CHAPTER 10

CONCLUDING THOUGHTS: THE FUTURE OF OFFSHORE AQUACULTURE

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ABSTRACT

The Offshore Aquaculture Consortium (OAC) was created as a collaborative, Gulf-wide, interdisciplinary research and development program in response to the U.S. Department of Commerce Aquaculture Policy. OAC research has demonstrated numerous components of offshore aquaculture in the Gulf of Mexico including permitting requirements, mooring systems, cage/mooring survival during several hurricanes and tropical storms, automatic feeding capabilities, and fish survival during hurricane passage. Other components of OAC research will support a future offshore aquaculture industry including use of genetic analysis to identify harvested product originating from aquaculture facilities and creation of both economic and environmental impact models. Numerous impediments still exist that each, in part, retard development of an offshore aquaculture industry in the Gulf of Mexico, and throughout the nation. These impediments include unsteady government support, an unsuitable permitting and regulatory environment, negative public perception and user conflicts, incomplete industry planning, technology suitability, and insufficient and inconsistent fingerling supply.

OFFSHORE AQUACULTURE CONSORTIUM

The Offshore Aquaculture Consortium (OAC) was created as a collaborative, Gulf-wide, interdisciplinary research and development program in response to the U.S. Department of Commerce Aquaculture Policy. The purpose of the OAC was to conduct studies in marine policy, ocean engineering, ocean environmental, and fish grow-out, among numerous other issues, to generate primary scientific data related to offshore aquaculture (http://www.masgc.org/oac/). OAC research has demonstrated numerous components of offshore aquaculture in the Gulf of Mexico including permitting requirements, mooring systems, cage/mooring survival during several hurricanes and tropical storms, automatic feeding capabilities, and fish survival during hurricane passage. Other components of OAC research will support a future offshore aquaculture industry including use of genetic analysis to identify harvested product originating from aquaculture facilities and creation of both economic and environmental impact models. However, economic viability and logistics to manage a commercial-scale operation offshore was not demonstrated. Now, with the termination of federal funds, the OAC has been forced to conclude its research. An offshore aquaculture sector still does not exist in the Gulf of Mexico.

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IMPEDIMENTS TO INDUSTRY DEVELOPMENT

Given the present dependence on foreign supplies to fulfill domestic seafood demand in the United States, one would imagine that developing a responsible aquaculture industry within the U.S. Exclusive Economic Zone (EEZ) would be a high priority. However, an industry has been slow to develop within the U.S., and certainly the Gulf of Mexico region, for a number of reasons. Below is a list of those reasons I feel are most important with discussion from my experiences in the Gulf of Mexico region (additional discussion and more specific research needs are presented, from a consensus of attendees at the most recent OAC regional workshop, in Bridger 2002).

Steady Government Support

The OAC was fortunate to receive funding through the National Marine Aquaculture Initiative (NMAI), administered by the National Sea Grant College Program. The NMAI was established in response to the Department of Commerce Aquaculture Policy signed August 10, 1999. The unfortunate aspect of the NMAI has been the diminishing level of funding provided over the course of the research work plan. Despite increasing seafood trade deficits and fishery pressures on U.S. wild stocks, NMAI Year 2 budgets were reduced by 60% of the original allocation, and subsequently zeroed out for Year 3 funding. The National Sea Grant College Program generously offered funds to the OAC in hopes of completing a grow-out trial, but those funds were insufficient when considering the research would be conducted 40 km offshore. If domestic seafood production is a priority for the nation, then funding for the necessary research to develop a responsible marine aquaculture sector should be established.

In a recent article, Cyr Couturier of the Marine Institute of Memorial University of Newfoundland discussed the “research to commercialization continuum” necessary for aquaculture industry development from a Canadian perspective (Couturier 2003). His commentary provided several important points regarding the continuum: a) duration of each phase (research, development, commercialization) varies but generally decreases along the continuum; b) each phase is interdependent on the others and none are mutually exclusive; c) ongoing research and development is required following commercialization to remain competitive and solve constraints; d) level of risk reduces as commercialization is achieved; and, e) the financial cost increases along the continuum. Couturier provides examples to support these characteristics that show a $1 million research effort requires $4–5 million for development followed by another $5–10 million in commercial financing (likewise the time required for each phase changes with 10–15 years for research and 5–10 years for development in the case of the salmon culture industry). These values may seem extreme but he finishes the argument by stating such levels of effort results in a return on investment potential of $10 million or more annually to the Canadian economy.

Those dollar values are relative in that they would be dependent on the species or system being developed. New species that utilize existing infrastructure and system management for grow-out would require research efforts to be focused on broodstock handling/spawning and larval/fingerling rearing. In the case of offshore aquaculture, grow-out systems and management plans need to be developed that might depart from existing operations and therefore would require additional funds apart from those designated to species development (both could occur simultaneously if new candidate species were to be raised offshore).

While aquaculture operations are developing in exposed sites throughout the world, most regions utilize adaptive management plans for industry success. In such cases exposed sites represent the natural evolution of the industry requiring additional space for increased production. This would not be the case for most of the U.S., having little coastal cage culture operations (with the exception of the Pacific northwest and Maine), therefore requiring additional research funding to create a new industry that is exceptionally dissimilar to the predominate land-based culture systems (ponds and tanks or raceways) located throughout the nation. A quick back calculation based on the proportions provided from the Canadian experience and a potential regional economic impact of $200 million annually for the Gulf of Mexico yields the requirement for $100–200 million for commercial financing, $100 million for development, and $20 million for research. These values are indeed substantially higher than the level of funding provided to the OAC through federal support for its research.

Despite these challenges, the NMAI program has funded several successful projects throughout the nation and resulted in coastal aquaculture operations off the coasts of Hawaii and Puerto Rico. In both cases, however, NMAI funds have been used mostly to provide the fingerlings for grow-out trials in the sea cages and conduct environmental monitoring of the sites with independent operators responsible for day-to-day management of the farm. The Hawaii case also benefited from approximately three decades of research effort by the Oceanic Institute and the University of Hawaii focused on developing spawning and larval/juvenile grow-out techniques for the candidate species, Pacific threadfin. These successes, however, are difficult to extrapolate to commercial-scale operations offshore given that both are located near shore and operating a very minimal number of cages each—further illustrating the need for government investment to establish regional commercial-scale demonstration farms throughout the nation, comparable to land-based catfish research stations in the southern states.

Permitting and Regulatory Environment

The permitting and regulatory environment for aquaculture in the U.S. has been the subject of much discussion (e.g. Goudey 1996; Bunsick 2003). Commercial ventures in state waters deal primarily with respective state agencies for the necessary permits. Decreased complexity and bureaucracy could be anticipated at this level of governance given the relative ease of access to local regulators and willingness of local agencies to work with industries having positive social and economic impacts for their state. Offshore aquaculture operators—by definition operating in the U.S. EEZ—should expect to experience a more complex regulatory structure, requisite to meet requirements of both state and federal agencies having oversight of aquaculture ventures. Additionally, the pace at which federal regulations change is much slower than at the state level, illustrating this complexity coupled with the political pressures from many stakeholder groups influencing the bureaucratic system of the federal government.

OAC researchers completed a review of the permitting requirements to site an offshore aquaculture operation in U.S. federal waters, and states along the Gulf of Mexico (Appendix A, this volume). This review has assisted several potential commercial operators with the identification of permits necessary and pertinent contact information. Regulatory changes are required, however, for more efficient permitting (not synonymous with easier permitting as some pundits would have you believe). It would be extremely beneficial to empower one lead permitting agency to create a single permit for offshore aquaculture that meets all agency requirements while simultaneously providing a single point-of-contact, one monitoring and reporting scheme, and one expiration/renewal date for that permit, rather than having to deal with all agencies having oversight.

Simply acquiring permits to occupy ocean space is not enough. Comparable to its land agricultural counterpart, the aquaculturist must have access to a long-term lease that encompasses the seabed, water column and surface to conduct its operations. Effective ownership of the entire site will allow the aquaculturist to expand its operations to potentially include multiple species within different trophic levels that might be grown on the seabed (e.g., liverock), in the water column (fish in cages), and within a polyculture or integrated aquaculture scenario (e.g., oyster relaying). A lease existing over a 15–20 yr period will attach monetary value to the farm location. This value could be adjusted based upon site performance associated with stock grow-out, fish health management, survival, and food conversion ratio over an extended period. Finally, and most importantly, a long-term lease will provide collateral that might be used by the aquaculturist to access traditional financial sources to raise the necessary capital funds required to establish commercial scale operations.

Once permitted for offshore aquaculture the operator must contend with operation regulations. In the U.S., aquaculture operators have to meet the demands of a suite of regulations and regulatory agencies. Numerous regulations are expected to exist owing to the nature of aquaculture (especially for cage culture operations) where one has to moor a structure to the seafloor, raise fish species that may also be managed in a wild fishery, meet environmental standards related to feces and excess feed exiting the cage, provide a product that is safe for human consumption, and perhaps dealing with both state and federal agencies that may frequently overlap in scope.

In many instances existing laws were not written specifically for aquaculture operations but attempts are being made to conform laws to meet aquaculture needs. Recently, the National Marine Fisheries Service (NMFS) conducted a legal review of its authority to provide a permit for commercial grow-out of cobia in Gulf of Mexico federal waters. Within its interpretation, NMFS legal council concluded that use of the term “harvest” in the Magnuson-Stevens Act did not allow exemption of aquaculture operations from the same regulations as wild fisheries. This meant that the Fishery Management Plan (FMP) for the species being raised would also regulate the aquaculture industry. In the case of cobia, only two fish per person per day could be “harvested” at the current legal size (84 cm) from the aquaculture cages as outlined by the FMP! One might venture to guess this would certainly remove any chances for economic success. This interpretation could also make it illegal for a fish farmer to hold juveniles under the indicated size in a cage for grow-out. Regardless of how ridiculous, this is just one example of the growing pains for a developing industry trying to fit into established regulations that cannot easily suit its needs.

The Gulf of Mexico Fishery Management Council is presently undertaking the public consultation process regarding a Generic Amendment to allow aquaculture of species federally managed in the Gulf of Mexico, thereby providing the necessary exemption of aquaculture to wild fishery regulations. Although this Amendment is being drafted, the process will require much debate and public review prior to possible adoption. In addition, at the time of writing, the National Oceanic and Atmospheric Administration are developing legislation to govern offshore aquaculture enterprises in the U.S. EEZ. However, criticism of this legislation is that it is in large part based upon near shore aquaculture operations and not commercial aquaculture experiences in the offshore environment. These arguments once again illustrate the need for substantially greater government funding to establish regional commercial-scale offshore aquaculture to determine potential impacts and set regulatory limits for future operators.

Public Perception and User Conflicts

Those groups that best inform create public perception. There seems to be no end recently to the advocacy groups and documents providing manipulated, outdated, and/or misleading information regarding aquaculture and its practices (even with the very limited marine aquaculture industry presently operating in the U.S., the Pew Oceans Commission summary report (2003) listed aquaculture as the fourth "major threat" to U.S. oceans, ahead of coastal development, overfishing, habitat alteration, bycatch, and climate change). In many instances the same individuals play a key role in the authorship applying a new spin to the same outdated and manipulated data. Manipulation may be quite blatant by comparing data that use different units of measure imparting an impression that the situation is much more serious than in reality. Sweeping generalizations of literature findings is also common practice whereby arguments are presented against the entire aquaculture industry as a whole (not separating various aquaculture sectors) based on data collected from a single location in the world and using a methodology that might not be standardized. Such generalizations are dangerous; as one poorly selected or managed farm site becomes representative of an entire industry. Other cases represent research findings that were directly supported by environmental advocacy groups. Regardless, these emotional messages are appealing to much of the general public, resulting in the placement of enormous pressures on government – which is heavily lobbied – and industry – which frequently finds itself occupying the defensive position. Tiersch and Hargreaves (2002) provided a concise discussion for contending with advocacy groups. Their discussion should be studied by individuals in the aquaculture industry prior to publicly commenting on environmental messages.

It is important to note that environmental advocacy is simply an industry to many of the multi-national organizations involved and no different than any other industry worried about its bottom line to survive. For those organizations I pose the questions: If there is no aquaculture industry where would seafood supplies originate in a world of increasing human population growth, increasing per capita seafood consumption, and decreasing wild fisheries resources? If not now, when? (After the majority of the fisheries resources have collapsed and we no longer have time to develop sustainable coexistent operations?)

On the other end of the environmental group spectrum are grassroots organizations composed of the public who are concerned with the integrity and safety of their local environment. Most of the general public can be reasoned with and relied upon to draw their own conclusions after balanced information is presented. With the appropriate dedication of time and consultation, these organizations will understand that aquaculture is indeed the only user group of the world's aquatic resources dependent on a clean and safe water supply for economic success. Even in the case of wild fisheries, wild fish populations will likely avoid polluted regions and wild fishers will follow those fish. Aquaculture, on the other hand, is fixed in space and therefore vulnerable to ambient environmental pollutants that may come either from external sources or originating from the aquaculture industry itself. For this reason alone aquaculturists must operate wearing their "environmental steward hats." While we develop aquaculture in this new frontier, however, we must not lead the public into expecting that offshore operations will have zero environmental impact. This is impossible and will become abundantly clear when numerous commercial scale operations exist in the same general location. A more suitable approach would be to ensure the public that through responsible industry development, impacts to the water column and benthic environment will be well within acceptable limits.

Throughout its existence the OAC has considered public education, outreach, and technology transfer of utmost importance. A considerable portion of the overall budget was allocated towards regional workshops, establishing a public education exhibit (Fig. 1), and maintaining a web site to ensure wide dissemination of research results and lessons learned (Reid and Bridger, this volume). A critical component of this was to inform not only the positive results but also the methods that did not work from our experiences. The integration of education and outreach should become mandatory with all research programs, regardless of the field of study or funding agency. This is becoming more commonplace with some funding agencies. A further step in this direction would be the involvement of an outreach and/or education specialist to ensure the effort is maximized to its greatest extent. Having the appropriately (scientifically) interpreted data enter the public arena for debate will decrease the amount of junk science and advocacy targeted toward aquaculture as the general public will further demand such rigors to be employed by environmental groups. You can't know what's wrong, if you don't know what's right!

User conflicts must be carefully considered to avoid further delays in the permitting process and subsequent vandalism and theft. In the case of the OAC, the cage site was selected merely on two attributes, neither of which was associated with the biological needs of the fish. First was the desire to be in 25 m of water to minimize the impact of northerly or tropical fronts moving through the region. Second was the presence of a manned gas production facility just a few hundred meters away. The latter criterion was very important in the vast expanses of ocean in the Gulf of Mexico and its enormous marine traffic associated with shipping, fisheries, and recreational boaters. Being near a manned gas platform served the OAC through passive protection and surveillance for vandalism and storm damage – to ChevronTexaco the relationship could best be described as altruistic, or being a great neighbor to a research program sharing the same marine environment.

Although passive protection might have been achieved against large ships, one instance was witnessed by workers on the gas platform involving the entanglement of a shrimp trawler into the mooring system. No

Fig. 1. The OAC public aquarium exhibit located at the University of Southern Mississippi's J.L. Scott Marine Education Center and Aquarium, Biloxi, MS (Photo credit: Carole Williams-Keenze, ChevronTexaco).

damage to the cage netting could be attributed with certainty to that incident but a similar event could be devastating to any aquaculture operator in the future. Further, numerous recreational fishers frequently fished in the vicinity of the cage as determined by the large number of hooks and other rigging (including a rod and reel) found on the cage and mooring system (Fig. 2).

The OAC took advantage of the "bird's eye view" of the gas platform by establishing Cage Cam to allow continuous observation of the cage via the internet (Fig. 3). Even with this degree of attention some unexplained holes occurred in the netting that might best be attributed to diver vandalism using a knife to cut entry into the cage (other holes also occurred but were determined to be the result of sea conditions). These experiences reiterate the need for offshore aquaculturists to have some form of control over a leased space and constant surveillance of the cage systems perhaps through a permanent presence offshore.

Appropriate Industry Planning

An important missing component to develop an offshore aquaculture industry has been industry planning. Planning might include a situation analysis to determine existing infrastructure and future needs of the industry; site selection based on existing marine uses and application of GIS technologies; social research to determine the exis-

Fig. 2. Fishing tackle collected off the offshore cage and mooring system (Photo credit: Tim Reid, Mississippi-Alabama Sea Grant Consortium).

tence of an accessible workforce and/or necessary training; and, legal methods to secure tenure of the water column and bottom for aquaculture. The latter has received some attention with regard to establishing Marine Aquaculture Zones (Fletcher and Neyrey 2003) that may be further extended to Marine Aquaculture Parks where numerous operators would co-exist. Most of the remainder of the planning list has received little or no attention to date despite numerous attempts by OAC researchers to acquire funds for these activities. Like most research topics, attention is only given when absolutely necessary and not as a proactive response for planning (i.e., planning and GIS will become a necessity after several farms have been haphazardly sited offshore). These are all critical components of industry development particularly if the research and industry wish to claim some sense of "sustainability" in the future.

Finally, industry planning must incorporate fish health management strategies from the outset to avoid epidemic situations that could devastate this emerging aquaculture sector. Nearly all of the open ocean operations presently operating in the U.S. are sited in sub-tropical environments. These regions will be particularly vulnerable to fish health issues given poor husbandry practices, high stocking densities, unsuitable industry planning, or high ambient water temperatures that favor spread of potential pathogens. Generally accepted fish health management strategies must be adopted including single-year class management, bay management systems, use of tidal excursions or current rates to set site distances, and fallowing.

Technology Suitability

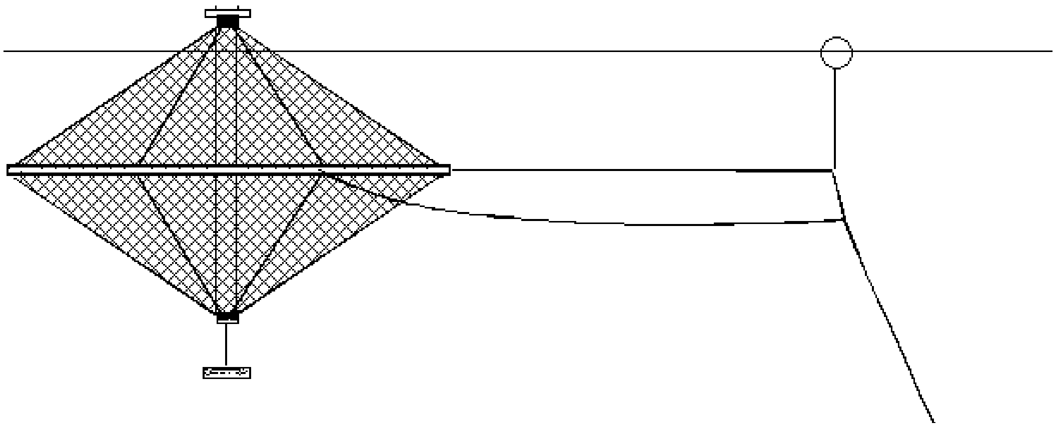
Worker safety and downtime associated with foul weather days should be the two main thrusts driving technology development and automation. Technology suitability requires effective use of individual components and holistic integration into a system for effective farm management. The OAC has made many strides in developing pioneering innovations suitable for offshore aquaculture—including a

Fig. 3. An image of OAC researchers working at the cage site captured from the internet-based Cage Cam (Photo credit: Tim Reid, Mississippi-Alabama Sea Grant Consortium).

suitable single-point mooring system (Fig. 4), an advanced mooring monitor, an autonomous feed system (Fig. 5), and a lift-boat specifically designed for offshore aquaculture (Fig. 6)—all the while keeping a complete offshore aquaculture system in mind for an efficient and safe working environment (Bridger and Goudey, this volume).

All of these innovative components fit together to ensure efficient operations while in the hostile offshore environment. A bottleneck to industry development, however, is integrating and operating these components at a commercial scale followed by production of the components in large quantities to ensure the system can be deployed in an economically feasible manner. Additional innovation is required to make offshore aquaculture a safe enterprise. Present operations in either exposed coastal and offshore environments rely heavily on scuba diving to complete standard farm chores. Dependence on scuba diving represents the "de-evolution" of aquaculture in some sense and certainly counterintuitive when the industry exists in more hostile environments than its near shore counterparts, but requires additional dive time than operations located in coastal bays or fjords. Net cleaning, cage inspection, mortality collection, and harvesting are all chores that presently use extensive diving. Automated

Fig. 4. Illustration of the OAC SPM showing the position of the shorter primary bridles 1.5-m above the longer redundant set of bridles and their respective connection points on the cage rim.



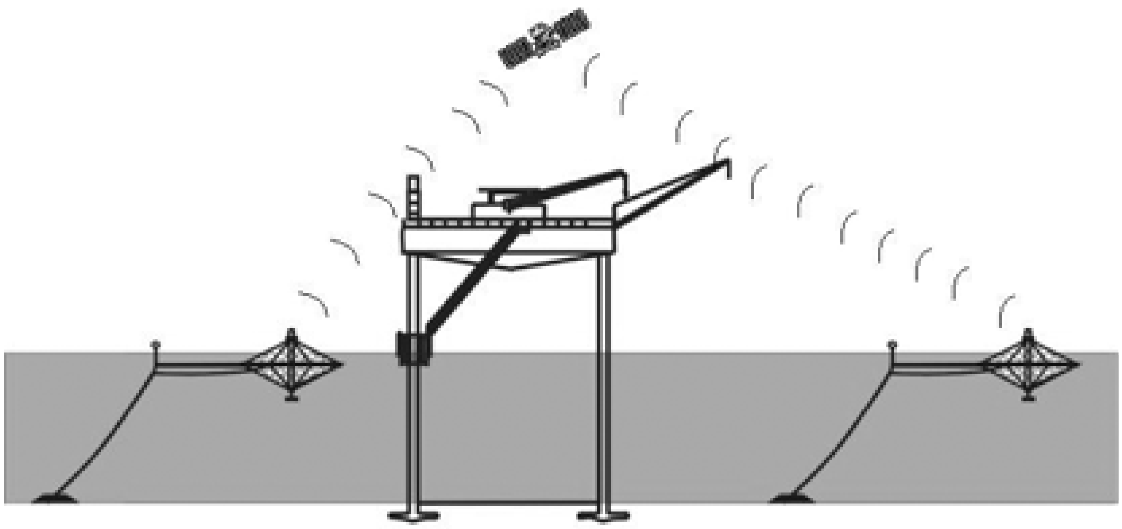
systems must be developed before commercial scale operations are likely to be established.

Fingerling Supply

The offshore aquaculture industry will require a continuous supply of an enormous number of fingerlings. A site consisting of 12–3,000 m^3 cages would require a minimum of 250,000 fingerlings per grow-out cycle for economic success (Posadas and Bridger, this volume; a site of this capacity would be small compared to numerous commercial farm sites throughout the world). With the exception of red drum, sufficient supplies of candidate Gulf of Mexico species are unavailable for

Fig. 5. The MIT Robofeeder (A) is attached to the top of the cage for autonomous fish feeding with feed placed in the silo and falling through two hoses exiting the spar (B).

Fig. 6. A conceptual design of the lift-boat ASV in its operational mode elevated up to 7 m above the water surface. Also note the presence of a helicopter pad, crane for lowering the work boat, satellite communication with each cage system, and a walkway extending to the water surface for easy access not requiring constant crane use to go to the platform.



grow-out and much research is still required to gain the knowledge for consistent fingerling production on demand. The OAC had access to a few hundred fingerlings of several candidate species. However, grow-out of a few hundred, or even a few thousand, individuals would be insignificant for industry development. Such quantities, coupled with inconsistent feeding offshore until automatic feed systems are perfected, would not provide any useful biological or economic data to make informed business decisions given the low stocking densities resulting from so few fish.

CONCLUSIONS

I feel the current situation in the United States is unfortunate. Growing up in Newfoundland and Labrador, I can draw many similarities between those fishing communities and Gulf of Mexico fishery-based communities. In both instances, fishermen refuse to believe that the wild stocks are collapsing, while having to invest increased fishing effort to capture allocated quotas. In addition, captured fish are either generally smaller in size or larger individuals only being caught further offshore. Overfishing, habitat degradation practices, and numerous other interrelated issues resulted in the collapse of the northern groundfish industries and the Gulf of Mexico could perhaps be 10–15 yr behind that situation. The difference is that the United States could learn from the mistakes of others in managing their fisheries and concurrently allocate appropriate levels of research towards aquaculture development. Presence of an aquaculture industry in the Gulf of Mexico during the collapse of commercial fisheries or downsizing an overcapitalized fishing sector could offset many of the economic and social problems expected in affected communities.

I feel confident that the presence of the OAC has raised the awareness for the potential of an offshore aquaculture industry in the Gulf of Mexico and our research efforts have advanced the development of offshore aquaculture throughout the nation.

ACKNOWLEDGMENTS

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The opinions expressed in this chapter are my own based on my experiences in the Gulf of Mexico and do not necessarily reflect the opinions of any of the agencies, individuals, or institutions mentioned and/or involved with the OAC.

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