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OCEAN REFLECTIONS

REFLECTIONS ON A CAREER UNPLANNED

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Abstract: Sometimes life takes unexpected turns. I never planned to be a marine biologist; yet, after a long and unpredictable journey, that's exactly where I found myself. After obtaining my B.S. in Fishery Biology from Colorado State University, I found myself meandering from job to job like a golden retriever following some vague scent. At first, I was hired by the Wyoming Game and Fish Department to work seasonally in Grand Teton National Park on the freshwater trout fisheries. Soon thereafter, I found myself cultivating oysters, clams, and other shellfish in California. The skills I developed there as an algologist led to my subsequent employment developing a Spirulina culture facility near Santa Cruz, CA. My next position, which ultimately shaped my career, was helping to establish the Caicos Conch Farm in the Turks and Caicos. I was subsequently hired to help develop a conch research program for the State of Florida. Thus began 35 years focusing on hatchery—based stock replenishment, ecological dynamics, reproductive ecology, ecotoxicology, metapopulation dynamics, gene expression, and other issues impacting conch distribution and recovery from local overexploitation. Simultaneously, the diverse aquatic and terrestrial ecosystems in Florida were rapidly changing due to a changing climate superimposed on an expanding human footprint. This provided opportunities work on crafting adaptation solutions for both ecosystems and societies. In 1996, I was offered a leadership position in the Gulf and Caribbean Fisheries Institute, a role within which I remain active. Taken as a whole, these positions have been rich in both scientific explorations and policy development. Despite my best efforts at retiring, the opportunities to explore new research approaches and to develop new programs conspire to keep me pursuing new and exciting projects.

Key words: Algae, conch, aquaculture, climate change, GCFI

The Early Years

"Why don't you major in marine biology?" _my mother asked
"Are you kidding, I'll never get a job!" _I replied

It was never meant to be. The above dialog with my mother occurred when I was trying to chart a career path prior to college. I purposefully had chosen not to pursue a career in marine biology not because I did not appreciate the intrigue of the ocean, but because it was unlikely that I would ever get a job, especially considering that my plans were never to go to graduate school. I was 16 growing up in Connecticut and was consumed by spending my time outdoors, but always in the mountains; the sea held no special attachment to me. When given the choice between going to the ocean or going inland, I always selected green over blue (Figure 1). So, given the prescient knowledge that I would never be employed as a marine biologist, and my fidelity towards working outdoors, I chose to major in forestry at Colorado State University – an institution well—known for its forestry, fishery and wildlife biology, and terrestrial ecology programs. But certainly not with a marine focus.

Forest biology, a program focusing on the science of forest management, became my major. It was a rigorous program with a science rather than management track. I focused on such arcane courses as dendrology and forest entomology which, for all practical purposes, were solely based on identifying and memorizing species but had no focus on developing critical thought processes, a skill I personally found more valuable. One of the required courses for Forest Biology majors was upper—level organic chemistry. This course was wholly about problem solving including the puzzles of synthesizing complex chemical compounds. Even better, the biochemistry courses I was attracted to were not about memorization; rather, they focused on concepts in physiology such as what happens to the body when starving, when pregnant, or during long—distance training. Sure, you had to learn the various metabolic and catabolic pathways, but by necessity they were conceptualized so that I could understand the changes a body

FIGURE 1. *The early years working in the mountains of New Hampshire.*

FIGURE 2. *Working the fish traps on Jackson Lake with the Grand Tetons in the background. My colleague Doug Stang (pictured) and I were working on the Lake Trout and Cutthroat Trout fisheries.*

would go through under certain stressful conditions. Therefore, I pivoted to majoring in chemistry to focus more on problem solving and concept development. Although, in some perverse way, while this was a great deal of fun, I realized after a few years of pursuing a chemistry degree that the last thing I wanted to be was a chemist.

So, here I was with numerous science credits and no major to pursue. Unfortunately, most majors that would keep me outdoors were very restrictive with respect to their required courses and I was left with very little room for all the electives I had accumulated. After carefully studying the entire course catalog, there was one major liberal enough to accept my wide suite of electives: fishery biology. Many of the classes that I took related to human physiology, nutrition, and biochemistry; yet these were acceptable as electives within a Fishery Biology major and, since I needed a major where I could graduate quickly, I found this major particularly attractive. As a Fishery Biology major, I could pursue one of 2 tracks: aquaculture or resource management. I chose the latter as I really had no interest in fish culture. And, as a bonus, some of the classes were focused on estimating fish abundance in ponds by sampling techniques such as fishing and using other more destructive methods including chemicals such as rotenone. I was no great student (although I excelled socially) and had no interest in continuing studies towards an advanced degree.

One of the requirements to graduate with a B.S. degree in Fishery Biology, which I did in 1979, was a summer of field work experience. There were numerous opportunities to complete this requirement throughout the western U.S. I was fortunate to secure a 5—month position with the Wyoming Game and Fish Department working on the Snake River with the Snake River Cutthroat Trout (*Oncorhynchus clarkii lewisi*) and on Jackson Lake with Lake Trout *(Salvelinus namaycush)* in Grand Teton National Park in the shadow of the Grand Tetons (Figure 2).

To say that working in the Tetons was fulfilling would be an understatement. Three times a week I flew in a 2—seat Bianca Scout prop plane along the Snake River along the Grand Tetons counting fly—fishers floating the river. We also fished from rafts to tag native Cutthroat trout; I snorkeled the Gros Ventre River to count whitefish, and, using the SCUBA skills developed while in college and honed in the late 70's in Utila Honduras, dove in Jackson Lake to plant cutthroat trout eggs. The latter almost killed me as I had to remain motionless on the bottom of the icy lake in a 5 mm wetsuit while others shuttled the eggs down to me so I could plant them in the murky sediment.

But this job was only temporary. Winters in Wyoming are very long and very cold; there were few activities for field biologists, and I was unemployed after the field season ended. Being jobless and with no prospects for employment, I loaded my 1968 Volkswagen squareback with snowshoes, hockey equipment, and a few clothes, and headed to visit a close friend in Santa Cruz, CA. While driving down the coast of California between Half Moon Bay and Santa Cruz, I picked up a hitchhiker. During our chat, he mentioned that there was an oyster hatchery along the route at the base of the iconic Pigeon Point Lighthouse (Figure 3) in Pescadero, CA. I had no idea what an

FIGURE 3. *The Pigeon Point lighthouse in Pescadero, CA where the Pigeon Point Aquaculture Center (PPAC) hatchery was located. The water intake was at the base of the cliffs on the left and the oyster hatchery was in the brown building to the right of the lighthouse. Larval and oyster seed were grown in this facility and either sold to other grow-out producers or sent to the PPAC growout operations in Tomales Bay, CA, or Arcata, FL. The entire peninsula is now designated as Pigeon Point Light Station State Historic Park, and the oyster hatchery has been demolished.*

oyster hatchery was, but, having no job, I felt it must have some relevance to a recently unemployed, fishery biology graduate. Serendipitously, I stopped at the hatchery and met the manager who wanted to know how I had heard that they had a job opening. My days as a jobless wanderer ended there and, unforeseen to me, I was entering my near–term future as an aquaculture mercenary.

Unfortunately, this job at the oyster hatchery was not a biologist position; rather, it was in the marketing department. I was hired by the Pigeon Point Aquaculture Center (PPAC) in Pescadero, CA to deliver Pigeon Point oysters to the finest, upscale restaurants in the San Francisco Bay area in an old Divco milk truck (Figure 4). The company was not entirely solvent and couldn't pay much salary; however, they offered me the opportunity to sell all the oysters I wanted to supplement my salary. What was a poorly paying job became quite lucrative; I sold oysters out of the back of my 1968 Volkswagen squareback in Chinatown in San Francisco while being pursued from street corner to street corner by the health department who frowned on raw oysters being sold surreptitiously from the back of a Volkswagen. Luckily, the Asian community was quicker to find me than the health inspectors and I seemed to always be one step ahead of the law.

FIGURE 4. *The Divco milk truck used to deliver the iconic Pigeon Point oysters to the finest restaurants around the San Francisco and Monterey Bay region. The refrigerated truck leaked in the rain and had no heat, but turned heads when driving through the San Francisco streets.*

The oyster hatchery quickly became insolvent yet again, but the timing was perfect; the spring field season in Jackson, WY with Wyoming Game and Fish was starting and, apparently, they were satisfied enough with my previous work to hire me back for a second season. Again, I loaded up my VW and headed back to Wyoming. Along the way, I was asked to serve as an underwater photographer for a wedding at an alpine lake in Colorado. This experience, coupled with the frigid egg–planting endeavor, served as an important life lesson – I was committed to avoid any future cold–water diving. The second season in Wyoming was much the same as the first and, as before, after 5 months, I was once again jobless.

The good news was that I had 2 jobs waiting for me. The first was at the re–financed Pigeon Point oyster hatchery but this time as a biologist. The second job was as assistant to the wildlife photographer, Wolfgang Bayer. The photography job would have had me traveling worldwide to assist in creating documentaries. He liked that I had been an underwater wedding photographer. The choice of which job to select represented a significant crossroads in my life – I could move into marine aquaculture science which seemed to be a good gig, or I could pursue what looked like a lifetime adventure in photography. I chose the latter. However, and sometimes I think unfortunately, the documentary that Wolfgang was working on was 'Yellowstone in Winter' and this was a season with a very low snowpack. This meant the wildlife remained high in the mountains which also meant that we were waiting for the snow that would force them downslope to facilitate filming. So, without money, my decision was simple. Documentary filmmaking was out, oyster farming was in.

A Biologists Life

Ironically, having decided not to focus on aquaculture in school, I was now a commercial aquaculturist growing seed oysters, clams, and sometime abalone for the PPAC. Commercial aquaculture by necessity requires many skills, and I was fortunate because Pigeon Point was the center of many innovations in commercial–scale molluscan aquaculture including the development of cultchless spat and upwelling systems to grow the oyster seed in culture (Andrews and Mason 1969). Working on a commercial oyster hatchery, nursery, and growout facility requires melding science and art, something I found quite appealing. I thoroughly enjoyed working among large cylinders of brightly colored algae, determining feeding regimes to larval oysters based on the color of their guts, and developing systems that increased the culture efficiency.

Given the limited funding available to pay their employees, I was provided 'housing' in a 1–room old, wooden, rickety shack. When it rained, as it often did in the winter in northern CA, I had to place a plastic tarp on the inside of the roof to direct rainwater away from my bed into mason jars. Additionally, there was no electricity and I had to run an extension cord from the hatchery to provide electricity. Unsurprisingly, once again the oyster hatchery floundered, and I was soon on the street.

A Move to Commercial Algal Culture

After the second demise of the PPAC, I noticed an advertisement seeking a commercial algal culturist in the local Santa Cruz newspaper. I can't be certain, but that is likely the first and last time a similarly well–focused and specialized job opportunity seemingly written just for me has appeared in a local newspaper. The job was at a commercial venture in the redwoods above Santa Cruz in a town called Boulder Creek. The owner, a self–described mystic, Dr. Christopher Hills, had made a fortune through a multi–level marketing scheme selling *Spirulina*, a blue–green alga collected from ponds in Mexico, as a health supplement. Because of the uncontrollable nature of the quality of the algae from these ponds (a microscopic examination of this product showed multiple insect parts), he wanted to start his own, controlled culture facility.

Dr. Hill's *Spirulina* business was run in association with a small 'university' he started and named the University of the Trees. He awarded himself an honorary PhD and built a community of devotees to help him achieve his goals. He purchased the town swimming pool in Boulder Creek and all its associated facilities including a snack bar and on–site housing (Figure 5).

FIGURE 5. *The Aquaculture Research Center in the redwoods of Boulder Creek, CA where we conducted Spirulina culture research. The facility was previously used as the town swimming pool. The pool for algal culture is underneath the plastic sheet in the foreground. The fiberglass tanks stored the chemicals and nutrients to grow the algae. The snack bar which was renovated into the laboratory is in the background behind the fiberglass tanks. The individuals in the photograph worked at the algae culture facility.*

His devotees provided the low–cost labor, but he needed someone who could provide technical insight into large–scale algal culture for his new company, Aquaculture Research Company. I was hired as Research Director and was given wide latitude to help develop his city pool into a pilot *Spirulina* culture facility. Despite his best efforts, I did not buy into their community psyche and refused to participate in the Friday–evening hot tub confessionals. Yet, culturing *Spirulina* was quite successful, proving that in a pool not all algae is bad. We demonstrated that simple algal culture procedures could scale up to culture, harvest, and process for sale of small quantities of *Spirulina*. However, Dr. Hill's ambitions were much larger. He saw an unlimited financial opportunity to occupy a significant percentage of the burgeoning *Spirulina* market. To accomplish this, he developed a joint venture with an Israeli company in Eilat on the Red Sea, and also purchased large acreage in Desert Hot Springs, located in the desert of southern California, upon which he hoped to build a very large *Spirulina* culture facility.

I was dispatched to Israel to assess their operations, learn their culture techniques, and report back. Quickly, it was obvious that their approach to algal culture was so academic as to be impractical; they were conducting multiple experiments on manipulating nutrients and other environmental conditions to favor the species they were trying to culture in a multi–algal stew. Although this makes good sense theoretically, it is antithetical to efficient and effective culture of unialgal strains. The long–accepted approach is to start with a very healthy starter culture of the single species you want (preferably axenic) and to increase the volume of the culture by ensuring you transferred algae to the media in larger vessels and tanks near the inflection point in the sigmoidal growth curve. In this way, the culture remains vigorous and healthy. So, because of my background in algal culture, the student became the teacher, a process that made the rest of my visit there very awkward.

On returning to California in 1982, Dr. Hills was ready to ramp up his southern California operation and asked me to design the $3.5 million facility. This included all hydraulic engineering including sizing pumps and various pipes, designing ponds and other culture containers, learning building code for commercial facilities in that county, and incorporating FDA requirements for food production into the design of the processing facilities. I was given a staff of 4 draftsmen, and various other professionals and we set about designing the facility by hand since this was in the time before computers were widely available.

After spending some time in the desert of southern California, I realized this area did not support a fulfilling lifestyle for me despite the generous perks of the position including housing and a car. I resigned from the job and went bicycling down the coast of California. On the trip, I was notified that PPAC had a resurgence and 3 of us who previously worked there were afforded the opportunity to take over and run the hatchery in Pescadero and the growout operation in Tomales Bay. There was no pay available; however, the new German owners were opening high–end oyster bars around the San Francisco Bay area, and we were to serve as their source of oysters. They needed us to harvest and deliver oysters but had no money to pay us. We negotiated a deal to harvest all the oysters we wanted and to sell them from the inventory of previously planted stock. This was a very lucrative opportunity yet, history repeated itself; as before, the oyster bars became insolvent, and we went on to other opportunities.

A World of Conch

The Caicos Conch Farm

After our oyster business closed, a biologist colleague of mine at PPAC was offered a job helping to start the world's first commercial conch farm on the island of Providenciales in the Turks and Caicos. He wasn't interested in the position. So, in keeping with my aquaculturist mercenary persona, I applied for a job with Dr. Megan Davis and jumped at the chance when offered the position. It sounded like an exotic adventure for a California biologist, especially given that I had no idea even where the Turks and Caicos Islands were. This position was the beginning of my 40+ year career working with conch.

In the early 1980s, Providenciales, or Provo, was a nest of outlaws. Drugs were rampant and the illicit trade was managed and controlled by Customs and other government officials (see for example https://www.latimes.com/archives/la–xpm–1985–03–23–mn–21093–story.html). Under this cloud of lawlessness, we set out building the geodesic—domed hatchery and the associated buildings. The hatchery was located on a natural deep—water channel on the east side of Provo with direct access to the extensive shallow—water Caicos Bank (Figure 6).

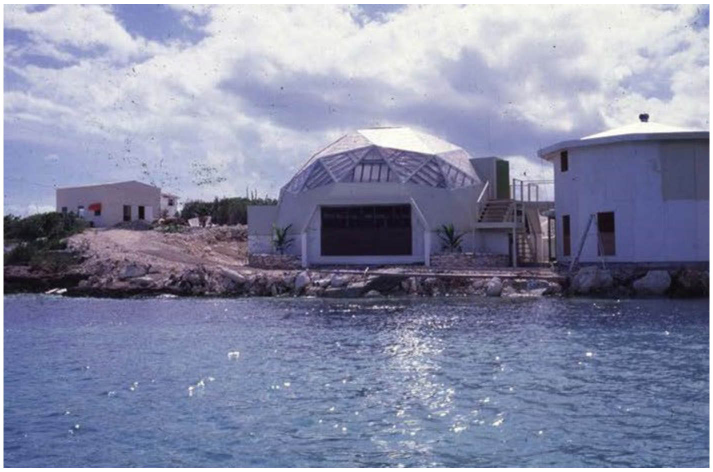

FIGURE 6. *The Caicos Conch Farm on Providenciales island in the Turks and Caicos. The dome is where the hatchery is located; the transparent top of the dome is where the algae was grown. The building on the right is where starter cultures of algae were grown. The structure on the top of the hill is the workshop. Since the photograph was taken, additional structures and grow-out ponds were constructed.*

Hatchery techniques for growing conch had already been developed by Dr. Davis and others, but the large—scale systems required for commercial juvenile production were not yet established. My first role was as algae—culture manager. The first obstacle I encountered was identifying an algal species that was robust to the climate and nutritious for larval conch. I had noticed a brown micro—algal film along the emergent karst adjacent to the hatchery building. I plated the algae I collected there in an agar media with dissolved nutrients. However, the hatchery had not yet been completed, so I resorted to developing an ad hoc algal culture system with 24—hr lighting perched on the tank of my toilet. From this isolate, I purified the algal clone CISO which at the time was a microalga of choice in many tropical aquaculture systems. Subsequently, the NOAA Shellfish Laboratory in Milford, CT, USA treated the CISO clone to make it axenic. The CISO was transferred from flasks to large cylinders (Figure 7) where they were cultured until ready to feed the larvae.

FIGURE 7. *The algal culture room at the Caicos Conch Farm. The algae used for culture was* Isochrysis *clone CISO isolated from the shoreline and cultured on the back of my toilet. The different colors are associated with the age of the culture and thus, different densities. At night, the translucent tubes would glow in brown and green hues. One evening, a group of lost tourists arrived at the hatchery and remarked that they thought they had arrived at Mars.*

The next technological hurdle was developing a culture system that could support the mass production of post—larval conch. Megan was skilled at growing larval conch and successfully inducing them to settle; however, the algae—culture systems were not sufficiently scaled to provide the quantity of feed required to support many thousands of juvenile conch. This was, and remains, one of the technological challenges of commercial conch culture. Unlike fish culture or even bivalve culture, juvenile and adult conch require both extensive areas of optimal substrate for grazing as well as large quantities of micro—algae (e.g., benthic diatoms) that are settled on the substrate. I began working on solutions (Figure 8). When I left the Caicos Conch Farm, I proposed 3 solutions: 1) develop an artificial diet, 2) culture benthic diatoms which are preferred by post—larval conch, and 3) culture planktonic algae which can be precipitated onto the substrate thus forming a nutritious algal film. All of these have their advantages and disadvantages; however, after I departed the conch farm, the latter methodology was employed successfully on large scale.

FIGURE 8. *The author culling post-larval conch in the early stages of development immediately after metamorphosis. This represents our early attempts at engineering a system to feed the conch. It had yet to be perfected when I was there, but it is now well-developed.*

Commercial conch culture was, and remains, an economic challenge including the space required for juvenile and subadults given their unique habitat requirements, the need for large amounts of fodder, the morphological deficiencies including reduced meat weight associated with conch cultured in high—densities, and other biological and systems—design issues. A well—crafted business plan for commercial conch culture should address these issues to provide a realistic estimate of the return on invested capital and accurate cash flow projections. In a consulting role, I was asked to produce 2 business plans: one for a tourism—based operation in Key West, FL and one for a large—scale commercial operation on Abaco in The Bahamas.

Commercial profitability for conch can only be achieved by reducing the cost of culture (e.g., developing high—efficiency systems, low—cost feed advances, high—density culture systems), selective breeding to overcome the natural barriers (e.g., morphological, physiological, and behavioral), and/or increasing the price per product. Conch produced for the aquarium trade or escargot markets command greater prices than the meat from adult conch. Furthermore, the price to culture these individuals is substantially lower since the area and feed required is much less per individual. However, the market for aquarium conch is limited, and the escargot market is small, especially in the U.S. Furthermore, as daunting as it is to culture conch for the commercial market, growing conch for restocking is even more problematic. Captive breeding of conch for restocking is fraught with the same challenges as with commercial culture in addition to other issues including the expected natural mortality after release.

Florida's Conch Research and Restoration Program

I departed the Caicos Conch Farm after 2 years with no job prospects. However, I was made aware of a new program starting in Florida with the Florida Fish and Wildlife Conservation Commission (then Florida Department of Natural Resources). The State had procured funding to help restore the conch population in the Florida Keys where conch was once a vigorous commercial fishery, and to monitor the recovery should there be one. The commercial and recreational fisheries for conch had been closed since 1986. I was hired in 1987 because there was a very strong interest in building a conch hatchery to restock the Keys. Dr. Carl Berg was the PI on the project; I was mostly focused on the aquaculture side, although assessing the local stock was a significant part of my portfolio.

Our approach for pro—actively restoring the Keys' population was to facilitate an increase of the larval supply to the Florida Keys system. A basic tenet of stock enhancement/restoration to produce a self—sustaining population is that the offspring must have a high probability of being retained in the targeted system, thus ensuring that subsequent generations contribute back to the local population. In principle, this can be accomplished by increasing the spawning stock; however, this approach will only be effective if larvae that are produced from an enhanced spawning stock are retained and deposited back into the system. Therefore, we needed to determine the origin of the larvae recruiting to the Keys.

We began a focused effort to answer this question by examining system—wide connectivity with the goal of developing an advection/retention model for the Florida Keys. This model was informed by 1) examining the existing literature on the hydrodynamic patterns in and around the Keys, 2) conducting plankton studies including larval trawls, 3) releasing drifters that simulate conch larvae, and 4) conducting and using existing genetic studies. The results of these efforts, when coupled with the prolonged length of time to see a recovery of the population, implied that the Florida Keys were a mostly isolated system and that larvae originating from upstream sources likely were transported by the Keys system along what we called the Florida Current shear (Delgado et al. 2008). Thus, increasing the larvae produced within the Keys was a logical approach to increasing larval supply to the Keys. Based on these analyses, we demonstrated that the Florida Keys conch population was likely self—recruiting, and that any pro—active enhancement strategy must focus on bolstering the local spawning stock.

Armed with this information, we began examining augmenting the adult spawning population by using hatchery—reared juvenile conch. Of course, the first hurdle was to procure enough juvenile conch necessary to conduct experiments to determine if this was a worthwhile approach. The easiest means was to purchase juvenile conch from an existing hatchery. At the time, the only hatchery producing large numbers of juvenile conch was the Caicos Conch Farm under the direction of Chuck Hesse. Our statewide protocols required that we examine the genetic composition of any potential hatchery—releases to make sure they were sufficiently similar to our native conch so as not to generate any unintended consequences. We hired an outside firm to conduct the assessment; using allozymes as the genetic marker, they concluded that were so many differences between the hatchery stock from the Caicos conch farm and the Florida native stock that we were denied the approval to release the conch. It was unclear if these results were an artifact of the hatchery—rearing process or if they were due to differences in the Keys versus the Turks and Caicos populations; nevertheless, to protect the genetic integrity of the wild population, prudence dictated that we should not release these conch. At the time, the regulations stated that genetic analyses did not need to be conducted if the broodstock was collected within 50 miles of the intended release site. So, we offered the Caicos Conch Farm some of our local egg masses to culture conch for us, but they declined. Thus, we began developing our own conch culture facilities. Our first attempt was in St. Petersburg at our home office; however, this proved futile as the water quality off Tampa Bay was, to say the least, not appropriate for conch culture. The next hatchery was a temporary facility in the laundry room at the Keys Marine Laboratory on Long Key. This was very makeshift – we had to use tanks that were not well—designed for conch larval culture, and other systems that were very difficult to use and not efficient for culture. However, Keys Marine Laboratory was formerly a Sea World facility, and we were given the sole use of the snack bar to convert into the conch lab. Together with my colleague Adrian Dominguez, we moved walls, built a larval culture room, rewired the facility, dug trenches for the seawater intake, built an algal culture room, installed an autoclave for sterilizing seawater, and built a very complicated ozone—based seawater treatment system. Through trial and error, we found that we needed the seawater to most closely resemble the chemistry of reef water which has an oxidation reduction potential approximating 385mv. To accomplish this, we installed an ozone system which turned our 'emerald green' seawater from the coastal waters to 'gin—clear' reef water. Based on this effort and my previous work at Aquaculture Research Center, I was acutely aware that my career seemed to focus on repurposing snack bars into aquaculture facilities.

Thus, we were on our way to producing sufficient larvae and the juvenile conch to conduct our experiments. One of the basic principles of stock restoration is recognition that the best growth and survival should be equivalent to the best reported for the species in the wild, especially with a well—studied species. Anything better and you are producing a genetically superior cohort that likely carries the baggage associated with hatchery—induced genetic selection. We were certainly aware of this basic premise. Our research nevertheless focused on understanding the barriers to survival of hatchery—reared conch and how to overcome them. Ultimately, our intention was to attach a cost for production of an individual conch reaching sexual maturity, thus providing a cost:benefit context. Our team began the process of methodically working towards this goal.

After release, recovering the outplants was a major consideration. Juvenile conch are notoriously difficult to detect in the wild, especially those that are relatively small. This was a major barrier to overcome. We found that affixing an aluminum tag to a juvenile conch and using metal detectors to locate them provide recapture rates >90% compared with <20% recovery when only searching visually (Figure 9, Glazer et al. 1997). This formed the basis for recovering juvenile conch after release. We began a series of field experiments to determine survival after release (i.e., season and moon phase of release, size at release, density, juxtaposition to predator habitats; Glazer and Delgado 2003). We also found that we could 'train' the conch to avoid predation by exposing them prior to release to the predator (Delgado et al. 2002). We developed a probability—based model using the movements of similarly sized conch within a grid (Glazer 2005). The location of the conch at release and the time between sampling allowed us to determine if a conch that was not recovered had 1) wandered from the grid, 2) fallen victim to a predator, or 3) been overlooked in sampling. Our analyses suggested that indeed we could approximate the best survival reported in the wild; yet, the cost to produce a conch to a size near reproduction was very expensive, even within our very efficient hatchery. Based on this result, we concluded that it would still be excessively expensive to produce enough conch for restocking (Glazer and Delgado 1999).

FIGURE 9. *My colleague Gabriel Delgado using an underwater metal detector to locate newly outplanted conch juveniles tagged with aluminum tags. When using this approach, we could locate 90% of the outplants; however, when searching only visually, < 20% were recovered (see Glazer et al. 1997). This technique formed the basis of our outplant research studies.*

There was an alternative. While conducting the outplanting experiments, we identified a strategy to increase the larval production of the population based on a physiological deficiency we identified in the local population. While examining the reproductive condition of various conch aggregations, we found that conch closely associated with the shoreline no longer reproduced (Glazer and Quintero 1998) despite historical evidence that they once did. We found, however, that if we translocated these conch to within offshore aggregations where reproduction was common, they would begin to reproduce (Delgado et al. 2004). We also discovered that there were no measurable deleterious effects of the existing conch found offshore (Delgado and Glazer 2007). Based on having identified the lower Florida Keys as the primary source of larvae recruiting back to the Keys, and that the lower Florida Keys was the primary source of those larvae (Delgado et al. 2008), we began a process of translocating the conch into this region and thus bolstering the larval output into the region (Delgado et al. 2004).

Identifying the reason for the reproductive deficiencies of nearshore conch was elusive despite comprehensively examining the issue. We examined differences between the offshore and nearshore zones including water and substrate chemistry, tissue chemistry, endocrine disrupting chemicals, proteomics, and gene expression (Glazer et al. 2008); it seems that the principle of Ockham's Razor was at play. It now appears that the temperature, including the range of temperatures that conch are exposed to, may be the culprit for the reproductive deficiencies although these investigations remain ongoing at the laboratory in Marathon (G. Delgado pers. comm., October 2023).

While this restoration work progressed, we continued our work on elucidating answers to ecological questions in a management context. We focused on understanding how conch utilized resources (Glazer and Kidney 2004) and moved within the matrix of habitats (Glazer et al. 2003) and how this could be translated to an understanding of spawning aggregation dy-

FIGURE 10. *The author collecting data within a conch spawning aggregation. The data were used to elucidate how conch utilized habitat and their reproductive dynamics.*

namics (Figure 10) and ultimately proposed an approach using these data to design marine fishery reserves (Glazer and Delgado 2006). We also dedicated significant effort to understanding changes within spawning aggregations as populations recover, including the relationship between density and reproductive output (Figure 11). During this period of my career, I received the first Florida Jaycees Outstanding Young Environmentalist Award in 1999 and the Southeastern Association of Fish and Wildlife Agencies Fisheries Biologist of the Year award in 2006, both in recognition of the work to restore the south Florida queen conch population.

Tackling A Changing Florida

Florida Fish and Wildlife Conservation Commission (FWC) is structured to provide the information necessary to make informed resource management decisions and to subsequently implement and enforce those decisions. The FWC is unique in that it has a research division, the Fish and Wildlife Research Institute (FWRI), which conducts the applied research that helps inform managers who can then craft policies. I was lucky. My boss, John Hunt, gave me the latitude to pursue other interests outside of the marine environment that still met the FWC mission of "Managing fish and wildlife resources for their long—term well—being and the benefit of people."

Climate adaptation science in the early 2000's was nascent but advancing. In June 2008, the State of Florida began examining responses to climate change by hosting their first Climate Change Summit in Miami. This launched the FWC efforts to mitigate the potential impacts of a changing climate on Florida's fish and wildlife resources. In 2008, the FWC established a climate change program that was built to identify the best science on vulnerability and adaptation and to use that to develop approaches that, when implemented, increased the resilience of the managed resources under its jurisdiction. I applied for the Research and Monitoring Workgroup chair and that became my secondary area of focus at FWC after conch. The role of the Research and Monitoring workgroup was to provide the information necessary for the Adaptation workgroup to develop adaptation strategies. We were given the opportunity to define some funding priorities that came to FWC from the federal government within the State Wildlife Grants program.

Florida was now at the forefront of climate adaptation through both federal and state governments' activities. The U.S. Geological Service had partnered with Massachusetts Institute of Technology (MIT) on a project to construct alternative future scenarios to begin understanding what a future Florida might look like, and I was able to participate in this project. The project was entirely terrestrial in focus, something I personally found compelling, probably given my original forestry interests. This project was a lightbulb moment. Scenario—planning, an approach originally developed by the U.S. Department of Defense and Shell Oil, is a way to envision multiple futures based on an integrated framework of land—use planning, social and eco-

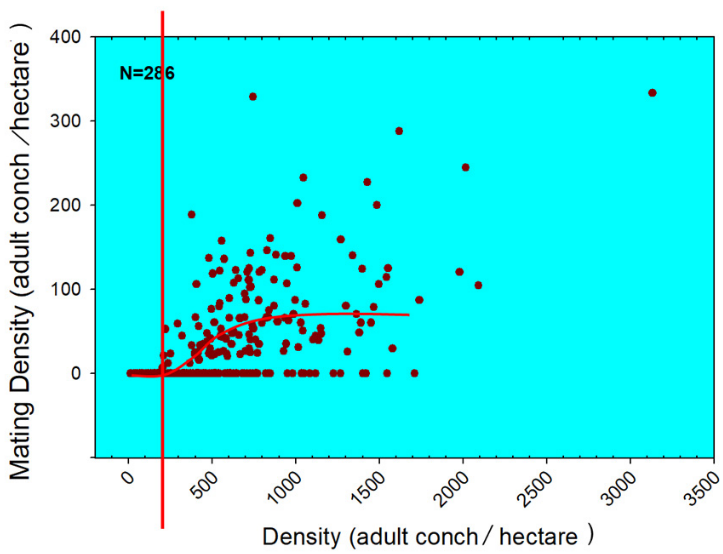

FIGURE 11. *The relationship between density of adult conch within spawning aggregations and the density of conch observed reproducing. The data were collected over 14 years of surveys and each point represents an aggregation. The vertical red line represents the threshold below which no reproduction was ever observed within an aggregation (<185 conch/hectare) and the red curved line represents the upper asymptote beyond which no increase in per capita reproductive output occurs (~850 conch/hectare).*

nomic dimensions, demographic changes, and diverse climate scenarios. When taken together, these dimensions provide spatial pictures of possible Florida landscapes. As an example, a scenario might focus on what Florida would look like if there was high sea—level rise, rapidly increasing human populations, policies that were conservation focused, and minimal funding for conservation. Alternatively, what would the landscape look like if there was minimal—sea level rise, proactive statewide conservation policies, and significant funding for conservation? The maps for these and other scenarios could then be used to engage stakeholders to craft adaptation strategies. For example, if you are a manager of the Florida panther and needed to ensure that there were sufficient corridors for migration, policies that promoted development over conservation would inevitably result in barriers to migration pathways, and therefore conflicts with developments. The adaptation approaches under this scenario would be very different than those for a greener Florida. Scenario—planning became a way for us to better understand the inherent uncertainty within projections of a future society, and to focus research on reducing those uncertainties.

For me, this approach was fascinating. We were awarded several grants which utilized scenario—planning to understand possible futures in the marine environment. Our first project, KeysMAP (Florida Keys Marine Adaption Planning), brought together partners from GEOADAPTIVE (an offshoot of MIT), U.S. Fish and Wildlife Service, NOAA, The Nature Conservancy, and in—house experts to model sea—surface temperature changes under different IPCC scenarios using the MOM3 model, high—resolution sea—level rise modeling (SLAMM), and coastal development. Using the outputs, we projected the changes to habitats including beaches, coral reefs, and mangroves. The effects of different climate futures on these habitats were linked with important marine resources including spiny lobsters (*Panulirus argus*), Goliath Grouper (*Epinephelus itajara*), and loggerhead turtles (*Caretta* spp.). With the help of experts, the potential changes to the habitats provided information on impacts to the species' biology and fisheries (in the case of spiny lobster). Based on these discussions, we developed a limited number of possible adaptation options (Glazer 2013).

We were getting our feet wet. Our next project, KeysMAP2, focused from the start on adaptation. We concentrated on the estuaries of southwest Florida and examined how changes to salinity, sea—surface temperature, and coastal development may impact suites of species (e.g., species associated with the shore, open estuarine waters, coastal waters) that shared common vulnerabilities. In this way, we developed adaptation options that addressed the vulnerabilities of a suite of species instead of focusing on only one (Glazer et al. 2017, Vargas—Moreno et al. 2017). This is referred to in the biodiversity conservation literature as the coarse—filter approach (Hunter et al. 1988). Of course, individual species also have unique vulnerabilities, and these also must be addressed if they portend significant impacts. The collective adaptation work ultimately led to my participation in the development of the National, Fish, Wildlife and Plants Climate Adaptation Strategy and I was subsequently awarded the first Climate Leadership Award Honorable Mention from the National Fish, Wildlife, and Plants Climate Adaptation Strategy in the Local and States category.

In 2014, Bruce Stein and coauthors at the National Wildlife Federation developed the climate—smart adaptation approach (Stein et al. 2014). This approach was refreshing and formed the basis for our evolving climate adaptation strategy development. It provided a logical framework upon which adaptation approaches could be developed. However, we focused on some additional parts of adaptation planning which we felt would add to adaptation strategy development and implementation. For example, we added steps that included identifying and monitoring for trigger points that identify when to implement the adaptation options. We also included steps which included overcoming barriers that stymie implementation of adaptation projects. Other steps in our climate—smart approach included monitoring for trigger points and monitoring to assess the efficacy of the adaptation strategy implementation (Benedict et al. 2018). In the spirit of trying to understand barriers to implementation, we began examining behavioral constraints to adaptation (Stoltz et al. 2021).

The holistic cycle we developed (Figure 12a), in concert with the FWC Climate Adaptation Plan (Florida Fish and Wildlife Conservation Commission 2016) became the de facto FWC approach to adapting to climate change. Each step in the process is very well—defined with a series of activities that provide the basis for moving to the next step. Furthermore, this cycle also helps identify areas where the state of the science is insufficient or lacking and thus serves as a gap analysis. Ultimately, reducing uncertainty in each step provides a better picture of each scenario. As models and analytical tools develop, inevitably the projections will become more realistic. Yet, as was abundantly clear, the planning side of the process is easy, but our work demonstrated that implementation was the most difficult part of the process and became a focus of ongoing efforts (Figure 12b).

In 2018, I received the Director's Award from the Director of FWRI in recognition of my work on behalf of FWC. I retired from FWC in December 2021.

The GCFI Years

The science and management associated with conch sustainability was very interesting and extremely rewarding. Likewise, the puzzles of climate change adaptation were, and remain, intriguing. Sure, science was fascinating and challenging. I enjoyed the entire process of defining the question and then crafting ways to develop laboratory and field experiments to elucidate the answers. Yet, my interests extended beyond the strict pursuit of science. Something was missing. Through FWC, I had attended numerous Gulf and Caribbean Fisheries Institute (GCFI) meetings. It seemed that the application of science to achieve science—based solutions that were applied and relevant was something that GCFI was working towards although, in the 1980s, GCFI was still steeped in science.

I first attended the annual GCFI conference in Curaçao in 1987; GCFI was at that time going through a transformation. The annual *Proceedings of the Gulf and Caribbean Fisheries Institute* had not been published for over 5 years, revenues into the GCFI

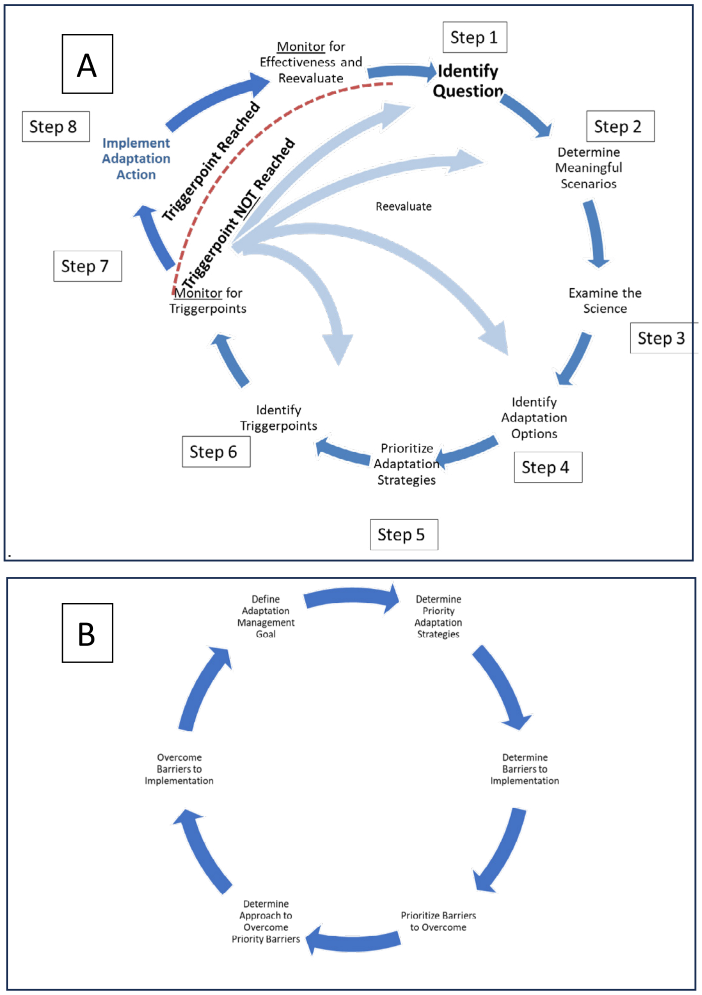

FIGURE 12. *The FWC climate-smart cycle designed to provide a roadmap for climate adaptation planning. A. The 8-step process is meant to integrate inputs from managers, scientists, and other stakeholders. There are 3 targets for monitoring: 1) Monitor the effects of climate on the target, 2) Monitor to inform when pre-defined thresholds for action are reached, and 3) monitor to evaluate the effectiveness of the adaptation strategies. B. The most difficult activity to accomplish is the implementation phase of the project and thresholds for actions as well as obstacles to implementation need to be clearly defined for roadblocks to be overcome.*

were minimal, and there was a pervasive feeling of frustration. Yet, it was undeniably great fun, and the science was approachable, especially for a young biologist. For me, the GCFI meeting provided a glimpse of what science could do for society if a variety of stakeholders were working towards a common goal.

Although my FWC job was time–consuming and stimulating with respect to designing projects that were focused on science–based management, I felt that the possible rewards of a more intensive involvement in GCFI would provide a perspective on more regionwide issues. At the 48th GCFI meeting in Santo Domingo in the Dominican Republic in 1995, my close friend LeRoy Creswell and I were enjoying a beer in the shadow of the old city and complaining about the current state of GCFI (Figure 13). We had just come from the opening ceremony at which it seemed that there were more dignitaries at the head

FIGURE 13. *Discussing the state of GCFI with LeRoy Creswell on a field trip at the GCFI conference in Barbados in 1996. Soon after this, LeRoy became Executive Secretary of GCFI.*

table than conference registrants in the audience. We were concerned about the ability of GCFI to survive and decided at that moment that rather than complain, we should offer solutions. When I returned home after the conference, I broached the idea of taking a more active role in GCFI with my boss and he was agreeable with the caveat, of course, that my existing job at FWC could not suffer.

Armed with that endorsement, at the 51st annual GCFI meeting in St. Croix, USVI in 1998, I offered to host the next meeting in Key West (1999) and was elected to the Board of Directors. At the time, the Chair, along with the Executive Secretary (LeRoy Creswell), ran GCFI. During the late 1990's, GCFI was primarily a venue for a conference and an outlet for publishing the Proceedings. It was clear that if we were to move GCFI forward, we needed to get the Proceedings up to date from the 5–year backlog. LeRoy, as Executive Secretary, with help from Dr. Alejandro Acosta at FWC, began the methodical process of editing past proceedings and ensuring that they were distributed to the membership.

Additionally, GCFI was evolving in other ways. This was during the early days of the internet and the world wide web, and for my part, I spent many late nights learning the intricacies of hand coding PhP, mySQL, and CSS to develop our first online presence. This was a very onerous process, but it was indeed intellectually stimulating.

In the late 1990's and early 2000's, GCFI's role in the region began to change. Besides our core activities, we recognized that GCFI had a brand – that is we served as an organization that does not have a political agenda, an ethic that continues to this day. Of course, GCFI supports sustainable practices, however, the annual GCFI conference became recognized as an event that can bring together disparate interests (academics, state biologists, managers, students, NGOs, fishers) to develop solutions to timely issues. During the early 2000s, GCFI developed several partnerships based on this principle. Principal among those was our work together with the United Nations Environment Programme—Caribbean Environment Programme (UNEP—CEP). However, the Chair of GCFI was then a 2—year term as defined in the bylaws, which was somewhat of an obstacle to continuity and was confusing with regards to our newly developing partnerships. Based on this constraint, the Board of GCFI created the position of Executive Director in 2008 at the 61st GCFI in Gosier Guadeloupe; I was asked to serve in that position.

In 2004, together with our partner the UNEP—CEP, we relaunched the dormant Caribbean Marine Protected Areas Managers Network and Forum (CaMPAM) under the management of Dr. Georgina Bustamante with the aim of developing capacity among MPA managers. This relationship grew into a more extensive partnership including with NOAA and various European countries and has since evolved under the GCFI umbrella into the MPAConnect network under the guidance of Emma Doyle (www.mpaconnect.org). Other initiatives followed. Subsequently GCFI was asked to co—host the Global Partnership on Plastic Polution and Marine Litter Caribbean Node in partnership with UNEP (www.gpml—caribe.org). The GCFI was also asked to develop a research strategy document for the Caribbean and North Brazil Shelf project (CLME+; Acosta et al. 2020) and other projects have ensued. Thus, GCFI expanded our portfolio, and it continues to grow in ways that were not easy to predict 20 years ago.

Since my retirement from FWC in 2021, more of my time has been spent working towards building out GCFI's initiatives. These have focused not only on the MPA and Marine Litter activities; we also focus our efforts on ensuring that students and young professionals are provided the opportunity to develop their careers through student awards and networking events focused on connecting students with established professionals. Furthermore, under the early guidance of Dr. Ken Lindeman, GCFI increased our efforts in a very focused manner on ensuring that fishers were part of the process by recognizing the synergies resulting from having fishers at the table with other stakeholders. The intent is that these initiatives do not operate independently from each other; rather, the goal is that they can work together when warranted to achieve a more sustainable Caribbean Sea.

Moving Forward

Now, in addition to working on GCFI activities, my wife Merlou, golden retrievers Grace and Maya—Papaya, and I have built a house in the Florida Keys with a separate wing which serves as an Airbnb. This small business has provided an opportunity to meet many people with disparate backgrounds. This has always been one of the aspects of travel that we most enjoyed, and we have developed many close and long—lasting friendships. We have also built a tropical garden (Figure 14) which is comprised of over 40 species of palms, numerous tropical fruit trees, and an extensive diversity of native plants. We are focused on feeding the body as well as the soul by designing the garden for food, aesthetics, and creating wildlife habitat. In other words, coming full circle back to my initial interests in terrestrial ecology; in our own way, we are now focused on building ecosystems. However, we are soon to be climate refugees and will be moving up north to the mountains to start the next chapter.

FIGURE 14. *The author in the garden at his home in the Florida Keys where current efforts are focused on building ecosystems.*

Acknowledgments

I wish to acknowledge the hundreds of people who have helped to shape my career from my high school days through the current years at GCFI. Unfortunately, the list is too extensive to name them all, and I am certain I will forget a number of them. So, I hope everyone who joined me along this ongoing journey will understand the precarious position of potentially forgetting some who joined me along the way. That notwithstanding, I do wish to extend a special and heartfelt thanks to my wife, Merlou, who continues to be my north star.

Literature Cited

Acosta, A.A, R.A. Glazer, F.Z. Ali, and R. Mahon. 2020. Science and Research Serving Effective Ocean Governance in the Wider Caribbean Region. Technical Report No. 2 for the UNDP/GEF CLME+ Project (2015—2020). Gulf and Caribbean Fisheries Institute, Marathon, FL, USA. 185 p.

Andrews, J.D. and L.W. Mason. 1969. Cultchless Seed Oysters. Marine Resource Advisory No. 3. Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA, USA. 3 p. https://doi.org/doi:10.25773/v5—810d—7357

Benedict, L., B. Glazer, S. Traxler, C. Bergh, B. Stys, and J. Evans. 2018. Florida Keys Case Study on Incorporating Climate Change Considerations into Conservation Planning and Actions for Threatened and Endangered Species. A Project Report for USFWS Cooperative Agreement F16AC01213. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA. 152 p.

Delgado, G.A. and R.A. Glazer. 2007. Interactions between translocated and native queen conch (*Strombus gigas*): Evaluating a restoration strategy. Endangered Species Research 3:59—266. https://doi.org/10.3354/esr00047.

Delgado, G.A., R.A. Glazer, and N.J. Stewart. 2002. Predator induced behavioral and morphological plasticity in the tropical marine gastropod, *Strombus gigas*. Biological Bulletin 203:112—120. https://doi.org/10.2307/1543463.

Delgado, G.A., C.T. Bartels, R.A. Glazer, N.J. Brown—Peterson, and K.J. McCarthy. 2004. Translocation as a strategy to rehabilitate the queen conch (*Strombus gigas*) population in the Florida Keys. Fishery Bulletin 102:278—288.

Delgado, G.A., R.A. Glazer, D. Hawtof, D. Aldana Aranda, L.A. Rodriguez—Gil, and A. De Jesús—Navarrete. 2008. Do queen conch (*Strombus gigas*) larvae recruiting to the Florida Keys originate from upstream sources? Evidence from Plankton and drifter studies. In R. Grober—Dunsmore and B.D. Keller, eds. Caribbean Connectivity: Implications for Marine Protected Area Management. Proceedings of a Special Symposium, 9—11 November 2006, 59th Annual Meeting of the Gulf and Caribbean Fisheries Institute, Belize City, Belize. Marine Sanctuaries Conservation Series ONMS—08—07. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Springs, MD, USA, p. 29—41.

Florida Fish and Wildlife Conservation Commission. 2016. A Guide to Climate Change Adaptation for Conservation, Version 1. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA. 295 p.

Glazer, R.A. 2005. A model decoupling emigration from mortality in recapture surveys of slow—moving benthic marine gastropods. Journal of Shellfish Research 24:387—392. https://doi.org/10.2983/0730—8000(2005)24[387:AMFDEF]2.0.CO;2

Glazer, R. 2013. Alternative futures under climate change for the Florida Key's benthic and coral systems. Final Report, State Wildlife Grant FWC 6242. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA. 39 p.

Glazer, R.A. and G.A. Delgado. 1999. Part I. Optimizing size at release of hatchery—raised queen conch outplants: A cost—benefit approach. Part II. Modification of behavior and morphology in hatchery—reared queen conch. U.S. Fish and Wildlife Service Project P—1, Marathon, FL, USA. 58 p.

Glazer, R.A. and G.A. Delgado. 2003. Towards a holistic strategy to managing Florida's queen conch (*Strombus gigas*) population. In: D. Aldana Aranda, ed. El caracol *Strombus gigas*: Conocimiento Integral para su Manejo Sustenable en el Caribe. CYTED, Programa Iberoamerican de Ciencia y Tecnologia para Desarolllo, Yúcatan, México, p. 73—80.

Glazer, R.A. and G.A. Delgado. 2006. Designing marine fishery reserves using passive acoustic telemetry. In: J.C. Taylor, ed. Emerging Technologies for Reef Fisheries Research and Management. NOAA Professional Papers Series 5, U.S. Department of Commerce, Washington, D.C., p. 26—37. https://spo.nmfs.noaa.gov/sites/default/files/pp5.pdf

Glazer, R.A. and J.A. Kidney. 2004. Habitat associations of adult queen conch in an unfished Florida Keys back—reef: Applications to essential fish habitat. Bulletin of Marine Science 75:205—224.

Glazer, R.A. and I. Quintero. 1998. Observations on the sensitivity of queen conch to water quality: Implications for coastal development. Proceedings of the Gulf and Caribbean Fisheries Institute 50:78—93.

Glazer, R.A., R.J. Jones, L.A. Anderson, and K.J. McCarthy. 1997. The use of underwater metal detectors to locate outplants of the mobile marine gastropod, *Strombus gigas.* Proceedings of the Gulf and Caribbean Fisheries Institute 49:503—509.

Glazer, R.A., G.A. Delgado, and J.A. Kidney. 2003. Estimating queen conch (*Strombus gigas*) home ranges using acoustic telemetry: Implications for the design of marine protected areas. Gulf and Caribbean Research 14(2):79—90. https://doi.org/10.18785/gcr.1402.06

Glazer, R., N. Denslow, N. Brown—Peterson, P. McClellan—Green, D. Barber, N. Szabo, G. Delgado, K. Krol, I. Knoebl, and D. Spade. 2008. Anthropogenic effects on Queen Conch reproductive development in south Florida. Final Report X7974799—03. Environmental Protection Agency, Washington, D.C., USA. 73 p.

Glazer, R., M. Flaxman, J. Vargas Mereno, K. Karish, and E. Ponte. 2017. Implementation of a scenario—based model of adaptation planning for the south Florida marine environment (KeysMAP). Final report, State Wildlife Grant 1253. Florida Fish and Wildlife Conservation Commission, Tallahassee, FL, USA. 10 p.

Hunter, M.L., Jr., G.L. Jacobson, Jr., and T. Webb, III. 1988. Paleoecology and the coarse—filter approach to maintaining biological diversity. Conservation Biology 2:375—385. https://doi.org/10.1111/j.1523—1739.1988.tb00202.x

Stein, B.A., P. Glick, N. Edelson, and A. Staudt (eds.). 2014. Climate—Smart Conservation: Putting Adaptation Principles into Practice. National Wildlife Federation, Washington, D.C., USA. 273 p.

Stoltz, A.D., M. Shivlani, and R. Glazer. 2021. Fishing industry perspectives on sea—level rise risk and adaptation. Water 13:1124. https://doi.org/10.3390/w13081124

Vargas Moreno, J.C., K. Karish, E. Ponte, and M. Flaxman. 2017. KEYSMAP2: Implementation of a scenario—based model of adaptation planning for the south Florida marine environment: Appendix 1. Florida Fish and Wildlife Conservation Commission, Fish and Wildlife Research Institute, Marathon, FL, USA. 167 p.

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