Project Title: Expanding Opportunities for Florida's Shellfish Industry through Clam Restoration

Scope of Work

This cooperative research project will purchase live excess aquacultured clams, some of which will have "sized out" of the commercial market or die due to diminished sales from COVID-19 closures - thereby directly helping growers - while allowing for testing the success of using larger and more genetically diverse clams to generate ecosystem services from restoration using clams. Clams will be harvested from the Gulf coast and sited on the east coast at a pre-approved aquaculture lease location that is already monitored as a no-take zone and can seamlessly be incorporated into existing environmental monitoring efforts.

Project Description and Rationale

The Indian River Lagoon (IRL) is an Estuary of National Significance located on the east coast of Florida and is bordered by seven coastal counties, the Kennedy Space Center and Canaveral National Seashore. This 156-mile long shallow lagoon complex ranges from 0.4 to 5 miles in width and is home to over 4,300 species, making it the most biodiverse estuary in the northern hemisphere. Dominated by extensive seagrass beds and extremely clear waters, the IRL became a sport fishing and eco-recreation destination in the 1970's and was the center piece of tourism in the region for the decades that followed. However, population on the "Space Coast" has risen dramatically over the last 20-30 years and with that increase in human population has come tremendous anthropogenic impacts to water quality of the lagoon.

By 2008, harmful algal blooms and associated fish kills had become recurring events, culminating in the unprecedented "super bloom" of harmful algae and dinoflagellates in 2011 that all but eliminated seagrasses in the lagoon. As the crash of the IRL ecosystem made national news, several restoration programs including fertilizer restrictions, septic to sewer conversions and storm water management were enacted to help the system recover. To date, these programs are making progress in restoring water quality. Additionally, dredging of nutrient rich sediments over the last few years has removed a portion of the internal nutrient load that fuels algal blooms. With all of this effort, it would seem that planting of seagrasses for restoration would be highly successful, however, to date there have been very few seagrass areas reclaimed post super bloom. This is due to continued algal blooms (although at a reduced scale), increased turbidity from resuspension of fine sediment materials, and a lack of filter feeding organisms to help maintain water clarity. To assist in improving water clarity, oyster restoration and oyster gardening has also been utilized extensively throughout the IRL with variable success.

Until very recently, other filter feeders, such as clams, have been widely overlooked as a restoration tool. Historically, hard clams have been significant regulators of healthy water quality and economic stability in the IRL. Unfortunately, a variety of threats such as eutrophication, freshwater releases and algal blooms, have drastically decreased bivalve abundance and thus filtering capacity. This filtration, which decreases water turbidity, is critical for the return of healthy seagrass communities which support local fisheries and the economy surrounding them. As water filtration is a significant ecosystem service provided by these organisms and a critical link to IRL recovery, bivalve population restoration is a primary objective in restoration planning.

Through historical catch reports (https://publictemp.myfwc.com/FWRI/PFDM/), we see strong evidence that some species of clams (particularly *Mercenaria* and *Macrocallista*) were overharvested in the mid-1980s and into the 1990s. As a result of this overfishing, and more recently, extreme environmental stress, there has been limited recruitment, likely due to a diminished brood stock and a significantly reduced ability for synchronous spawning (Arnold et al. 2002).

In an effort to return clams to the IRL, UF has been spawning and repatriating hard clams from isolated individual *Mercenaria* clams found in the Lagoon. This approach leverages the short-term natural selection that has occurred as these individuals were exposed to and survived several environmental stressors such as prolonged HABs and hypoxia events. To date, over 3 million IRL clams have been returned to strategic locations within the Lagoon to provide filtering capacity and serve as sources for reproduction (https://www.irlclamproject.com/p/about-us.html).

Recently, COVID-19 has dramatically affected the hard clam culture industry in Florida (https://www.wuft.org/news/2020/05/28/inside-the-clamming-capital-of-the-us-during-covid-19/). As perhaps best summarized by a member of our advisory committee (pers. comm., Southern Cross Sea Farms, 06/01/20):

> *Our biggest concern is whether clam markets will increase enough to help farmers sell their product within the clams "window of opportunity." Once clams have grown to market size, there is a "best harvest time" before the product begins to overgrow in the cultured bags they are raised in. If not harvested within a reasonable time frame, clams begin to die off. In addition, the longer the bags remain on the bottom the more difficult the labor to harvest them becomes. Eventually after reaching market size and a six month window has passed, the clams are threatened where farmers sometimes just have to salvage what they can but most of the profit is lost. Another problem farmers will face is that as markets are down their inventory of clams continue to get backed up. As pressure builds to try to sell the extra clams, market price to the farmers could be threatened.*

Given that the original source of these clams was the IRL many years ago and that these clams are large and, therefore, have high filtering capabilities (and potentially lower mortality rates due to reduced predation), this product could provide substantial filtration service to areas in which the clams are planted. They could also bring genetic diversity to the next generation of the IRL clam population, which would enable the IRL to maintain a portfolio of genetically diverse species as insurance to the environmental stressors that have been increasing in the region. Although it is not known how these clams may respond to the challenging conditions of the IRL, they can be included in the established monitoring program UF is already conducting thus giving an opportunity to systematically compare these different varieties and ages for use in restoration efforts. In addition to the ecosystem service of water filtration they will provide, they will also be very useful in testing the broader assumptions that only certain genotypes/ phenotypes are suitable for restoration applications.

Approach

This project will be accomplished through the Shellfish Aquaculture Research and Extension Program (https://shellfish.ifas.ufl.edu/about-us/) within UF/IFAS. The main goal is to establish a new restoration site in the IRL using large clams purchased from licensed commercial farmers along Florida's Gulf Coast. The site is already in a protected and monitored no-take zone that is permitted for aquaculture production. The site will augment existing restoration sites in the IRL (www.irlclamproject.com), as such, the goal of this component of the cooperative research proposal is to determine the relative benefits of

using market-sized, farm-raised, and genetically diverse clams for both water quality restoration and commercial use. As the project involves stakeholders on both coasts, it also maximizes the reach of impact of this program. The specific objectives are to:

1) Arrange for the purchase of live market-sized Gulf Coast hard clams to be delivered for restoration on Florida's east coast.
2) Through UF's Whitney Marine Bioscience Laboratory, devise and implement an experimental design to allow for comparison with existing restoration sites in the IRL and similarly monitor growth, survival, and ecosystem services generated by clams in the new site.
3) Conduct stakeholder engagement to solicit volunteers and to promote the benefits to industry and ecosystems derived from the program.

Timeline

Activity	***Sep-Oct***	***Nov-Dec***	***Jan-Feb***	***Mar-Apr***	***May-Jun***	***Jul-Aug***
Phase 1						
Ascertain participation of growers and wholesalers	X					
Finalize participants, payouts and delivery schedule	X					
Deliver clams	X	X				
Phase 2						
Devise experimental design and prep for placement	X					
Schedule deployment dates, arrange for volunteers	X					
Deploy and begin monitoring	X	X				
Routine monitoring			X	X	X	X
Final report (environmental monitoring, stakeholder engagement)						X
Stakeholder Engagement*	X	X	X	X	X	X

* This engagement throughout the project will be coordinated by Florida Sea Grant Extension Agents. In addition to the co-PI Leslie Sturmer, local agents Holly Abeels (Brevard County), Vincent Encomio (Martin and St. Lucie Counties), and Angela Collins (Manatee, Hillsborough and Sarasota Counties) will assist with the communicating about the project with participant volunteers, local resource managers, the public and policy makers interested in the potential for restoration projects to support the commercial shellfish sector.

Benefits

This project will provide direct and timely relief to small shellfish aquaculture businesses suffering from sales losses due to COVID-19, and explore the potential for expanding economic outlets for shellfish aquaculture products used for habitat restoration. In doing so, this project intersects two national focus areas: 1) Healthy Coastal Environments and 2) Sustainable Fisheries and Aquaculture, and would contribute to the following National Sea Grant and Florida Sea Grant performance measures:

- Number of acres of coastal habitat enhanced or restored as a result of Sea Grant activities.
- Economic and societal impacts derived from Sea Grant activities.
- Number of citizens who participate in programs to restore coastal habitat or water quality.