, mistrusted anything initiated under his predecessor Edwin Edwards, and made decisions very deliberately. When Edwards successfully ran against him in the next election, he quipped, "David Treen is so slow it takes him an hour and a half to watch 60 Minutes." Treen appointed a close ally to the Board of Regents, instructing him to kill the LUMCON project. Rather, that regent became a crucial advocate in convincing the governor. Member universities were of little help, as they were competing for the same pot of funds for buildings on their campuses. In April 1983 Governor Treen presided over the ceremony to break ground—actually it was more of a quagmire—for the Marine Center. Three years later, it was Governor Edwards who spoke at the joyous dedication ceremony.

As one drives to Cocodrie, the LUMCON Marine Center looms as an incongruous mirage, seeming like an airport terminal set down in the middle of a salt marsh (Figure 2). It is a

***FIGURE 2.*** *The Louisiana Universities Marine Consortium Marine Center, with R/V* Pelican *and R/V* Acadiana *in port. Photo from the* New York Times.

massively constructed, highly capable laboratory linked with attached accommodations for students and apartments for visiting scientists. Its style, capabilities and durability are due to the talents and imagination of a young architect named Jim Frey, scion of the meat—packing family that produced wieners and cold—cuts from my old Bywater neighborhood of New Orleans. The iconic feature of the Marine Center is its observation deck, rising up like the control tower. As I made pitches to secure funding for construction, invariably I was asked about the cost of this extravagance. Jim would always get back to me with some ridiculously low figure, like $20,000. Watching school kids' eyes widen when they are able to look out over the vast expanse of marshes and waterways, I am glad we were able to keep it in.

In 1996 the center was named the W.J. "Woody" DeFelice Marine Center after a late regent. In the darkest early days, I sought Woody's counsel and he gave me advice that I have followed since. He was president of a small community bank and formerly the superintendent of schools for Lafourche Parish, well known for its politics and patronage. Woody told me that every day he looked his wife and children in the eyes and told them what he did that day. Thus, he avoided doing anything that he would be ashamed of.

As the completion of the Marine Center approached, I recruited a small faculty of young research professors, all of whom, I am proud to say, have had successful careers and made significant contributions to GOM science. Many at the member universities felt that the resident scientific staff should be kept very small, with the laboratory facilities used largely by scientists from the universities. Those at the LSU Center for Wetlands Resources (which grew into the present College of Coast and the Environment) were particularly wary, but also envious. They had long conducted productive and impactful research in the coastal zone in field trips using small boats, while occupying pretty lousy spaces on campus. Economically difficult times and politics conspired to prevent needed growth in state funding by the time I left in 1990. Despite LUMCON's success in attracting extramural funding, supporting its excellent research vessel operations, and growing its education programs, the dearth in state funding continued to be a problem. It is gratifying to see a number of vacant resident faculty positions finally filled.

While in Louisiana, I became increasingly involved in national level ocean science issues, serving on federal agency advisory committees and on committees and boards of the National Academy of Sciences. I guess that, coming from a Gulf Coast state, I was considered a member of an underrepresented group. In this service, I tried to bring more attention and opportunities to GOM science and to Louisiana's universities.

In the mid 1980's, Louisiana was ineligible to participate in the National Science Foundation's (NSF) Experimental Program to Stimulate Competitive Research (EPSCoR), intended to assist scientists in states that receive relatively little federal research funding. Louisiana's federal research awards exceeded the threshold, even though funding per scientist and engineer was lower than for most of the smaller EPSCoR states. I mounted a successful campaign to persuade NSF to allow Louisiana to compete. The timing was fortunate because the Board of Regents committed to provide generous matching funds from a newly created trust fund in support educational quality. The funds destined to this trust came from settlement of a long—standing dispute over the proportion of offshore oil and gas revenues generated along the state boundary due to the states. Surely, I argued, stimulating competitive GOM research would be an appropriate use of such revenues. When NSF declined to fund our 1986 proposal, the chair of the review panel came down and explained that reviewers were skeptical that Louisiana voters would actually approve the permanent dedication of funds. In fact, they very soon did, and by a large margin. The Regents decided to fully fund the projects selected for our EPSCoR proposal, including the federal share. This included research that contributed significantly to the understanding of development of hypoxia on the continental shelf. In 1988, we successfully resubmitted the EPSCoR proposal and Louisiana scientists and engineers have continued to receive federal support through EPSCoR. The Board of Regents also adopted the competitive peer—review process we established for selecting projects supported by the trust fund.

I found myself trying to manage activities and developments at the new Marine Center at the far end of a bayou while also serving as the Louisiana EPSCoR director from an office in Baton Rouge. I was also frequently flying from New Orleans to Washington and other points. When Maryland came calling in 1990, I had to decide what I wanted to be when I grew up. As strong as my emotional attachment is to the Louisiana coast, I concluded that, foremost, I was a citizen of the world. I was compelled to work on bigger issues and see if I could advance a larger, more established institution. Just as importantly, I assessed that my skills and interests were more in line with higher level management and public policy than with day—to—day operations of a marine laboratory. Some of my colleagues agreed with me on the latter point.

**University of Maryland Center for Environmental Science (UMCES)**

The UMCES is an unusual institution in many respects. It is not in one place, but has laboratories across Maryland. It is not a unit of a specific university, but is one of 13 separately administered institutions of a public university system. And, it is unusually effective in executing its mission. Internal and external reviews have concluded that few peer institutions had as much impact by bringing highly credible, actionable environmental science to serve its principal client, in this case the citizens of Maryland. I like to think that I helped

UMCES reach that standard during my 27 years at the helm, but a very capable tradition was already there. The challenge that I accepted was to continue the evolution of UMCES from very good to great.

That deep foundation began with the 1925 founding of CBL, as discussed later. Associated field stations were added under the umbrella of the Natural Resource Institute (NRI), one became the Appalachian Laboratory for investigations of inland environments and natural resources. In 1973, the NRI was involuntarily merged with a new laboratory planned for a former du Pont estate at Horn Point on the Eastern Shore of the Chesapeake Bay to constitute the Center for Environmental and Estuarine Studies (CEES). As with NRI, CEES reported to the head of the University of Maryland system rather than the University of Maryland College Park (UMCP). A few weeks after I accepted Maryland's offer, it was announced that the new system Chancellor would be Donald Langenberg, the very person who chaired the NSF peer—review panel that had declined Louisiana's 1986 EPSCoR proposal. We overcame that contentious start to maintain a very effective relationship. When his successor, William E. Kirwan, took over in 2002 he asked me to serve also as the interim Vice Chancellor for Academic Affairs for "not more than 6 months." After more than a year of this double duty, I opted for environmental science over broader academic administration. A critical but underappreciated responsibility of a marine laboratory director is to contribute to the goals of the parent unit: the college, university, or system.

A parallel autonomous institution for advanced research and education had been formed in 1986 for the emerging field of biotechnology. Founded and led by well—known marine microbiologist Rita Colwell, the University of Maryland Biotechnology Institute (UMBI), like UMCES, had several separately located research centers. Despite the fact that we were both titled Director, we had responsibilities equivalent to the presidents of the 11 degree—granting institutions and a seat at the table of the Council of University System Presidents. Rita made the case that her title should be President. The System Board of Regents made the change for both UMBI and UMCES, but, at least in my case, without any increase in salary.

Stable leadership has been important to UMCES. When I concluded my tenure in 2017, I had been just its fifth head over 92 years. When Rita Colwell left in 1998 to become the Director of the NSF, questions were raised about whether a separate institution for biotechnology should be maintained, given the explosion of capabilities in molecular biology on the campuses. That evaluation entrained UMCES as the other research institution. The Board decided to keep UMCES autonomous and this status was reaffirmed by the Regents and the state legislature several times subsequently. The primary reason was not so much that the unusual model produced exceptional extramural funding, highly regarded research, or numerous graduate degrees, which it did. Rather, it was that any organizational demotion risked the Center's highly valued scientific guidance for management of the Chesapeake Bay and the state's environment and natural resources. In 2010, the Board of Regents finally decided to "disaggregate" UMBI, with its Center for Marine Biotechnology, located in a magnificent building on the waterfront in downtown Baltimore, coming under the co—management of UMCES (marine environmental science), the University of Maryland Baltimore (biomedicine), and the University of Maryland Baltimore County (engineering). The renamed Institute of Marine and Environmental Technology became UMCES' fourth laboratory. The responsibility for operating the Maryland Sea Grant College Program had earlier also been transferred from UMBI to UMCES.

Management of the 4 UMCES laboratories is quite devolved. The directors of each laboratory are responsible for the supervision of the faculty and staff, the operating budget, and facilities operations. While this builds collegiality and pride within tight—knit laboratories, the challenge of this structure is to maintain the strong coherence and identity as one institution needed for recognition, effectiveness, efficiency and accountability to the university system and the state. While UMCES had gained in international prestige, research funding and graduate instruction under my predecessor, it needed to reinvigorate its commitment to public service, the core of its value proposition. We did this, in part, by organizing faculty appointments, annual evaluations, and promotion around the 4 functions of scholarship articulated in Ernest Boyer's (1990) influential report, *Scholarship Reconsidered: Priorities of the Professoriate*. While relative contributions vary within the faculty, every member is expected to contribute to discovery (not just grants or publications, but new knowledge), integration (putting one's science into the broader context), application (of knowledge to address consequential problems), and teaching. It took time, but the 4—function approach became thoroughly engrained in the UMCES culture.

With UMCES's statutory mandate "to develop and apply a predictive ecology for the improvement and preservation of Maryland's physical environment," effective integration and application are particularly critical. Since 1985, Maryland governors have been advised by the Governor's Council on the Chesapeake Bay, commonly known as the Bay Cabinet. It consists of relevant agency secretaries, all appointed by the governor, and the UMCES President, who is not a political appointee. I filled this role under the administrations of 5 governors, 3 Democrats and 2 Republicans. The UMCP Dean of Agriculture and Natural Resources was later added to the cabinet. This arrangement has allowed senior university leaders to speak truth to power directly, but also to take the science needs of the state back to their institutions. As far as I know, such academic participation in a state environ-

mental cabinet is unique in the United States. I also held a similar position on the Maryland Commission on Climate Change from when it was established in 2007 until I turned over the reins in 2018.

These experiences certainly honed my skills in truthfully and clearly conveying scientific understanding under sometimes challenging political circumstances. Prior to one meeting with Governor Parris Glendenning, a department secretary who was already in hot water with the governor and was concerned that he would not be happy with the information we were about to present, suggested to me, "Boesch, you tell him, you've got tenure." During his first year in office, Governor Martin O'Malley (Figure 3), in a private meeting after expressing his appreciation for my ability to explain things, added: "But, just don't tell me 'it depends' anymore. I can't deal with that." I responded, "I'll tell you what, Governor,

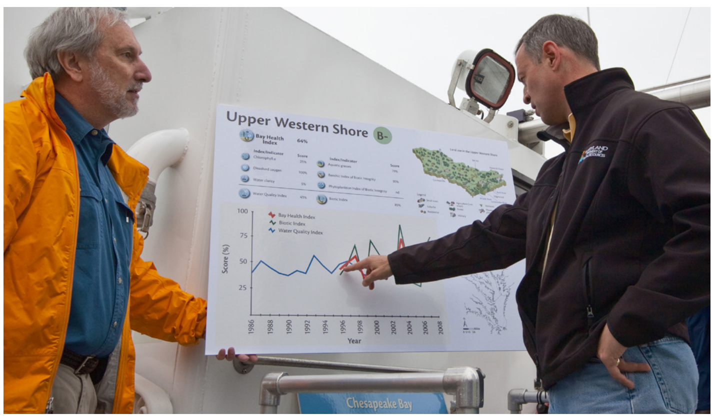


***FIGURE 3.*** *Don Boesch explaining trends in the Chesapeake Bay ecosystem to Maryland Governor Martin O'Malley on R/V* Rachel Carson.

henceforth the only time you will hear me say that is when I am trying to make it clear that it depends on you." This was a joking reference between us for the next 7 years he was governor.

The experience I gained advising political leaders in Maryland came into very good use when in 2015 I was called back to the GOM as one of the 7 members President Barrack Obama appointed to the National Commission on the BP Deepwater Horizon Oil Spill and the Future of Offshore Drilling. Reflections on that experience must await another publication.

## The Ontogeny of Gulf Coast Marine Laboratories

### European and American Precursors

The need for marine laboratories, where scientists could make collections, conduct research and train students, emerged during the second half of the 19th century. Anton Dohrn, a prominent German Darwinist, envisioned a network of European marine laboratories that scientist could visit. In 1873 he established the Stazione Zoologica Napoli, now named for him, at his own expense. Before the end of the century, marine laboratories had been established in France at Roscoff, Arcachon, Endoume, Banyuls—sur—Mer, and Villefranche—sur—Mer; in Great Britain at St. Andrews, Millport and Plymouth; in Belgium at Ostend; in the Netherlands at Den Helder; in Germany on Helgoland; in Sweden at Kristineberg; and in Norway at Bergen. With few exceptions, these marine laboratories are still in vibrant operation, with scopes of research extending beyond marine biology and housing sizeable complements of resident investigators. Most are now affiliated with universities and partially funded by national research agencies.

In the United States, famed Harvard biologist Louis L. R. Agassiz convened short—lived summer schools of natural history on Pekinese Island off Cape Cod, MA. In 1885, Spencer F. Baird, the first U.S. Fish Commissioner, established a permanent research station for the commission at Woods Hole, MA. Baird worked with the Boston Society of Natural History to establish the adjacent Marine Biological Laboratory (MBL) in 1888. For 132 years the MBL has served the venerable role of a place for mainly summer research by biologists and for teaching of students from across the country. Many famous scientists trained there and many other distinguished people attended courses at MBL, including the aforementioned novelist, poet and playwright Gertrude Stein, who took the embryology course in summer of 1897.

Soon, several marine laboratories had been established on the U.S. West Coast: Stanford University's Hopkins Marine Station in 1893, the University of California's Scripps Institution of Oceanography in 1903, and the University of Washington's Friday Harbor Laboratories in 1904. Laboratories were slower to develop along the mid—Atlantic and southeastern states. William K. Brooks, who had studied under Agassiz on Pekinese Island and became a professor at Johns Hopkins University, initiated the first summer session of the Chesapeake Zoological Laboratory (CZL) in 1878 at Fort Wool, a small artificial island in the lower Chesapeake Bay (Conklin 1913). However, over the next 18 years, the summer sessions moved among other locations in the Chesapeake, Beaufort, NC, the Bahamas, Woods Hole, Jamaica, and the Dry Tortugas. The CZL was not a fixed facility as we now think of marine laboratories.

It was 37 years after the founding of the MBL that Reginald V. Truitt established CBL in 1925 as the next permanent marine laboratory on the east coast. Truitt, a professor at the Maryland Agricultural College in College Park (now UMCP), was a Maryland native whose family was in the seafood business. He had a different vision for a marine laboratory as a place not only for student training and basic research on marine organisms, but also for science needed to sustain and enhance living marine resources (Fincham 2013). The CBL was the first marine laboratory operated by a public university on the U.S. east coast. Truitt's model of a marine laboratory for a public purpose has been replicated in one form or another in all other Atlantic seaboard states and had

significant influence on the development of GOM marine laboratories.

Although plans were developed for marine laboratories in Texas and Louisiana at the end of the 19th century, the GOM states entered into the marine laboratory enterprise after the Atlantic and Pacific coast states. Except for Federal fisheries laboratories in Galveston, TX and Gulf Breeze, FL, there really was not much research or teaching activity based on the U.S. Gulf Coast until after World War II. This is hardly surprising. In 1880 New Orleans, with 216,090 residents, was the only sizeable city located on the U.S. Gulf's tidal waters. Pensacola, with 6,845 people, and Apalachicola, with 1,336, were the only towns of any size along the entire Florida Gulf coast. When my maternal grandfather was born there in 1884, more people resided in Galveston, TX (about 24,000) than in Houston. The rest of the coastal Texas was very sparsely populated and remote. The University of Texas Board of Regents authorized $300 to establish a marine laboratory on Galveston Island and its first class of 5 students was welcomed in the summer of 1900 (Haberer et al. 2010). At the end of that summer the Great Galveston Hurricane demolished most of the island's buildings (Larson 2000), including the embryonic laboratory. It took the university more than 4 decades to again mount an effort to establish a marine laboratory.

**Mysterious Demise of the First Gulf Marine Laboratory**

Judging from the founding dates of the present—day marine laboratories along the U.S. Gulf Coast (Table 2), Louisiana, with its long coast and bountiful marine resources, seems

***TABLE 2.*** *Active marine laboratories on the U.S. coast of the Gulf of Mexico*

| Institution | Location | Type | Founded |
|---|---|---|---|
| University of Texas Rio Grande Valley Coastal Study Laboratory | South Padre Island, TX | University | 1973 |
| Texas A&M University Corpus Christi (TAMUCC) Harte Research Institute | Corpus Christi, TX | University | 2000 |
| University of Texas Austin Marine Science Institute (UTMSI) | Port Aransas, TX | University | 1941 |
| National Marine Fisheries Service<br>Galveston Laboratory | Galveston, TX | Federal | 1929<br>1950 |
| Texas A&M University Galveston (TAMUG)<br>Department of Marine Biology | Galveston, TX | University | 1952<br>1956 |
| Lamar University<br>Center for Coastal and Marine Studies | Port Arthur, TX | University | 1998 |
| Louisiana Universities Marine Consortium (LUMCON)<br>DeFelice Marine Center | Chauvin, LA | University Consortium | 1980 |
| Louisiana Department of Wildlife & Fisheries<br>Grand Isle Marine Laboratory | Grand Isle, LA | State | 1958<br>2007 |
| University of Southern Mississippi Gulf Coast Research Laboratory (GCRL) | Ocean Springs, MS | University | 1947 |
| Alabama Marine Environmental Sciences Consortium<br>Dauphin Island Sea Lab (DISL) | Dauphin Island, AL | University Consortium | 1971 |
| U.S. Environmental Protection Agency<br>Gulf Ecosystem Measurement and Modeling Division | Gulf Breeze, FL | Federal | 1938<br>1970 |
| Florida State University Coastal and Marine Laboratory (FSUCML) | St. Teresa, FL | University | 1950 |
| University of Florida Nature's Coast Biological Station | Cedar Key, FL | University | 1997 |
| University of South Florida College of Marine Science (USF-CMS) | St. Petersburg, FL | University | 1967 |
| Florida Fish & Wildlife Conservation Commission Fish & Wildlife Research Institute | St. Petersburg, FL | State | 1955 |
| Eckerd College Galbraith Marine Science Center | St. Petersburg, FL | University | 1992 |
| New College of Florida Pritzker Marine Biology Research Center | Sarasota, FL | University | 2001 |
| Mote Marine Laboratory (MML) | Sarasota, FL | Private | 1955 |
| Florida Gulf Coast University Vester Field Station | Bonita Springs, FL | University | 2007 |
| Florida Institute of Oceanography (FIO) Keys Marine Laboratory | Long Key, FL | University Consortium | 1983 |

a decided laggard. Surprisingly, there were remarkable early efforts in Louisiana to establish permanent marine laboratories that failed. Interestingly, scientists who had conducted research at the MBL in Woods Hole inspired these early efforts. Instructively, the reasons for the failure remain relevant today.

In 1898 a committed and forward—looking entomologist named H. A. Morgan convinced the Louisiana General Assembly and Governor Murphy J. Foster to enact a statute to establish the Gulf Biologic Station (GBS). This was done "in order to investigate the flora and fauna of the Gulf of Mexico and waters adjacent thereto" (Gulf Biologic Station, 1902—1910). The following, largely untold story of the founding and failure of the GBS is both fascinating and pertinent.

Harcourt A. Morgan (1867—1950) was born and educated in Canada before coming to LSU in 1889. He pursued post-graduate work at Cornell University and in 1895 conducted research at MBL. While a young professor, he organized and co—coached LSU's first football team and was part of the group responsible for selecting the iconic purple and gold colors and Tigers mascot. Professor Morgan also endeared himself to Louisiana's agricultural community through his dogged and practical research on the state's major insect pests: the cattle tick, boll weevil, and sugarcane borer. Also in 1895, he married the daughter of a prominent educator, who had served as Louisiana's Superintendent of Education. Morgan possessed a rare combination of strong scientific interests, commitment to practical resource enhancement and stakeholder engagement, news media savvy, and political skills and connections. This allowed him to advance his vision for a coastal research and teaching station at a time and in a place where one would think it highly improbable. The 1898 act established a GBS Board of Control consisting of the Governor as President, the presidents of LSU, the State Normal College (now Northwestern State University of Louisiana), Louisiana Industrial Institute (now Louisiana Tech University) and the South West Industrial Institute (now the University of Louisiana Lafayette), the Superintendent of Education (then, as now, responsible for K—12 education), and the Commissioner of Agriculture and Immigration (who had responsibilities for fisheries). The Board was no mere figurehead, but actually met periodically, often in the Governor's office or parlor.

The first step in establishing the GBS was the selection of the Station's location. Professor Morgan and the president of the State Normal College were appointed to visit the coast and select a site. Civic interests in Houma made the case for a location in seafood—rich Terrebonne Parish (*The Times–Picayune*, July 32, 1899, page 6), where the LUMCON marine laboratory was sited some 80 years later. However, in December 1899, the Board approved a site near the settlement of Cameron, only 30 miles from the westernmost extent of the state's "1,950 miles of coastline," as the best point on the Louisiana coast. It seems the fix was in, as the key political champion for the GBS was Speaker of the House Samuel P. Henry. He owned Cameron's general store, the cotton gin and most of the village. He settled there in 1871 and was considered the founder of Cameron Parish. A key reason given for the selection was accessibility. While today the Cameron–Holly Beach area is one of only 2 spots in Louisiana where one can drive to the GOM shoreline, that was not the case at the beginning of the 20th century. At that time, one would have to travel by horse westward along the cheniers on poorly developed roads or take the mail steamer from Lake Charles more than 30 miles down the Calcasieu River and Lake Calcasieu. The steamer ran only on Monday, Wednesday, and Friday.

Mr. Henry donated 10 acres of land near Calcasieu Pass, a few hundred meters back from the GOM shoreline. The General Assembly was asked to appropriate $15,000 and the parishes of Calcasieu and Cameron promised $1,500 and 90,000 feet of lumber from local mills. State appropriations were not received until 1900 and totaled only $5,000, with $1,000 provided by the parishes. The death of Mrs. Henry slowed the acquisition of the proper title to the land, delaying the start of construction of the laboratory building until Spring 1901. The building was designed in the shape of a cross (Figure 4), purportedly in order to limit the extent of continuous surface against which prevailing storm winds might blow (*The Times–Democrat*, June 5, 1903, page 3). While annual reports included in the GBS Bulletins assured that the site was "most adequate for a biologic station," it was also "found most inconvenient for the erection of a building, due to its inaccessibility." Nonetheless, "through strictest economy, and many personal sacrifices, an admirable laboratory," complete with a prescient observation cupola, was erected. In July 1903, the GBS was formally opened by Governor William Wright Heard, a protégé of Governor Foster. However, its chief political patron, S.P. Henry, had died of pneumonia in March of 1902. Nonetheless, Director Morgan gained Governor Heard's continued support for the GBS, as the governor mentioned its progress and accomplishments in his annual messages.

***FIGURE 4.*** *The Gulf Biologic Station at Cameron, LA as it neared completion in 1903.*

Harcourt Morgan lobbied hard for $11,385 in additional funding for a steam launch, a sail boat, seines, dredges and trawls, laboratory tables, microscopes, ponds, and "one pair of mules, wagons, plows, etc." Like every good marine laboratory director, he had his wish list. The GBS Treasurer's report indicates that $10,000 was received from the state over the next 3 years. Director Morgan had a flair for hyperbolic promise that present—day marine laboratory hucksters can only envy. A gulf station and laboratory—properly equipped and directed, of course—will be "an educational force of untold value and yield a fund of practical, scientific, and educational information now very much in demand," he proclaimed. "In a word, mines of wealth lie unexplored along every mile of the coast that Louisiana possesses." He was not referring to oil and gas. "While our own interests are to be consulted first, trained scientific investigators enticed to our State by the facilities offered by our Station for the study of the life of the gulf will widely advertise our State and her resources among a most desirable class of immigrants."

An agriculturist, Morgan envisioned the GBS conducting research leading to commercial opportunities through enhancing seafood production. "What the Experiment Stations have done for the improvement of our lands and their products, the Gulf Biologic Station should do for the waters of the Gulf and their products," he wrote. To kick the research off, he invited O. C. Glaser and R. P. Coles (years later Rachel Carson's master's degree advisor) of Johns Hopkins University and James L. Kellogg of Williams College to spend summers at the new Station to examine the feasibility of enhancing oyster production. What they found was that the Calcasieu Pass region was not very conducive for cultivating oysters. Although there was good spat set emanating from natural oyster populations in the area, Lake Calcasieu, which the Pass connects with the GOM, typically became fresh during the spring, killing the growing oysters. They examined the feasibility of cultivating oysters in the nearshore GOM, but not only was there little spat set, but also the bottom sediments were muddy and mobile along the coast of the Chenier Plain. While oysters are harvested in parts of Lake Calcasieu today, that is only because the ship channel to Lake Charles, first constructed in 1922 and progressively expanded, has allowed evermore saline intrusion from the GOM into the brackish lake. The Station's location did, however, prove to be quite a good place to study horseflies, which were so abundant as to limit the use of the coastal terrain for cattle grazing. Among the 15 Bulletins presenting GBS progress and research is a treatise on this diverse fauna of tabanids.

As Director, Harcourt Morgan was based at LSU in Baton Rouge, even today 175 miles away by road. There was a caretaker at the GBS and, within a few years, 2 to 3 resident biologists were hired. As will happen with 38—year old, impressively successful professors, Morgan was lured away in 1905 to establish the University of Tennessee's agricultural experiment station by that university's new president, Brown Ayers. Ayers had been professor of physics and electrical engineering, Dean, and Acting President at Tulane University, and was thus was well acquainted with Morgan's talents and accomplishments in Louisiana. At the University of Tennessee, Morgan (Figure 5A) became Dean of Agriculture in


***FIGURE 5.*** *Early pioneers of Gulf marine laboratories. A. Harcourt A. Morgan during the period he was President of the University of Tennessee. B. Ellinor Helene Behre, a southern woman educated in the North.*

1913 and President from 1919 to 1934. He went on to serve on the board of the Tennessee Valley Authority and eventually became its chair until 2 years before his death in 1950. Morgan was well known for his philosophy of "the common mooring," which stresses a harmonious relationship between humans and their environment (Morgan and Landess 1947). Yet, much to the disappointment of members of the university faculty, Morgan avoided making public statements defending the science of evolution during the Scopes Trial in 1925. Learning that Morgan also left the Louisiana marine laboratory that he built and loved to take on bigger challenges assuages, just a bit, the lingering feelings of guilt about my departure from LUMCON 85 years later.

Upon Morgan's departure, Braxton Honoré Guilbeau, a 24—year old assistant professor of entomology at LSU, was appointed as GBS Director. Guilbeau was born and raised in Breaux Bridge of multigenerational Louisiana heritage, mostly descendants of the Acadian diaspora. He received his bachelor's degree from LSU and had just returned after postgraduate work at Cornell University. As evidenced in the GBS Bulletins, Governor Newton C. Blanchard's annual messages, and numerous press accounts, Guilbeau continued his predecessor's tradition of active promotion and development of GBS. Work by resident biologists and invited experts expanded to include investigations of living resources along the state's long coastline. This extended east to the Chandeleur Islands, where Dr. Milo H. Spaulding of Stanford University was brought in to help assess the potential for scallop and hard clam fisheries. The GBS held a 4—6 week Summer School of Biology specifically oriented to school teach-

ers. Guilbeau, resident biologists, and other experts served as instructors (*Times–Democrat*, February 11, 1906, page 31; *The Weekly Iberville South*, 9 May 9, 1908, page 2). The school was provided free to state residents, but students had to cover their "ordinary expenses," including housing at a Cameron hotel or board and lodging of $4 per week in the newly constructed dormitory. Special courses could be arranged after the summer school session.

On 14 January 1909, Braxton Guilbeau let it be known that he intended to resign as Director and asked that the next Board meeting be delayed until he completed his report and could find all vouchers to be turned over to his successor. Two days later, after asking his wife to bring him a glass of water, he committed suicide by shooting himself in the head while sitting at his desk at home in Baton Rouge ["Guilbeau dead by own hands." *The Times* (Shreveport), 17 January 1909]. He left a widow and 2 young daughters. Fellow LSU professors observed that Guilbeau's mind was over—taxed and he had given way to a morbid despondency as a result of the strain. He seemed preoccupied with his thoughts, walking through their rooms but not speaking. A subsequent audit showed that all of the Station's financial records were accurate and that its funds had been properly and correctly dispersed.

Exactly what happened after Guilbeau's death remains a mystery. The 15$^{th}$ and last Bulletin of the GBS, on oyster culture in Louisiana by resident zoologist W.H. Gates, was published in 1910 and lists Gates as the Acting Director. In 1910, the General Assembly amended the act that created the GBS, merging it with the State Conservation Commission. Two years later, operations at the laboratory ceased and the property reverted to the ownership of Samuel Henry's heirs (Galtsoff 1954). An April 2011 communication to the Board of Commissioners for the Protection of Oysters, Game and Fish asserted that the inland waters of Cameron Parish made an ideal ground for planting oysters, but that the result of the GBS tests and experiments had never been made known ("Cameron inland waters may be ideal oyster territory." *Town Talk*, 22 April 1911). Hope, much like the rejection of inconvenient science, springs eternal!

At the demise of the GBS, its political champion, Samuel Henry, had been dead for 8 years and its scientific mastermind had decamped to Tennessee 5 years earlier. I am sure that Cameron also proved to be a problematic location because of the nature of its environments (dramatic swings in salinity and the muddy Chenier Plain littoral zone), remoteness from the rest of the state, and inaccessibility. Cameron also turned out to be particularly vulnerable to hurricanes after the middle of the 20$^{th}$ century, having been nearly totally devastated by Audrey in 1957, Rita in 2005, and Ike in 2008, each producing 12 to 15 feet of storm surge.

**Second Chance at Grand Isle**

Eighteen years after the demise of Morgan's GBS, Ellinor Helene Behre (Figure 5B), a pioneering woman scientist and LSU professor experienced in research at the MBL, established a marine laboratory on Grand Isle, LA. Born in Atlanta, GA in 1886, and raised there, Behre received her B.A. from Radcliffe College and her Ph.D. from the University of Chicago. Her father Charles Behre, a former pharmacist, relocated to New Orleans in 1909, where he became a prosperous and prominent businessman as the President of the Pelican Ice Company, the largest in the South. After completing her Ph.D., Ellinor took a position as an Instructor at Sophie Newcomb College, the women's college of Tulane University, and frequented summer sessions at MBL from at least 1912 onward. In 1920 she moved to LSU as the first biology faculty member in Louisiana to hold a Ph.D. degree. Behre established the LSU Marine Laboratory at Grand Isle in 1928 and served as its director until 1946, after which she published the oft—cited annotated list of the fauna of the Grand Isle region (Behre 1950).

The Grand Isle laboratory was never intended for year—round use, but primarily for teaching in the summer. It was simply built, with a kitchen, dining room and sitting room on the ground floor and one room for a laboratory and teaching classroom on the upper floor. Parasitologist Harry Bennet took over as director after World War II, and the facility was renamed the Ellinor Behre Field Laboratory. During 1947–1950 a team of researchers used the Grand Isle facility year—round for the TAMU Project Nine investigations and subsequently for the following Project 23 standby effort (Mackin and Hopkins 1961, Hopkins 1980). However, in 1956 the LSU administration pulled the plug and closed down the Grand Isle laboratory. LSU entered into an agreement to use the Gulf Coast Research Laboratory (GCRL) that was then developing at Ocean Springs, MS.

Another early GOM marine laboratory should be mentioned. In 1904, one year after the completion of the GBS in Louisiana, the Carnegie Institution of Washington established a laboratory on Loggerhead Key in the Dry Tortugas (Colin 1980). W.K. Brooks held his CZL summer sessions there in 1905 and 1906 (Conklin 1913). Remote and difficult to reach, the Tortugas laboratory was operated during summer months until it was discontinued in 1939 due to the high costs of maintenance. Nonetheless, 33 volumes of the Papers of the Tortugas Marine Laboratory and many articles in other periodicals were produced covering coral reef biology and geology, fishes, physiology and development, and mangroves.

Let us now turn our attention to the ontogeny and phylogeny of the GOM marine laboratories that are operating today. For this, I will draw from a series of entertaining and informative papers published in 2010 in a dedicated volume of the journal *Gulf of Mexico Science*, which ceased publication in 2018 but is archived at the *Gulf and Caribbean Research* website (www.aquila.usm.edu/goms/). John "Wes" Tunnell and George Crozier assembled and edited that volume and present and future generations of GOM scientists owe them

a debt of gratitude.

**Texas Granddaddy**

In 1941, just before the United States entered World War II, University of Texas Professor Elmer J. Lund constructed a rough—lumber shack on the Corps of Engineers dock at Port Aransas, TX to support his field research, dubbing it the Institute of Marine Science (Gunter and Marsh 1969). Lund was an eminent physiologist who had done research and taught at MBL and the Puget Sound Biological Laboratory and had visited the Stazione Zoologica Napoli and other marine laboratories in France and England. Lund donated 12 acres of land on which the University built its first permanent research station, the present—day University of Texas Marine Science Institute (UTMSI, Haberer et al. 2010).

Gordon P. Gunter (Figure 6A) was a Ph.D. student under Lund, even as he conducted studies of coastal fishes for the Texas Game, Fish and Oyster Commission in Rockport, TX. To work with him in Rockport, Gunter brought in Joel W. Hedgpeth (Figure 6B), a friend with whom he had explored in California and who had recently completed his master's degree at the University of California in Berkeley. In his oral history, Hedgpeth (1996), a legendary and colorful character in marine ecology, tells the story of when Lund came to him in Rockport one Thursday or Friday in 1946 and asked him to relocate to Port Aransas on the next Monday because they needed someone in residence to meet fire insurance requirements. Hedgpeth made the move and registered as a doctoral candidate under Professor Lund. After a while, he discovered that Lund was in hot water with the university administration and had greatly antagonized his fellow faculty members in Austin. Sensing that this could mean trouble, Hedgpeth decided to complete his Ph.D. at the University of California, writing his dissertation on research he had conducted on the Texas coast. Professor Lund was, indeed, expelled from the faculty in 1949, but became quite wealthy from investments in real estate in Austin. He retired to Port Aransas, where he conducted his independent research on oysters. With Lund's separation, Gordon Gunter served as the acting director from 1949 until he was appointed director in 1954 (Haberer et al. 2010). He did not remain long, moving to become Director of GCRL in Mississippi in 1955.

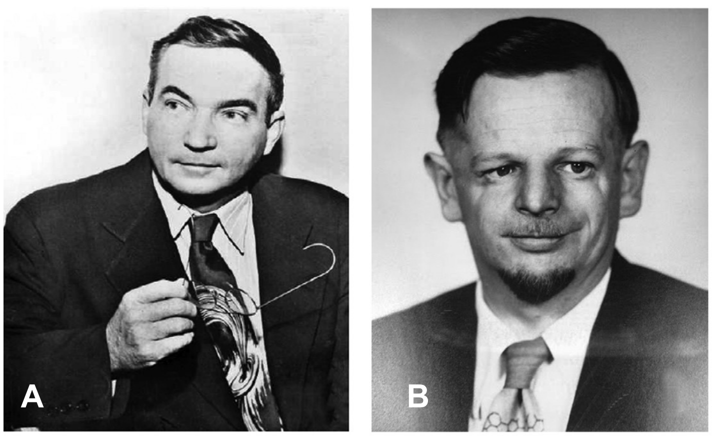


*Figure 6. Influential mid-20th century GOM marine scientists. A. Gordon Gunter. B. Joel Hedgpeth.*

To this aspiring marine ecologist studying at Tulane University during the mid—1960s, Hedgpeth and Gunter were giants because of their role in producing the "Big Red Book," the first volume of the *Treatise on Marine Ecology and Paleoecology* (Hedgpeth 1957). Written by national and international luminaries of the 1950s, the Treatise was still the only comprehensive reference in marine ecology at that time. Hedgpeth was the editor and author of 6 chapters and Gunter authored the chapters on salinity and temperature. Gunter was instrumental in enlisting Hedgpeth as the editor for the effort, which had been languishing for many years under a committee of the National Academy of Sciences. As a result of their involvement, the *Treatise* provided more insights and examples from the GOM than one might expect. Hedgpeth and Gunter also made contributions to another of the bibles in my nascent library that was published around the same time, *Gulf of Mexico: Its Origin, Water, and Marine Life* (Galtsoff 1953). Hedgpeth wrote chapters on bottom communities and several obscure invertebrate phyla and Gunter wrote the chapter on mammals. I was a little daunted when early in my career I got to meet each of these eccentric pioneers.

As had been the tradition at European marine laboratories and the MBL, Professor Lund initiated a periodical, *Publications of the Institute of Marine Science*, to present the results of the laboratory's research. The first volume, published in 1945, consisted only of Gordon Gunter's studies of marine fishes of Texas. By then, Gunter had become a research associate at UTMSI since Lund had started the tradition of having a small number of research scientists in continuous residence at the marine laboratory. The second volume was not published until 1950 and it and subsequent volumes contained multiple papers by Gunter, Hedgpeth and other scientists based at the laboratory. Hedgpeth's (1953) marvelous zoogeography of the northwestern U.S. GOM—as much ecology as biogeography—mesmerized this aspiring Gulf ecologist with its hand—drawn and lettered figures. The *Publications* also began to include additional articles on the flora, fauna, and hydrology of the coastal GOM written by scientists not affiliated with the laboratory. In this way, the UTMSI was for many years the leading catalyst for advancing GOM science. Following Gunter's departure, Howard T. Odum, the younger and more heretical brother of Gene, became Director at UTMSI. There, for the next 7 years, he pioneered his approach to ecosystem metabolism and energy flow in studies of the Texas coast.

**Ocean Springs**

In 1947, Dr. Richard Claytor, a professor at Delta State Teachers College and persistent advocate for a marine research facility on the Mississippi coast, held the first official summer session of the GCRL at Magnolia State Park under

the auspices of the Mississippi Academy of Sciences (Shaw 2010). Three years later, the location of the main campus was purchased and the Mississippi Legislature enacted formal statutes creating the Laboratory under the Board of Trustees of State Institutions of Higher Learning. In 1988, the direct administration of GCRL was transferred to the University of Southern Mississippi (USM), where it is now a unit of the School of Ocean Science and Engineering. Oyster biologist Aubrey E. Hopkins was appointed GCRL Director in 1952, secured funding for a teaching laboratory and research vessel (the R/V *Hermes*, just retired in 2019), and began to hire resident scientific staff. He died in 1955 and the new Mississippi enterprise recruited Gordon Gunter from UTMSI.

Gunter was not unfamiliar with these parts. He was born and raised in Louisiana and had conducted research on oysters and shrimp around the Mississippi River delta when he worked for the U.S. Bureau of Fisheries in the 1930s and later as part of TAMU Project Nine. He had studied the effects of the opening the Bonnet Carré Spillway on Mississippi Sound—an issue of great interest currently because of its more frequent and prolonged use to prevent flooding along the lower Mississippi River—and had already developed his concept of the "fertile fisheries crescent" along the Louisiana and Mississippi coasts. Gunter was GCRL Director for the next 16 years, building its facilities and stable of resident scientists. When I was an undergraduate around 1966, I visited GCRL to examine specimens in its collections. Dr. Gunter spied me among the shelves and gruffly asked what the hell I was doing there. Shaking in my Weejuns, I told him what I was working on and ensured him that my visit had been prearranged by my mentor, Tulane professor Al Smalley. Mentioning Al seemed to help and, as he let me be, Gunter admonished me not to break anything and put everything back where I found it. More than 10 years later, I attended a Department of Energy workshop on the GOM. When we young Turks reported out our research ideas, Gordon, then about 70, repeatedly opined that they had tried that over 20 years earlier, it did not work then and would not work now!

Gunter was born almost exactly a year after my own father and both men were proud southerners of their era. Gordon remained a stronger devotee of the Lost Cause, serving as an officer in the local chapter of the Sons of Confederate Veterans and defender of displays of the Stars and Bars (Shaw 2010). Recounting this, the more progressive Joel Hedgpeth (1996) reminisced: "We are still friends, though I must say, his politics is something." Reflecting on this, I thought about how far our society has come while attending the laying of the keel ceremony for the new National Science Foundation oceanographic research vessel for the Gulf and Caribbean. The R/V *Gilbert R. Mason* will be operated by USM and LUMCON. Namesake Gilbert Mason was an African—American physician who led the "Biloxi wade—ins" that took place between 1959 and 1963 to protest segregation. His granddaughter Aria Mason, the sponsor of the new vessel, participated in GCRL's marine education program in her youth.

**Beyond Panacea**

In 1949, two years after GCRL's first summer session and just after the Florida State College for Women had been transformed into a co—educational institution, the Florida State University (FSU) formed The Oceanographic Institute. Its mission was to train graduate students, provide marine research facilities, conduct basic research in the northeastern U.S. GOM, and conduct applied research toward improving Florida's fishing industry and developing other marine resources (Greenberg et al. 2010). Harold J. Humm, a marine botanist who was the resident director of the Duke University Marine Laboratory (DUML), was recruited as the Institute's director, and a marine laboratory was soon under construction at Alligator Harbor, FL, 43 miles from the FSU main campus in Tallahassee. For a while, The Oceanographic Institute also operated another U.S. Gulf Coast field station on Mullet Key at the mouth of Tampa Bay. In 1954, Humm left FSU "precipitously" and returned to Duke, but among the young students he inspired was "Her Deepness," the ocean explorer Sylvia Earle, an FSU undergraduate who later completed her Ph.D. under Humm at Duke. Among the marine science graduate students at FSU at the time were my former VIMS colleagues, William J. Hargis, Marvin L. Wass (my major professor) and Frank O. Perkins. Perkins was Hargis' successor as VIMS Director and the namesake of *Perkinsus marinus*, the oyster disease organism known as Dermo that was discovered through the TAMU Project Nine investigations.

In the late 1950s the eminent ecologist Robert T. Payne, then a graduate student at the University of Illinois, conducted much of his dissertation research on the burrowing brachiopod *Glottidia pyramidata* at the Alligator Harbor Laboratory. There he became fascinated with the complex relationships among predatory gastropods living on the sand bars at the mouth of the harbor, that inspired his later work on how keystone species structure communities through predator—prey interactions. Until Payne's death in 2016, he remained an advisor to the FSU laboratory. Greenberg et al. (2010) chronicle many other important scientific advances made using what is now known as the Florida State University Coastal and Marine Laboratory (FSUCML).

Further highlighting the small world of GOM marine science and interconnections among the marine laboratories of the region, in 1962, FSU recruited Albert Collier as the director of The Oceanographic Institute. Collier had been a staff biologist at the TAMU Marine Laboratory in Galveston (TAMUG) that was initiated in 1952 and moved into a World War II surplus building at Fort Crockett in 1957 (Ray 2010). Collier left the directorship of the Institute for the FSU Biology Department in 1964 and Carl Oppenheimer, a microbiologist who worked at the UTMSI between 1957 and 1961, was brought in as director. He oversaw the funding, design and

construction of a replacement marine laboratory at Turkey Point, 9 miles to the west. The move provided more space and vessel accessibility as the entrance to Alligator Harbor had become occluded by the sand bars that so fascinated Payne. Oppenheimer, a Scripps—trained oceanographer, expected to develop a major seagoing research program, including docking for an ocean research vessel. In 1971 Oppenheimer returned to Port Aransas as the director of the UTMSI for less than 2 years when he joined several other ex—directors on the faculty there.

**Shuffleboard City Transformed**

Unlike other U.S. GOM marine laboratories, the FSUCML remained, until recently, more of a base to support field and experimental research and courses. Both its locations were about a one—hour drive from the main campus in Tallahassee. Only since 2006 has FSUCML had a director and researchers in full—time residence. Down the Florida coast, an alternate approach developed, when in 1967 Harold Humm came back down south to start the Marine Science Institute for the University of South Florida (USF, Muller—Karger et al. 2010). Based in a former Merchant Marine training station on the shores of Tampa Bay near downtown St. Petersburg, the resident faculty quickly grew to the point of becoming the College of Marine Science (USF—CMS) by 2000, now by far the largest marine science program located on the U.S. Gulf Coast. While USF—CMS reports to the main campus across the bay in Tampa, the USF St. Petersburg campus has grown around it. The state's Fish and Wildlife Research Laboratory and the Florida Institute of Oceanography, which operates research vessels and the Keys Marine Laboratory for Florida's public universities, are co—located there. Branches of the U.S. Geological Survey and National Marine Fisheries Service (NMFS) were attracted to locate nearby, creating a sizeable marine science campus adjacent to revitalized downtown St. Petersburg.

**Fourth Time's A Charm**

In 1963 the University of Alabama hired George A. Rounsefell, a noted fishery scientist recently retired from the Bureau of Commercial Fisheries after serving as director of its Biological Laboratory at Galveston, to develop a marine laboratory (Shipp et al. 1977). Attempts to establish a joint facility on Dauphin Island with the Alabama Department of Conservation and Natural Resources ended badly, and a laboratory was initiated on a quarters barge across Mississippi Sound on Point aux Pins, but ceased after a destructive fire in 1971 (Crozier and Dardeau 2010). Coincidentally, the U.S. Air Force declared the radar station at the eastern end of Dauphin Island surplus property and the Marine Environmental Sciences Consortium (MESC), consisting of the University of Alabama, the University of South Alabama, Troy State University, Auburn University, and 13 other institutions, was formed to operate what became known as the Dauphin Island Sea Lab (DISL) at the site.

After a few short—term directors, George F. Crozier (Figure 7A), a veteran from the early days at Point aux Pins, was select-


***FIGURE 7.*** *Long serving GOM marine laboratory directors. A. George Crozier of Dauphin Island Sea Lab. B. Kumar Mahadevan of Mote Marine Laboratory.*

ed as the DISL director in 1977 and served in that capacity for the next 34 years, surely a record among marine laboratories in the GOM and probably nationally. Like me, George is a native of New Orleans. He graduated from Loyola University of the South and I graduated from Tulane University, just next door and 4 years later.

Functioning as a consortium to serve the needs of Alabama's multiple universities and its citizens, DISL has operated as a multifaceted hybrid. It has a relatively modest complement of research scientists in full—time residence—most with professorial appointments at the principal member universities—and also facilities and residences for use by visiting researchers. It is not degree—granting, but offers undergraduate and graduate courses in summer and year—round. Its resident scientists do, however, supervise graduate student research. DISL and GCRL also have the largest programs on the U.S. Gulf Coast for K—12 educational experiences that accommodate overnight stays. The Estuarium, an education—oriented public aquarium, is operate by DISL for broader public outreach. Finally, DISL scientists engage rather directly and frequently with Alabama's environmental and natural resources managers.

**New Kids**

Nancy Rabalais, one of my successors as LUMCON Executive Director, dubbed it the "relatively new kid on the block" (Rabalais 2010. Its concept borrowed heavily on the multi—institutional organizational model of Alabama's MESC. Earlier I reflected on my experiences in getting the LUMCON Marine Center "off the ground." Although its growth has been constrained by funding, LUMCON researchers have played key roles in regional research on deltaic wetlands, fisheries and, in particular, continental shelf hypoxia. The Marine Center has also provided a venue for many thousands of Louisiana students to learn about their otherwise inaccessible coast.

The University of Florida (UF) has since 1950 conducted field research and brought undergraduate and K–12 classes to its marine laboratory at the old lighthouse on Seahorse Key

off Cedar Key. In 1997, UF began operating the Nature Coast Biological Station on Cedar Key to support research. An even newer kid on the block is the Harte Research Institute for Gulf of Mexico Studies at Texas A&M University–Corpus Christie (TAMUCC), established in 2000 as result of a $46 million donation by Mr. Edward H. Harte (Tunnell 2010). The Harte Institute seeks to provide international leadership in generating and disseminating knowledge about the GOM and its economic role. It has sponsored or inspired many activities that include Mexican, Cuban and U.S. scientists. In addition, it provides valuable services to the GOM scientific community such as GulfBase, a database of people, places, projects, events and organizations, and the Gulf of Mexico Research Initiative Information and Data Cooperative. In addition to the above university—affiliated laboratories with a resident faculty engaged in research, there are a number of others that function primarily as a location for undergraduate education and research and public outreach. These include laboratories operated by the University of Texas Rio Grande Valley, Lamar University, Eckerd College, New College of Florida, and Florida Gulf Coast University (Table 2).

**Going It Alone**

The marine laboratories discussed thus far are all affiliated with public universities (except for Eckerd College), but the privately—owned Mote Marine Laboratory (MML) in Sarasota, Florida has stood the test of time. Although there were privately supported field stations along the southwest coast of Florida as early as the 1930s, MML marks its origins from the formation of the Cape Haze Marine Laboratory at Placida in 1955 by the "Lady with a Spear," Eugenie Clark, with financial support from members of the Vanderbilt family (Mahadevan 2010). Five years later the laboratory moved to Siesta Key, near Sarasota, and for a while Sylvia Earle was the interim director. In 1967, with the philanthropy of William R. Mote and the direction of Cornell University shark researcher Perry Gilbert, the laboratory transitioned from a field station to a permanent research center as the MML, which relocated to is present location on City Island in 1978. My fellow benthic ecologist Kumar Mahadevan (Figure 7B) became director in 1986 and served in that capacity for 27 years, nearly as long as George Crozier. Kumar has been an enthusiastic and tireless promoter of the laboratory to the retirees and donors needed to sustain its core financial support in lieu of a supporting government or university. Research on local environmental issues such as red tide and the effects of development and Everglades drainage on coastal ecosystems was a focus of MML, but since has expanded into aquaculture and biotechnology. MML also has an aquarium and large public outreach program, oriented not only to K—12 students, but also to all those wealthy retirees.

**Metamorphoses of Federal and State Marine Laboratories**

Even though this reflection is mostly about academic research laboratories, let us briefly consider the government's applied research laboratories in the U.S. Gulf, as they have important commonalities as well as differences and often interact with academic laboratories. The government laboratories initially focused on marine fisheries and most still do. Over the years they have had to adapt not only to the changing priorities of parent agencies, but also to occasional government reorganization and lapses of attention. In 1970, President Richard Nixon brought together weather, coastal charting and fisheries bureaus that were dispersed across different departments into one agency, the National Oceanic and Atmospheric Administration (NOAA). Before then, federal responsibilities for fisheries were located in the U.S. Fish and Wildlife Service (FWS) of the Department of the Interior.

In 1929, the FWS Bureau of Commercial Fisheries (BCF) established a field station on Offatts Bayou on Galveston Island, TX, focusing on oyster research under the direction of Aubrey E. Hopkins. In 1931, it became one of 4 field stations conducting shrimp research in the U.S. Gulf, directed out of New Orleans. In 1937, Hopkins established the Pensacola Fisheries Biological Station in a decommissioned quarantine facility located on an island built on ballast rocks in Santa Rosa Sound, south of Gulf Breeze, FL (Jordan and Wilhour 2010). Recall that Hopkins became the director at GCRL in 1952, thus completing a trifecta of directing laboratories in 3 U.S. Gulf States. Both the Galveston and Gulf Breeze laboratories are still in operation as the major federal marine laboratories on the GOM, now the NOAA National Marine Fisheries Laboratory at Galveston and the Gulf Ecosystem Measurement and Modeling Division of the U.S. Environmental Protection Agency (EPA) at Gulf Breeze.

In 1950, the BCF Biological Laboratory Galveston moved to its present location at U.S. Army's Fort Crocket (Zimmerman 2010). The base was originally established as a garrison during the Spanish—American War in 1897 and it housed troops during both world wars and served as a German prisoner—of—war camp during World War II. Soon after the move, Albert Collier assumed the position of director, but George Rounsefell was brought in in 1956 to address complaints that the laboratory was not publishing enough. The next year, Collier moved next door to head the TAMU Marine Laboratory when it also moved into the Fort Crockett complex, and Rounsefell took over the Federal fisheries laboratory. According to Gordon Gunter, the replacement of well—regarded Collier did not sit well with the staff and Rounsefell bore their resentment (Shipp et al. 1977). As mentioned earlier, Collier left Galveston Island for FSU in 1962 and Rounsefell for the University of Alabama in 1963. The TAMU Laboratory was absorbed into the College of Marine Sciences and Maritime Resources, which became the foundational element of TAMU at Galveston (TAMUG). In 2010, its marine science program moved from Fort Crockett to new quarters on the TAMUG campus on Pelican Island, across from the Port

of Galveston (Ray 2010).

The Galveston Biological Laboratory once had field stations at Pascagoula, MS, and Miami and St. Petersburg, FL. With the incorporation of the FWS marine fisheries programs into NOAA in 1970, the laboratory became the Gulf Coastal Fisheries Center and managed these field locations, as well as the laboratory of the FWS Bureau of Sport Fisheries established at Panama City, FL in 1966 (Zimmerman 2010, Sheridan and Davenport 2010). Later the Southeast Fisheries Science Center was designated in Miami, with the Galveston, Pascagoula and Panama City laboratories as subsidiaries. Over the years the Galveston Laboratory has had to shift its research programs—sometimes dramatically—in response to the priorities of its parent agency (Zimmerman 2010). Initial work focused on life histories and distributions of shrimp species. After a major red tide outbreak along the west coast of Florida in the late 1940s, the focus switched to research on the biology and control of *Karenia brevis.* A major program on shrimp aquaculture began in the 1960s, but after it was phased out in the late 1970s, the laboratory was threatened with closure. Controversies regarding bycatch mortality of listed species of sea turtles led to research on turtle conservation and on fisheries bycatch more generally. Delineation of essential fish habitat and multispecies stock assessment are current mission priorities.

Meanwhile, the FWS Pensacola Fisheries Biological Station on Sabine Island, under direction by A.E. Hopkins for a decade and then for 20 years by Philip A. Butler, conducted research on the biology of oysters and other mollusks, expanding after 1960 into broader studies of estuarine ecology (Jordan and Wilhour 2010). Gulf Breeze became a national center for monitoring and research related to the effects of DDT on marine life and was transferred in 1970 to the newly created EPA in the interagency cross—shuffling with NOAA. The laboratory has endured several wrenching shifts in organization. With the Trump administration reorganization in 2018, it is now known by this mouthful: Gulf Ecosystem Measurement and Modeling Division (GEMMD) of the Center for Environmental Measurement and Modeling of EPA's Office of Research and Development. As at Galveston, the mission of the laboratory at Gulf Breeze has shifted over the years. Long a center for toxicological research, it has also engaged in predictive toxicology, coastal assessments, and nutrient pollution research. In its current configuration, its relevant research includes a human well—being index, ecosystem services, coral reef condition, coastal condition assessment, and watershed stressors.

Marine laboratories on the U.S. Gulf Coast operated by state agencies also primarily focused on fisheries development and management. As mentioned earlier, in the early 1940s both Gordon Gunter and Joel Hedgpeth worked at the Rockport Marine Laboratory, initiated in 1935 on a houseboat and operated by the Texas Game and Fish Commission, later the Texas Parks and Wildlife Department. While work continues there, the Department's fisheries research now takes place at multiple stations distributed along the expansive Texas coast. The Louisiana Department of Wildlife and Fisheries operated a marine laboratory on Grand Terre Island from the early 1950s. Grand Terre, which cannot be reached by road, is the island where the legendary pirate Jean Lafitte and his band of Baratarians had their headquarters. The laboratory was adjacent to the ruins of Fort Livingston. Operations ceased there in 2005 after the island suffered severe erosion and the laboratory incurred substantial damage as a result of Hurricane Katrina (Figure 8). The replacement Grand Isle Fisheries

***FIGURE 8.*** *The Grand Terre Laboratory of the Louisiana Department of Wildlife and Fisheries was abandoned after Hurricane Katrina.*

Research Laboratory was completed on that more accessible barrier island in 2009.

The Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission (McRae 2010) is the largest state marine laboratory on the GOM. It originated as a small outpost on Bayboro Harbor in St. Petersburg, established by the University of Florida to study the red tide scourge. This was taken over by the State Board of Conservation and over the years the scope of its research expanded to include a wide range of the state's fishery resources, with several field stations around the state. The institute was nearly closed in 1972 because of lack of funding, but after 1980 grew stronger through the leadership of Karen A. Steidinger, a world—recognized red—tide researcher. In a taxonomic revision, the genus of the culprit organism, *Karenia brevis*, was named in her honor. It was Steidinger who partnered with USF to expand the co—located facilities of the Institute and the university's College of Marine Science.

**Marine Laboratories in Mexico, Cuba and the Caribbean**

Marine laboratories along the GOM coasts of Mexico and Cuba are relatively few in number. In Mexico, the Autonomous University of Campeche established the Program for

Ecology, Fisheries and Oceanography of the Gulf of Mexico in 1990 (Villalobos Zapata et al. 2010). The National Polytechnical Institute has since 1997 operated a field station at Telchac, Yucatan (Chávez 2010). The University of Veracruz initiated the Institute for Marine Sciences and Fisheries at Boca del Rio in 2009 (Arenas Fuentes and Lozano Aburto 2010). However, the laboratory best known internationally is the Station of Marine Research in Ciudad del Carmen in the state of Campeche that has been operated since 1969 by the National Autonomous University of Mexico (Escobar Briones and Lecuanda 2010). The Station has supported extensive research on mangroves and seagrass beds in Laguna de Tèrminos and offshore waters in the Campeche Bay, including collaboration with U.S. researchers, notably including John Day and Robert Twilley at LSU and some of my UMCES colleagues as well.

In Cuba, a Laboratory of Marine Biology was established in 1962 under the Cuban Academy of Sciences in conjunction with a small aquarium in the western part of Havana (Claro 2010). This grew into the Institute of Oceanology in 1965 and linkages with the University of Havana were built. Building Cuba's scientific and technical capacity has been a major focus. Investigations extended onto the continental shelf and Campeche Bank. International collaborations were initially limited to the Soviet Union and other Eastern Bloc nations, but have gradually expanded to include Mexico and, more recently, organizations and universities in the United States. The Harte Institute at TAMUCC has provided a significant catalyst in bringing marine science in Cuba, Mexico and the U.S. together in collaboration.

Of course, there are other marine laboratories on the American Mediterranean Sea, including mostly small field stations around the shores and on the islands of the Caribbean Sea. The Association of Marine Laboratories of the Caribbean has over 20 of these as members, including laboratories or field stations in the Bahamas, Turks and Caicos, Dominican Republic, Puerto Rico, the U.S. Virgin Islands, St. Kitts, St. Eustatius, Barbados, Grenada, Cayman Islands, Jamaica, Curaçao, Bonaire, Venezuela, Panama, Costa Rica, and Belize. The Association provides a forum among research, education and resource management institutions for the production and exchange of science (e.g., Cortés et al. 2019), advancement of regional education, and cooperation and mutual assistance.

## Recent Evolution of Gulf Marine Laboratories

### Organization

The marine laboratories of the U.S. Gulf Coast in current operation (Table 2) range greatly in the size of facilities and scientific and support staff. They also differ with respect to their parent organizations, whether they are institutions of higher education, private corporations, or state and federal agencies. A few of the higher education laboratories are essentially field facilities that support student training, sampling or experimentation but without senior research scientists in full–time residence. Over 150 scientists holding professorial or equivalent rank are in residence at the 10 major academic laboratories, including MML. Over 50 additional Ph.D.–level scientists and 250 graduate students also conduct research and training at these laboratories. Annual operating expenses exceed $120 million and sponsored research $60 million.

Organizational administration of the 9 university–affiliated marine laboratories varies considerably. Arrangements include a separate college (USF–CMS), departments within a science college (UTMSI and TAMUG), a division within a school of ocean science and engineering (GCRL), a field station for the university as a whole (FSUCML) or its food and agriculture programs (UF), and two public university consortia (MESC in AL and LUMCON in LA). One of these laboratories is on the campus of its parent institution (the Harte Institute at TAMUCC). Others are within an hour's drive (USF–CMS, FSUCML, DISL for the University of South Alabama) or two hour's drive (UF, USM–GCRL) from the doctoral research universities with which they are affiliated. UTMSI, LUMCON and DISL (for University of Alabama and Auburn University) are more than 2 hours away. Below I consider the numerous ways that organizational models and proximity influence laboratory operations.

### Facilities

Facilities of most current U.S. Gulf marine laboratories are a far cry more substantial and capable than what existed in the 1970s. Several repurposed buildings from the World War II era or earlier are still in use at the NOAA Galveston laboratory, DISL, the EPA Gulf Breeze laboratory and USF–CMS. Hundreds of millions of dollars in investments have been made since the 1970s for modern research facilities each at UTMSI, TAMUCC, TAMUG, LUMCON, USM–GCRL, USF–CMS and MML. Armed with instrumentation, information technology and connectivity, U.S. Gulf Coast marine laboratories are generally equipped to perform state–of–the art analyses, but offer opportunities for regular and continuous field and mesocosm measurements not possible on university campuses inland.

Because marine laboratories are situated adjacent to coastal waters, they all share a vulnerability to tropical cyclones and sea–level variability and rise. Hurricanes and tropical storms have disrupted the activities of virtually all U.S. Gulf Coast laboratories, several of which have incurred major damage. While the UTMSI was damaged during past hurricanes such as Carla (1961) and Celia (1970), it received $45 million in damages during Harvey in 2017. The main floor of LUMCON's Marine Center is elevated 5.5 m above ground level and storm surges have only damaged ground level infrastructure, however in 1992 Hurricane Andrew caused substantial wind and water damage when airborne debris broke thick glass window walls and winds peeled back its roof. GCRL suffered significant damage during hurricanes Camille (1969)

and Katrina (2005). Even before Hurricane Katrina, USM had acquired the Cedar Point campus for future expansion from the more exposed and lower—lying Halstead Road campus of GCRL, a 4—mile drive away. Access to DISL was disrupted for 3 years when Hurricane Frederic (1979) destroyed the bridge connecting the mainland to Dauphin Island—dubbed the unluckiest island in America because of the recent frequency of storm damage. The FSUCML was damaged by storm surge from Hurricane Dennis in 2005. Although the west coast of the Florida Peninsula escaped major tropical storms for many years, MML suffered damage from Hurricane Irma in 2017. Given the severity and frequency of the risks, all U.S. Gulf coast marine laboratories have rigorous protocols for hurricane preparedness that require initiation of actions to minimize damages and disruptions to research well in advance of an approaching storm. As often as not, the storm might weaken or veer in another direction, but it requires an additional day or more to resume operations: precautionary losses of time that are recurring, but prudent.

Relative sea—level rise poses risks to low—lying marine laboratories, contributing to increased and more frequent flooding unrelated to tropical storms. The extreme example is the LUMCON Marine Center located near the distal edge of a deltaic plain, with vast expanses at very low elevation and underlain by more than 50 meters of consolidating Holocene sediments. Since its construction 35 years ago, the land has subsided such that the parking lot and ground level infrastructure are often inundated under southerly winds. This is likely to occur several dozen times per year over the next 10–15 years (Kolker et al. 2019). Adaptation will require raising the elevation of the parking lot and reconfiguration of elevator access to the laboratory and housing spaces, but the highway providing access to the laboratory is also occasionally inundated. LUMCON plans to build another facility just south of Houma, 45 km inland, that will provide room for sensitive analytical equipment and workspace for scientists and support staff when the Marine Center is inaccessible. The plight of the Cocodrie laboratory has recently received national press attention by National Public Radio and the *New York Times* as a harbinger of things to come for marine laboratories and other facilities required to be located on the coast.

**Globalization in Research**

The ontogeny of U.S. Gulf Coast marine laboratories is replete with directors moving from one developing laboratory to another. Whether this represented constructive cross—fertilization or inhibitory inbreeding, it is clear that the U.S. Gulf research enterprise has changed dramatically since those early decades. A substantial majority of research scientists working at U.S. Gulf marine laboratories today had graduate training and early career experience outside of the U.S. Gulf states. Numerous researchers are foreign—born and some of these hold graduate degrees from institutions outside of the United States.

Perhaps even more significant to the nature of the enterprise, is that researchers at U.S. Gulf laboratories are likely to see themselves primarily as a part of a global community of scientists in their disciplines rather than as a part of a regional community of marine scientists. They publish primarily in international journals and their preference is to attend national rather than regional scientific meetings. They compete nationally for research funding and know that securing an NSF or National Institutes of Health grant is important to their career advancement. While their institution provides at least some salary support as well as facilities, it generally does not provide funding for graduate and research assistants and field, laboratory and travel costs. Investigators need to secure external support for these necessary components of their research. This can create a situation where principal investigators see themselves as an independent small business, more attentive to program officers and peer reviewers, than as a part of an institution. Don't get me wrong. Overall, the globalization of U.S. Gulf science has had a very positive effect on the caliber of researchers and their science, but it can come at a cost to the mission of an institution and its responsiveness to clients within the university, state and citizenry.

The U.S. Gulf science community is now in the midst of an experiment. It will be interesting to follow its long—term outcome. I am referring to the consequences of the substantial increase in research and scientific assessment that followed the *Deepwater Horizon* explosion and oil spill in 2010. Some scientists based at U.S. Gulf Coast marine laboratories received rapid response grants from the NSF or other federal sponsors. Many were involved in assessing the damages to natural resources, under contract by federal or state agencies or the responsible party, BP. Still more were involved in the Gulf of Mexico Research Initiative (GoMRI) for which BP provided $500 million to investigate the impacts of this unprecedented oil spill on GOM ecosystems (Shepard et al. 2016). Most of the GoMRI funds came via grants to 15 research consortia, supported over 3—9 year periods. Eight of these consortia were led by units overseeing marine laboratories (UTMSI, TAMUG, LUMCON, USM—GCRL, DISL and FSU), although most consortia included participants from universities. There were additional research grants to individual investigators or small groups. In all, Deepwater Horizon oil spill studies resulted in a huge emphasis on research on the fate and effects of oil and chemical dispersants. They also supported a substantial cohort of graduate students at U.S. Gulf institutions, in evidence at large Gulf of Mexico Oil Spill & Ecosystem Science Conferences sponsored annually by GoMRI from 2013 through 2020. As it concludes, GoMRI is presently synthesizing results and assessing its legacy. How will U.S. Gulf marine laboratories be influenced over the long term after this spike in research funding and expansion of graduate training? Can the gains be sustained?

Extensive efforts in environmental restoration in the U.S.

Gulf will continue longer into the future, fueled by criminal plea agreements with the parties responsible for the 2010 blowout and settlement for Clean Water Act violations and Natural Resource Damages. Altogether, these will provide over $15 billion through the early 2030s for wetland and barrier island restoration, diversions of Mississippi River sediments, and recovery of resources ranging from offshore fish populations to oyster reefs to marine turtle populations (Henkel and Dausman 2020). These provide new opportunities for marine laboratories to conduct research to guide effective restoration design and monitor outcomes (NASEM 2017) and contribute to public education.

Under the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies Act, funds derived from Clean Water Act penalties also support a NOAA Science Program and Centers of Excellence in each GOM state. Good and useful research is being conducted at U.S. Gulf marine laboratories under support by both programs. However, the requirement to broadly subgrant funds makes it unlikely to result in centers that become renowned in a certain field, which seems to me was the original Congressional intent. Under the plea agreement, a fixed—term endowment of $500 million was established within the National Academies of Sciences, Engineering and Medicine (NASEM) to support a Gulf Research Program (GRP). To this point GRP has mainly sponsored early—career fellowships and relatively small research grants. The GRP, which has 25 years of its 30—year lifetime remaining, should consider the role of U.S. Gulf marine laboratories in addressing the long—term energy, environmental, and social future of the GOM. From my perspective formed in marine laboratories and as a former member of the GRP Advisory Board, this seems ripe for partnership.

**Education at Multiple Levels**

In my 37 years of experience in higher education governance in Louisiana and Maryland, I cannot think of programs providing a broader scope of delivery of education than marine laboratories. Most are engaged in research intensive graduate education and some also participate in non—thesis degree programs. Many are engaged in undergraduate education, at least by continuing the tradition of field trips, summer courses and research experiences for undergraduates. Some are located on campuses offering undergraduate degrees (e.g., TAMUG and TAMUCC). Marine laboratories are beginning to offer instructional programs for professional development, ranging from short courses to professional master degrees. What really sets marine laboratories apart—yet not often recognized or valued by provosts, presidents and regents—is their engagement in "pre—K to gray" education. Most U.S. Gulf Coast marine laboratories have active educational programs for thousands of K—12 students and hundreds of their teachers each year, bringing learners to the laboratories from the whole state and even beyond. In addition, some laboratories have mobile or online educational programs that extend their reach even further. Marine laboratories are attractive and effective in reaching adult audiences, from the affluent retirees in Sarasota, FL to the imperiled bayou communities of south Louisiana.

**Public Policy at the Frontline**

Through research and synthesis, U.S. Gulf Coast marine laboratories develop knowledge to inform public policy related to environmental protection, living resource uses, human health, economic and social development, and adaptation to coastal change. While this also occurs on large university campuses, marine laboratory scientists have a front—row seat within this often—contentious coastal interface, with no opportunity to retreat to the ivory tower. To an extent, marine laboratory scientists function as extension agents, living and working in communities along with fishers, oil field workers, and those dependent on the tourist economy, right alongside waterfront property owners and victims of hurricanes and environmental injustice. Keep in mind that environmental science can become a contact sport. During the 1980s a number of scientists I knew were physically threatened by irate shrimpers required to use turtle excluder devices.

**Research Vessels**

As ocean portals, marine laboratories or associated units operate most of the region's research fleet. Of the research vessels exceeding 15 m (50 feet) in overall length currently operated by academic institutions (Table 3), the first 3 are

***TABLE 3.*** *Research vessels over 15 m length overall that are operated by academic marine laboratories along the U.S. Gulf Coast.*

| Research | Length (meters) | Year Constructed | Operating Institution |
|---|---|---|---|
| *Point Sur* | 41.1 | 1981 | Louisiana Universities Marine Consortium for The University of Southern Mississippi |
| *Pelican* | 35.3 | 1985 | Louisiana Universities Marine Consortium |
| *Weatherbird II* | 35.0 | 1981 | Florida Institute of Oceanography |
| *Tommy Monroe* | 29.9 | 1981 | The University of Southern Mississippi – GCRL |
| *W.T. Hogarth* | 23.8 | 2017 | Florida Institute of Oceanography |
| *Trident* | 21.3 | 2015 | Texas A&M Galveston |
| *Alabama Discovery* | 19.8 | 2008 | Dauphin Island Sea Lab |
| *Apalachee* | 18.3 | 2013 | Florida State University Coastal and Marine Lab |
| *Jim Franks* | 18.3 | 2016 | The University of Southern Mississippi – GCRL |
| *Acadiana* | 17.7 | 1986 | Louisiana Universities Marine Consortium |
| *Katy* | 17.3 | 1981 | University of Texas Marine Science Institute |

capable of operating in the Gulf and Caribbean and beyond; the others can operate at least across GOM continental shelf waters. In addition, NOAA's fisheries research and survey vessels, *Gordon Gunter* (74.4 m), *Pisces* (63.4 m), and *Oregon II* (51.8) are homeported at the Gulf Marine Support Facility in Pascagoula, MS. All three NOAA vessels and all but 2 of the academic research vessels (*Point Sur* and *Alabama Discovery*) were constructed by the U.S. Gulf Coast's highly capable shipyards. The aluminum catamarans *Trident*, *Apalachee* and *Jim Franks* were built at the same New Iberia, LA shipyard.

I am particularly proud of the 35 years of outstanding service of the R/V *Pelican* (Figure 9A) as I was responsible for completing its design, funding, construction and placement into service. Overcoming obstacles, we were able have the *Pelican* designated a University—National Oceanographic Laboratory System (UNOLS) vessel, facilitating its support of research sponsored by NSF and other federal science agencies. It is the only U.S. Gulf—based vessel currently in UNOLS and has earned a reputation for the "can—do" attitude of its South Louisiana crew, maintaining a nearly full schedule when usage of many oceanographic vessels was in decline. *Pelican* was the first research vessel on the scene sampling after the explosive loss of the *Deepwater Horizon* drilling rig. R/V *Weatherbird II*—originally built as an offshore oilfield supply vessel but repurposed for research in 1989 by the Bermuda Biological Station—also served as a capable platform for research and natural resource damage assessment following the blowout. Follow—up investigations have brought many other larger oceanographic research vessels into the GOM. To meet growing needs, in 2016 USM brought the R/V *Point Sur* (originally the R/V *Cape Florida* when operated by the University of Miami) to the GOM from the central California coast, after the NSF decided to retire it from UNOLS funding.

All 4 of the academic research vessels of 30 m in length or more are approaching 40 years in age (Table 3). U.S. Gulf researchers have long sought a larger and more modern and capable oceanographic research vessel, particularly after TAMU ceased operation of the 54.9—m R/V *Gyre* in 2015. The NSF issued a plan to build 3 Regional Class Research Vessels (RCRV), but later scaled back the appropriation request to 2, with Oregon State University and the University of Rhode Island selected to operate them. As a result of efforts of influential members from U.S. Gulf states, the U.S. Congress appropriated funds for a third vessel. The NSF selected the Gulf–Caribbean Oceanographic Consortium, led by USM and LUMCON, which have successfully partnered in the operation of the R/V *Point Sur*, to operate the new RCRV in support of research in the GOM, Caribbean and Atlantic Ocean. Universities operating U.S. Gulf marine laboratories are members of the consortium.

All three RCRVs, built on the same 60.7—m hull design, are presently under construction at Gulf Island Shipyards in Houma, LA. The GOM—based vessel, R/V *Gilbert R. Mason* (Figure 9B), is scheduled to enter service as a UNOLS vessel in 2023. This next—generation platform will offer advanced research opportunities, with longer cruises and larger scientific parties. However, it will not eliminate the need for one or more smaller research vessels to replace the aging fleet for shorter cruises, regular monitoring, and servicing *in situ* instrumentation.

**Journals**

Starting with the GBS in 1902, several U.S. Gulf marine laboratories published their own journals, in keeping with the tradition of European marine laboratories and the MBL's *Biological Bulletin*. This was done as not only a scientific record of the research conducted at the laboratories, but also as a periodical exchanged with institutions publishing similar serials. Even small laboratories could build their journal holdings through such swapping. Most of the journals focusing on the GOM region have been discontinued (Peterson et al. 2011), with UTMSI's *Contributions in Marine Science* (formerly *Publications of the Institute of Marine Science*) sunsetting in 2009 after

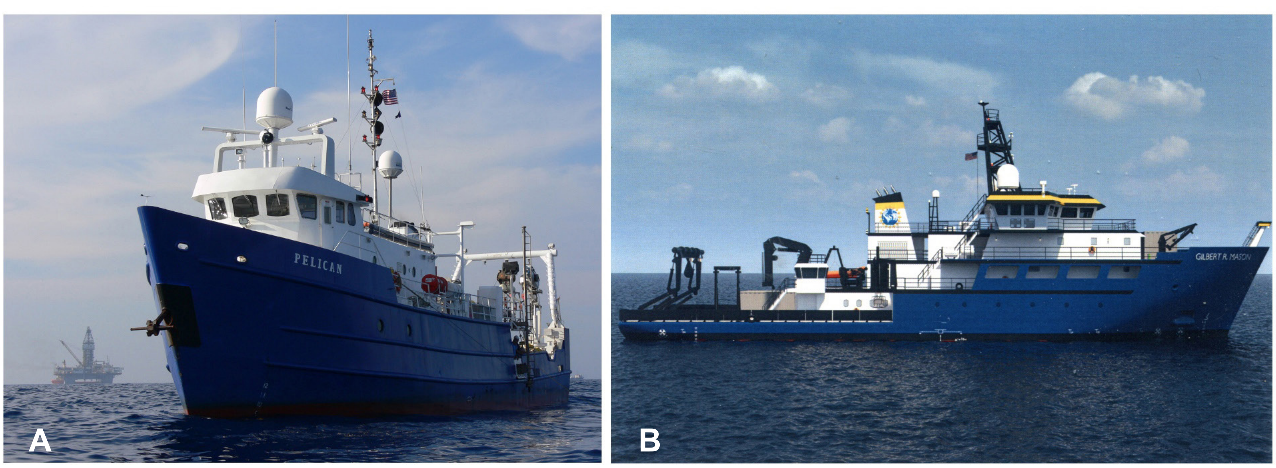


***FIGURE 9.*** *Gulf research vessels present and future. A. R/V* Pelican, *constructed in 1985. B. Rendering of the Regional Class Research Vessel* Gilbert R. Mason, *anticipated to be in service in 2023.*

60 years and DISL's *Gulf of Mexico Science* [formerly *Northeast Gulf Science* (1977—1996) and *Journal of Marine Science* (1969—1973)] in 2018 after 47 years. *Gulf and Caribbean Research* (the successor to GCRL's *Gulf Research Reports,* established in 1961), continues the tradition but with rigorous peer review and a regional scope expanded to the GOM and Caribbean regions.

While some journals originally associated with European marine laboratories are still being published in one form or another, the demise of laboratory—hosted journals reflects not only a general changing of the times, including the proliferation of commercially published journals, but also maturation of GOM science. As new cohorts of scientists joined the regional laboratories, they have generally preferred to publish in international journals. The global reputation of science conducted at U.S. Gulf marine laboratories has grown substantially since I returned to the GOM in 1980.

**Working Together**

While there has long been communication and collaboration, not to mention personnel transfers, among Gulf Coast marine laboratories, coordination became more organized in the 1980s (Tunnell 2010). In 1984, DUML Director John Costlow organized the development of a position statement on the importance of marine laboratories in order to make the case for the resumption of NSF's program to support marine laboratory instrumentation. The following year, representatives of 11 laboratories along the southeast and GOM coasts met at GCRL and agreed to form the Southern Association of Marine Laboratories (SAML), which was incorporated in 1986. In 1989, a nationwide group met in Baltimore and agreed to form the National Association of Marine Laboratories (NAML), with SAML as one of 3 regional affiliates. Currently, SAML lists some 47 member institutions, 19 of which are based on the U.S. Gulf Coast.

I was involved in all 3 of the organizational meetings, but when I moved to UMCES in 1990 as the head of that system, the directors of its marine laboratories (CBL and the Horn Point Laboratory) continued to represent their laboratories in SAML and NAML. I am gratified to see that both remain viable and useful associations. They allow marine laboratory leaders to remain informed about federal science and environmental program developments, collectively advocate for programs they depend on, and share effective practices in facility operations, storm resilience, and research and education operations. It should also be pointed out that a number of U.S. Gulf marine laboratories and research universities are active members of the Consortium for Ocean Leadership that works to ensure sound science underpins ocean policy and decision making at the federal level. In addition to the existing functions of these national and regional associations, the National Research Council (NRC 2014) pointed to many additional opportunities for networking among marine laboratories for discovery and innovation at a time when human activities are altering nature an unprecedented rate.

## What I Learned About Marine Laboratories

**Places That Work**

Marine laboratories have remained durable through many storms, both economic and meteorologic. While substantial investments in facilities and support within both local and the scientific communities contribute to permanence, durability is ultimately based on the value of services the laboratories provide. Marine laboratories must be not only great places for scientists to work, but also places that do great work. At its core, this work is founded on the scientific discoveries produced through research, but discoveries about the marine environment also emanate from inland university campuses and research centers. It is experimental advantages and the continuity of observations that sets marine laboratories research apart. However, the value proposition is also substantially founded on the breadth and depth of the educational experiences provided by marine laboratories, as well as on the application of the knowledge they generate to maintaining the health of both human society and the ecosystems of the coastal zone and ocean. Ultimately, the success of marine laboratories depends on such convergence (NRC 2014).

Historically, marine laboratories were places for scientists to visit to conduct research and teach students. At most marine laboratories today the conduct of research and delivery of education is predominantly by resident faculty members. This ensures that costly facilities are fully and productively used, but is a practical economic reality for supporting laboratory operations through externally—funded grants and contracts as opposed to "bench fees." Furthermore, family life has changed from the time when professors had the flexibility to spend their summers working at a marine laboratory. Working spouses, children's activities, and accommodation standards and costs all provide constraints. Still, there are many benefits to hosting non—resident scientists at marine laboratories, even for periods shorter than a summer, as it expands thinking, fosters collaboration and strengthens linkages with the "main campus." Marine laboratories should ensure that they accommodate and foster such temporary or periodic users.

To thrive in such a diverse field as marine science, there has to be a critical mass of resident faculty or research scientists. There is no magic number, as it is scalable with the mission of the unit and proximity to other scholars. From my experience it seems difficult to sustain coherent and stable research output with fewer than about 8 resident faculty members. Gaps in expertise and disruptions due to departures and funding volatility are difficult to overcome with a smaller complement. Resident scientists are generally expected to support their research with extramural funding sufficient for at least part of their own salary; the salaries of research assistants, graduate students, and post—docs; tuition support; and all laboratory, field, travel and publication costs. It is not surprising, then, that as rational beings they would strongly orient to satisfying

their research sponsors and the scientific peers who evaluate their proposals and papers. Unfortunately, this can be accompanied by relative indifference to integration, application and teaching, as less important for success. Yet, it is the full—spectrum delivery in all 4 functions on which the success of the marine laboratory rests. While laboratory directors can provide assistance and incentives on these other fronts, emotionally intelligent resident scientists will realize that the success of their individual research enterprise depends quite tangibly on the multi—function success of the marine laboratory and contribute accordingly.

**Dealing with Isolation**

Many marine laboratories, though not all, are distant from their institutional parents and located in small communities. Such out—of—sight—out—of—mind isolation is both a blessing and a curse. There are the greater opportunities for both observational and experimental science, regular contact with people who live on or depend on the coast, and lower teaching loads. On the other hand, many resources of a university campus are not as readily available. While this is no longer the case for library resources or even computational capacity, access to high quality students, the full curriculum, scholars in allied fields, student services, social and intellectual enrichment activities, and philanthropic assistance is certainly constrained.

Most marine laboratories have long used interactive video connectivity to receive and deliver course instruction and conduct virtual meetings. This has overcome some of the barriers of access to coursework by graduate students in residence at marine laboratories. Disruptions caused by the COVID—19 pandemic have made such platforms familiar and ubiquitous. This will forever change the game for courses and conferences, providing new opportunities for marine laboratories to extend their services and relevance, not only among the university campuses and across the states, but worldwide.

Relative isolation has a significant effect on the recruitment and retention of the professional workforce, even beyond the senior scientific staff. Spouses are often themselves academics or professionals who face difficulties gaining rewarding employment in coastal communities. While laboratories often use creative employment of both spouses, appointment and nepotism policies limit flexibility. Parents may want to provide better educational opportunities for their children than available locally. Some scientists just prefer a work and family life offered on a university campus. Personal situations change over time, making it challenging to retain scientists who have prospered at the laboratory. Search and appointment processes should take into account the likely compatibility of candidates for working at the marine laboratory and living in the community just as much as on scientific qualifications and promise.

Marine laboratories are comfortable workplaces, allowing informal dress, close relationships, repetitive tasks and flexible hours. While this is generally conducive to productivity, for some scientists the conditions become too comfortable. Routines take over, questions narrow, and ambition to make a difference in science wanes. High expectations among the leadership and peers regarding the scholarship of discovery and integration must guard against this.

**Addressing Challenges within Universities**

University affiliated laboratories are typically lodged within a department, school, or college, although the resident faculty members at some have appointments in separate disciplinary departments—not a very workable arrangement in my view. A few laboratories, such as DISL and LUMCON, are managed by university consortia and UMCES is an autonomous institution within a university system. Both the consortium and autonomous arrangements present their own set of challenges regarding relationships with the programs and aspirations of the allied universities. Under any arrangement, marine laboratories labor under the common disadvantage of being seen as peripheral, rather than central, to the education and research enterprises of the university. Decision—making processes on the main campus or in a university system affect the allocation of financial resources, positions, and capital investments and, occasionally, result in well—intended, but potentially disruptive, plans for reorganization.

This disadvantage is compounded by trends in financing U.S. public higher education, as states have cut or constrained governmental funding and universities raised tuition rates to secure needed revenues. General revenues derived from tuition grew from less than 30% in 2000 to approaching 50% during most of the 2010s. Marine laboratories generate little of the tuition revenue, which predominantly goes to support undergraduate education. As a result, funding for traditional public service functions, such as agricultural experiment stations, has diminished. On—campus faculty members often perceive those at marine laboratories as privileged with lower teaching loads without having to demonstrate any greater research output. Although attitudes have improved, faculty members at the marine laboratory were often seen as "field station" scientists doing pedestrian, applied research rather than cutting—edge basic research.

Marine laboratories must work to counteract these internal disadvantages, while taking advantage of their productivity, public visibility and societal relevance. Do not be a stranger on campus and build strong relationships with social sciences and fields needed for collaboration in addressing contemporary issues. Make sure those who govern and administer the university understand and appreciate the value the laboratory brings to it and the state. Establish reliable base funding commitments that can be supplemented from diverse funding sources (NRC 2014). Push the envelope in building political support for appropriations, facilities, and programs. Make sure that principal investigators understand that recovery of facilities and administrative costs (also known as indirect costs

or overhead) from grants and contracts is not a tax to avoid, but is critical to the operations of the facilities that allow their success. Retain as much of those recovered costs as possible for operation of the marine laboratory. Creatively develop additional revenue—generating enterprises, including non—traditional education, analytical services, and cooperative agreements with both the public and private sector.

**Providing Life—Long Education**

The ability of marine laboratories to provide full—spectrum education from pre—K to gray makes them unusual in higher education. Most laboratories are deeply engaged in graduate education where they provide particularly intimate opportunities for mentoring from the first day of graduate school and exceptional peer—to—peer learning among the sub—community of graduate students. Some laboratories also provide undergraduate courses, during the summer, between semesters or year—round, and most offer research experiences for undergraduates. What sets marine laboratories apart is that they are an educational magnet for the rest of society. This includes school children, their teachers, resource users and citizen scientists involved in the co—production of knowledge, and residents and visitors of all ages. Many marine laboratories have programs that serve these segments, but I think that there are yet unexploited opportunities both to inform society and to gain its support. This will require a stronger embrace of a broader educational mission by the research and higher education enterprise and more effective integration across educational programs. As discussed in the next section, I think this can be accomplished within the context of preparing society for the changing world it is facing.

## Future Roles of Gulf Marine Laboratories

I am confident that GOM marine laboratories will endure for many decades to come, surviving, recovering from, and adapting to tropical cyclones, pandemics and fiscal challenges. However, as the Danish philosopher Søren Kierkegaard observed, "Life can only be understood backwards; but it must be lived forwards." For marine laboratories this means learning from and building on the past, but shape—shifting traditions to be highly relevant to the future, with all its uncertainties.

In his Pulitzer Prize—winning environmental history of the GOM, Jack Davis (2017) chronicled the extensive changes caused by human exploitation of fish and wildlife populations beginning in the 19$^{th}$ century. That was followed by pervasive changes in coastal environments due to population growth and development, channeling the Mississippi River, intensification of agriculture and construction of dams in the catchments, engineering projects, industrial and municipal wastewater discharges, and coastal and offshore oil and gas exploitation. If there were ever anything such as a baseline, it has long been shifting in the GOM. Well—funded restoration programs are now providing unprecedented opportunities to rehabilitate long—degraded ecosystems. Marine laboratories have a critical role to play in providing scientific guidance and adaptive learning in this multi—decade restoration (NASEM 2017) and in understanding the evolution of the coupled natural—human systems of the GOM (NASEM 2018).

Human—induced global climate change is already accelerating sea—level rise, warming and acidifying GOM waters, intensifying cyclones, and altering river inputs, ocean circulation and wind patterns. The scale of changes during the rest of this century and beyond depends on the trajectory of global emissions of greenhouse gases that are responsible (IPCC 2014). Reducing emissions sufficient to limit global warming to 1.5°C or even 2°C above pre—industrial levels is needed to make adaptation to climate change manageable. This would limit the rise of global mean sea level to much less than a meter, in contrast to more than 2 meters, during the next century (IPCC 2019). It would also allow the rebuilding of degraded marine life with appropriate conservation strategies (Duarte et al. 2020, Knowlton 2021). But, limiting warming to this level requires the reduction of $CO_2$ emissions levels to net—zero by 2050 or shortly thereafter (IPCC 2018). Over just the next 30 years, global society, including the nations and states surrounding the GOM, will have to achieve an enormous transformation in its use of energy and materials, with profound implications for key economic activities of the GOM, including oil and gas extraction, chemical manufacture, shipping, food production, fishing, and tourism. Ocean—based approaches can help close the mitigation gaps by providing renewable energy, decarbonizing marine shipping and transportation, rebuilding coastal "blue carbon" ecosystems, reforming fisheries by reducing carbon emissions while ensuring sustainable harvest, and seabed storage of carbon (Hoegh—Guldberg et al. 2019).

The people of the U.S. Gulf Coast will have to be actively engaged in avoiding unmanageable climate change at the very same time they have to manage its unavoidable consequences, in part by restoring the resilience of GOM ecosystems. There is no choice between mitigation and adaptation, a particularly difficult requisite for highly vulnerable, oil and gas producing regions of the GOM (Boesch 2020). Marine laboratories and the scientists privileged to work at them have not only an extraordinary opportunity, but also a responsibility to create the convergence of scientific research, application, education and community understanding required over these next 30 years. Community engagement will be challenging, as fewer than half of the residents of most coastal counties and parishes around the U.S. Gulf Coast accept that global warming is caused mostly by human activities (Marlon et al. 2019). However, marine laboratories have an effective connection with children and their teachers. I do not know a marine scientist in the U.S. Gulf states who does not accept that climate is changing because of human emissions, but few publicly speak out about it. A scientist at one U.S. Gulf marine laboratory

related to me that their U.S. Senator's staff told them it was alright to seek support for research on sea—level rise, as long as they did not mention human—caused climate change. It does not really matter which state that Senator represented as it could have happened in any of them. The anecdote just underscores the challenge U.S. Gulf scientists face. If we do not a make concerted effort now historians writing 30 years from now should not be kind to us.

Over 20 years ago, marine ecologist Jane Lubchenco (1998) argued for a new social contract for science as the world entered the 21st century with all its environmental challenges. This social contract centers on the commitment of all scientists to "devote their energies and talents to the most pressing problems of the day, in proportion to their importance, in exchange for public funding." The contract requires not only fundamental research, but also faster and more effective transmission of knowledge to policy— and decision—makers and better communication of this knowledge to the public. Jane renewed her call at the American Geophysical Union meeting in 2019, stressing the need for science that is accessible, understandable, relevant, credible, salient and useful. I recommend that the terms of this social contract be incorporated in the mission statements of all marine laboratories.

In anticipation of the United Nations Decade of Ocean Science for Sustainable Development, Jane Lubchenco and Steve Gaines (2019) framed a new narrative for the ocean that should also guide the future of U.S. Gulf marine laboratories. In the past the ocean was thought so vast that it was simply too big to fail. As scientists documented that the ocean had been massively depleted and disrupted, thinking shifted to the ocean as simply too big to fix, resulting in depression and lack of engagement and motivation. Now, Jane and Steve posit that the ocean is recognized as so central to our future, it is too big to ignore. Their narrative is certainly relevant to the GOM, which is so central to the region's future that it is too important to neglect.

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