Florida A&M University: Economic Development through Artificial Intelligence and Data Science-based Education and Training in Advanced Aquaculture Location: Crestview, Okaloosa Impacted Sites: Bay, Franklin, Okaloosa &Wakulla.

Victor M. Ibeanusi, Ph.D., Dh.c. (*Honoris causa*), PI
FAMU-Dean School of the Environment

Project Summary

Aquaculture is critical to resolving the world's food insecurity and projected future food shortages. Food production needs to double by 2050 to feed the projected world population. The world's oceans represent the greatest potential source of protein by generating 30 x more yield per acre of water versus an acre of land. Aquaculture will be an ever-growing portion of the seafood industry and will enable us to have available, accessible, and affordable seafood while bringing much-needed economic development. The federal government recognizes the importance of growing the aquaculture industry. The U.S. Department of Defense has designated fish imports as a serious national security issue as finfish imports are often used for trafficking weapons and narcotics. Large-scale seafood imports also provide a basis for the use of biological weapons against the United States, emphasizing domestic production and achieve self-sufficiency in finfish production. Global Aquaculture Market is valued approximately at USD 31.94 billion in 2019 and is anticipated to grow with a healthy growth rate of more than 7.1% over the forecast period 2020- 2027.

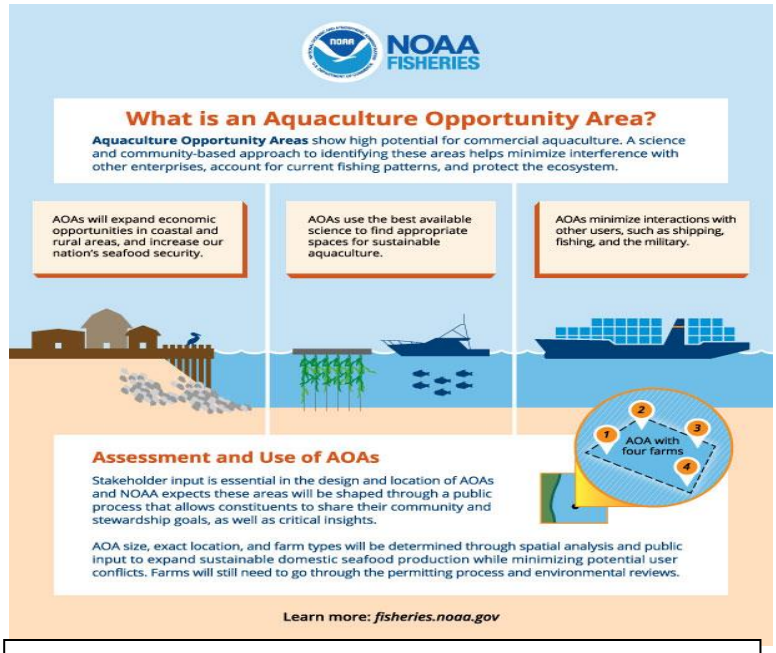

Figure 1: Aquaculture Opportunity Zones (Source: fisheries.noaa.gov)

Aquaculture products in the US market have significant growth potential over the coming five years. IBISWorld forecasts US industry revenue to increase at an annualized rate of 5.0% during the five years 2022 to 2027, reaching an estimated $2.9 billion. The National Oceanic and Atmospheric Administration (NOAA) has stated that marine aquaculture is an important part of its strategy for building economic and environmental resiliency in coastal communities. (Ref., https://www.fisheries.noaa.gov/leadershipmessage/momentum-grows-aquacultureunited-states, September 2017). Seafood farming, if done responsibly—as it is in the United States—is increasingly recognized as one of the most environmentally sustainable ways to produce food and protein. Aquaculture Opportunity Areas and expanded domestic aquaculture industry are critical for the economic and environmental resiliency of our coastal communities, and national food security.

NOAA Fisheries announced federal waters off the Gulf of Mexico (GoM) as one of the first two regions to host Aquaculture Opportunity Areas. The selection of these regions is the first step in a process designed to establish 10 Aquaculture Opportunity Areas nationwide by 2025. GoM was selected for future aquaculture opportunity area locations based on the already available spatial analysis data and current industry interest in developing sustainable aquaculture operations in the region. Aquaculture Opportunity Areas (AOAs) (Figure 1) are called for in the May 2020 Executive Order on Promoting American Seafood Competitiveness and Economic Growth. They are defined as geographic areas that have been evaluated for their potential for sustainable commercial aquaculture. Selected areas are expected to support multiple aquaculture farm sites of varying types including finfish, shellfish, seaweed, or some combination of these farm types. To identify each area, NOAA will use scientific analysis and public engagement to highlight spaces that are environmentally, socially, and economically appropriate for commercial aquaculture.

FAMU being the host institution for NOAA's Centre for Coastal Marine Ecosystem will play a vital role in this process and will have first-hand information on such AOAs and their appropriate aquaculture designations.

Florida Agricultural and Mechanical University (FAMU) is proposing:

1) To lead job creation, investments, and economic growth for communities throughout northwest Florida through the creation of a vertical business model for finfish aquaculture that builds on the growing aquaculture industry in four disproportionately affected Counties.

2) To develop educational and training programs for students that will establish pathways to careers in the rapidly growing aquaculture industry, especially in the disproportionately affected.

3) To develop a business framework for the finfish aquaculture industry that will assist small businesses in creating jobs, investments and economic growth for communities throughout Northwest Florida.

4) To scale-up and commercialize newly isolated strains of microalgae (patent pending) to significantly enhance the overall health and productivity of finfish aquaculture that is economically and environmentally cost-effective relative to the existing algal feedstock;

5) To ensure the ecosystem restoration for the area through best aquaculture practices, and

6) To implement a state-of-the-art underwater drone school technology (patent pending), that uses SASER (Sound Amplification by Stimulated Emission of Radiation) energy to ensure the protection against invasive species and harmful micro-algae, while providing real-time environmental monitoring and control.

FAMU Request: $5,204,840

Matching Funds: 5,390,679

Florida A&M University-Economic Development through Artificial Intelligence and Data Science-based Education and Training in Advanced Aquaculture: Impacts to the Fin Fish Labor Market

As referenced in the National Oceanic and Atmospheric Administration's Fisheries of the United States 2019 Report, 70 to 85 percent of seafood is imported into this country, with nearly 50 percent of this imported seafood made available through aquaculture. As of 2019, the United States seafood trade deficit approached $17 billion.

Our project is intended accelerate innovation to amplify existing markets and create new ones. Consumers are becoming health conscious and demanding high quality products. Our Aquaculture curriculum, accompanied with the proposed technologies will impact new skills to fish production, genetic improvements, and control of parasitic diseases.

Fish are the primary sources of protein, which also drives the growth of the global fin fish market. However, increasing rise in the temperature leading to increase in water pollution has to be monitored.

We have recently deployed an aquatic sensing water quality buoy off the gulf coast that gives us real-time water quality data 27/7 on key parameters (nitrates, salinity, conductivity, total solids, dissolved oxygen, oxidation reduction potential, algae as chlorophyll, temperature, and pH). Although not included in our matching funds, the buoy brings innovation and added value to our project and to the labor market.

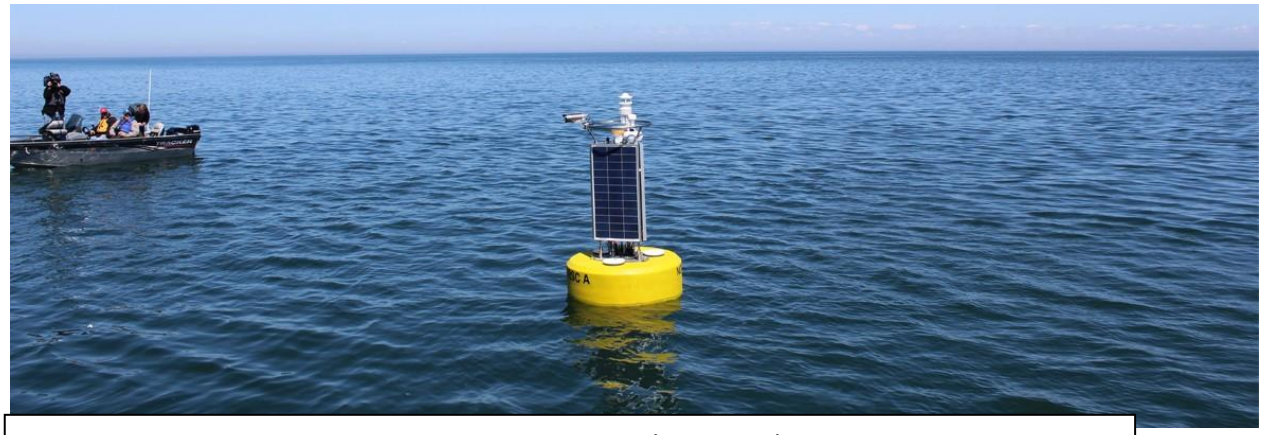

Figure 1: FAMU Aquatic Sensing Water Buoy: Victor Ibeanusi, Ph.D., PI

Report shows that Florida ranked 11th among U.S. states in 2016 for fresh seafood production with 87 million pounds harvested and a dockside value of $237 million, which is 4.5 percent of U.S. total value. Data from the Florida Department of Agriculture and Consumer Services shows seafood production in Florida accounted for 4,000 jobs and had an economic impact of more than $400 million in 2016 alone.

With 1,350 miles of saltwater coastline, commercial and recreational marine fishing is a big business in Florida. In 2015, Florida's commercial and recreational marine fishing industry

supported 176,000 jobs and generated $28.7 billion dollars in sales, ranking as the third-highest state in employment impacts and second-highest state in sales, income, and value-added impacts.

TABLE 1

Economic impacts of commercial and recreational fisheries in Florida, 2015

	Number of jobs	Income impacts (dollars)	Sales impacts (dollars)	Value-added impacts (dollars)
Commercial	79,714	3,319,369,000	17,713,169,000	5,931,263,000
Recreational	96,801	2,620,297,000	10,967,678,000	6,611,445,000
Total	**176,515**	**5,939,666,000**	**28,680,847,000**	**12,542,708,000**

Source: National Oceanic and Atmospheric Administration Office of Science and Technology, Fisheries Economics of the United States, 2015: Economics and Sociocultural Status and Trends Series (U.S. Department of Commerce, 2017), https://www.st.nmfs.noaa.gov/economics/publications/feus/fisheries_economics_2015/index.

CAP

https://www.americanprogress.org/article/warming-seas-falling-fortunes/

Seafood production in Florida is mainly from the eight gulf coast counties, which needs to be kept in a sustainable way to provide for today's needs without damaging the ability of the species to reproduce and be available for future generations. For fin fish farming, labors are needed to hatch fin fish in hatcheries. It is urgent to understand the quantity and nature of labor requirements to provide training for improved farming practices, feeds, and water quality.

In 2016, the dockside value of finfishes is $2,094,505. From 1997-2016, finfish production is 47,240,523 lbs.

Florida Commercial Landings by County — 2018

County	Pounds	Estimated Value
Monroe	10,464,207	$56,810,139
Lee	8,446,210	$17,953,886
Pinellas	5,311,528	$16,755,57
Gulf	3,947,603	$2,026,605
Hillsborough	3,559,083	$6,692,553
Duval	3,490,567	$7,954,680
Manatee	3,235,679	$3,457,688
Brevard	2,985,416	$5,777,361
Bay	2,434,354	$7,479,881
St. Lucie	1,881,576	$4,649,075
Franklin	1,840,645	$5,539,512
Palm Beach	1,587,178	$3,835,520
Collier	1,317,458	$5,611,248

Martin	1,308,357	$1,969,656
Volusia	1,245,451	$2,671,242
Hernando	1,120,154	$5,768,569
Citrus	1110,415	$3,787,886
Escambia	1,028,444	$1,834,639
Okaloosa	1,027,280	$3,072,256
Miami-Dade	960,743	$2,899,182
St. Johns	924,234	$2,166,727
Nassau	865,657	$2,139,741
Charlotte	847,939	$1,195,886
Levy	782,041	$2,450,411
Dixie	682,077	$2,361,268
Indian River	493,012	$1,209,091
Wakulla	473,469	$1,042,189
Broward	414,730	$1,769,662
Taylor	364,357	$789,406
Pasco	321,367	$1,696,542
Santa Rosa	184,612	$231,077
Putnam	129,604	$281,167
Sarasota	75,716	$337,043
Flagler	54,587	$38,769
Clay	32,529	$52,705
Walton	29,471	$39,902
Jefferson	667	$1,704
Source: Florida Fish and Wildlife Conservation Committee		

The workforce for a growing aquaculture development includes those that are needed to support the entire value chain. Thus, workforce development efforts will need to include the skillsets required to expand the feed manufacturing, food processing, warehousing/distribution, equipment manufacturing, and other upstream and downstream sectors essential for aquaculture products to move efficiently through to end consumers.

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Proposal Status & Updates – November 11th, 2021

Okaloosa Board of Country Commissioners (BCC) Support:
We are expected to be placed on the agenda for the Okaloosa BCC meeting on their November 16th meeting, pending confirmation on November 12th. Alternatively, we are informed that we will be moved to their December 7th meeting if we are not included in their November meeting.

FL DOE CAPE list application status:
As indicated in the proposal, the CAPE code will be applied for the SASER Drone Swarm Technology training, which has applications beyond aquaculture, including defense and overall environmental monitoring and control of underwater ecosystems. The current prototype at FAMU needs to be scaled-up using Triumph Gulf support to build capacity for offering this training at FAMU. This will be a unique training opportunity pioneered by FAMU. Hence we are targetting the 2022 deadline for complete submission under the assumption that we will be funded before that. Although FAMU is committed to developing the curriculum and training programs, establishing the proposed training programs at FAMU is contingent upon Triumph Gulf's support.

Region's labor market:

The Economics of Aquaculture Policy and Regulation says 40 million tons of fish will be needed to meet global demand by 2030. According to the National Research Council, with the world population projected to reach 9 billion by 2050 and per capita seafood consumption on the rise, America will need a diverse set of food sources to meet these needs. More than 90% of Americans' seafood is imported, creating a trade deficit of over $17 billion annually. The United States is missing an opportunity to create a competitive seafood industry with new jobs and a boost to the economy at a time when it's needed most. The current status quo estimated by IBISWorld *(www.ibisworld.com*) the 2021 US aquaculture market at ~$2 Billion, of which ~22% is estimated to be from the Gulf of Mexico. But the potential of the Gulf of Mexico for aquaculture, especially sustainable marine aquaculture, is 20 fold the current capacity. The USDA Fish and wildlife estimates, aquaculture production to about 1 million tons could create an additional 50,000 direct and indirect jobs, assuming 20 direct jobs per 1,000 tons produced and five total jobs (including jobs in equipment, feeds, processing, marketing, and food service) for each direct job. While this is a small increase in jobs relative to the national labor market, the context of the

location of these jobs and who might be employed is critical. These jobs could provide stable, year-round employment opportunities in coastal and fishing communities, where opportunities are often limited and seasonally dependent. Therefore, the number of certifications estimated in this proposal must be scaled up several folds by 2030 as the aquaculture market grows in the eight counties served by Triumph Gulf.

Project outcomes:
Although FAMU had cut back on the number locations where the demonstration site will be built under this project to only one, the estimated outcome in terms of certifications will remain the same. Moreover, FAMU will seek additional funding from the EDA and other federal agencies to replicate the success demonstrated by this project to multiply the impact of the Triumph Gulf Support.

FAMU - Triumph Gulf_Revised Budget -Victor Ibeanusi, PhD., PI											
Budget Categories	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 6**	**Year 7**	**Year 8**	**Total Requested**	**Matching Funds**	**Total Budget**
Finfish Business Infrastructure: Building Innovation for High-Quality Finfish Aquaculture											
Finfish Aquaculture Business Program - (NOAA Designated Aquaculture Metabolic Hub demo site setup in one of the 3 counties) - Recruitment & On-Site Training	$250,000	$0	$0	$0	$0	$0	$0	$0	$250,000	$0	$250,000
Computational and IT Upgrades (Virtual Algae Farm, AR/VR Systems)	$40,000	$0	$0	$0	$0	$0	$0	$0	$40,000	$0	$40,000
Drone Schools/Swarms	$250,000	$250,000	$0	$0	$0	$0	$0	$0	$500,000	$0	$500,000
Algal Silage Infrastructure (Microwave assisted algal silage production)	$200,000	$100,000	$0	$0	$0	$0	$0	$0	$300,000	$0	$300,000
Subtotal	**$740,000**	**$350,000**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$1,090,000**	**$0**	**$1,090,000**
K-14 Educational and Training Operations:											
K-12 Certifications for Aquaculture Training (summer camp training)- FLDOE standards (100 Certifications/year)	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$400,000	$0	$400,000
Vocational Training/Certifications											
FLDOE USINS001 Small UAS (sUAS) Safety Certification: Level 1 Training - 30 Certificates/yr	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$120,000	$0	$120,000
FLDOE USINS002 Visual Line of Sight System Operator (VSO) Ground - 30 Certificates/yr	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$120,000	$0	$120,000
Underwater Drone School Training (Will be submitted to FLDOE for CAPE Code) 30 Certifications/yr	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$15,000	$120,000	$0	$120,000
Subtotal	**$95,000**	**$95,000**	**$95,000**	**$95,000**	**$95,000**	**$95,000**	**$95,000**	**$95,000**	**$760,000**	**$0**	**$760,000**
Other											
Community Outreach, Dissemination, Stakeholder Engagements (Bringing Industry investors for on-site demonstrations and tours)	$50,000	$0	$50,000	$0	$50,000	$0	$50,000	$0	$0	$200,000	$200,000
Subtotal	**$50,000**	**$0**	**$50,000**	**$0**	**$50,000**	**$0**	**$50,000**	**$0**	**$0**	**$200,000**	**$200,000**
Salaries (incl. Fringes)											
Senior Personnel											
Victor Ibeanusi, PI – (20%)	$45,900	$45,900	$45,900	$45,900	$45,900	$45,900	$45,900	$45,900	$0	$367,200	$367,200
Satyanarayan Dev (Co- PI) – (20% - 9-Month Salary)	$28,312	$28,312	$28,312	$28,312	$28,312	$28,312	$28,312	$28,312	$0	$226,498	$226,498
Satyanarayan Dev (Co- PI) – (13 wks summer)	$48,465	$48,465	$48,465	$48,465	$48,465	$48,465	$48,465	$48,465	$387,720	$0	$387,720
Other Personnel											
Gang Chen (20% - 9-Month Salary)	$32,382	$32,382	$32,382	$32,382	$32,382	$32,382	$32,382	$32,382	$0	$259,056	$259,056

Gang Chen (1month-	$17,990	$17,990	$17,990	$17,990	$17,990	$17,990	$17,990	$17,990	$143,920	$0	$143,920
Yudi Wu (100% - 1 FTE)	$88,000	$88,000	$88,000	$88,000	$88,000	$88,000	$88,000	$88,000	$704,000	$0	$704,000
Project Coordinators (2)*	$130,000	$130,000	$130,000	$130,000	$65,000	$65,000	$65,000	$65,000	$780,000	$260,000	$1,040,000
Faculty lines -2	$199,800	$199,800	$199,800	$199,800	$199,800	$199,800	$199,800	$199,800	$799,200	$799,200	$1,598,400
Students employees (Undergraduates - 25 Certifications/year)	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$400,000	$0	$400,000
K-12 Teachers Engagement (Training the teachers for curriculum infusion)-	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$50,000	$400,000	$0	$400,000
Sub total	**$690,849**	**$690,849**	**$690,849**	**$690,849**	**$625,849**	**$625,849**	**$625,849**	**$625,849**	**$3,614,840**	**$1,911,954**	**$5,526,794**
Other Matching Funds											
Core Lab Manager (0.15 FTE)	$8,250	$8,250	$8,250	$8,250	$8,250	$8,250	$8,250	$8,250		$66,000	$66,000
Recruiter (0.2 FTE)	$11,000	$11,000	$11,000	$11,000	$11,000	$11,000	$11,000	$11,000		$88,000	$88,000
Core Lab Instrumentation	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000		$160,000	$160,000
Maintenance and service	$13,500	$13,500	$13,500	$13,500	$13,500	$13,500	$13,500	$13,500		$108,000	$108,000
FAMU CREST (34%)	$340,000	$340,000								$680,000	
FAMU CSER (30% Salaries	$62,500	$75,000	$67,625							$205,125	
USDA NRCS Mississippi	$86,500	$86,500	$86,500							$259,500	
NSF HDR: AI Across the curriculum (50%)	$87,500	$87,500	$87,500							$262,500	
Projected Matching Funds from Grants over years 2-8		$150,000	$150,000	$150,000	$150,000	$150,000	$150,000	$150,000		$1,050,000	
Faculty Salaries for years 9 &10										$399,600	
Total FAMU Matching	$885,744	$998,244	$700,869	$409,244	$524,244	$474,244	$524,244	$474,244		**$5,390,679**	
Total Triumph Request	**$1,319,355**	**$929,355**	**$579,355**	**$579,355**	**$449,355**	**$449,355**	**$449,355**	**$449,355**	**$5,204,840**		
Total Budget	$2,205,099	$1,927,599	$1,280,224	$988,599	$973,599	$923,599	$973,599	$923,599	$5,204,840		**$10,595,519**

Highlights

1. Finfish Aquaculture Business Program - (NOAA Designated Aquaculture Metabolic Hub demo site setup in one of the 3 counties instead in all 3 counties) -this reduction reduces our total FAMU request to $5,204,840

Recruitment & On-Site Training

2. Letter of support from World Ocean Counncil- their support and experience will attract aquaculture and other industries in the counties

3. The new award from NOAA is not included in the match. I shared the award information as another evidence of FAMU in being able to attract economic development in the area that include student training

Funding Match Explanation for the FAMU Triumph Gulf Project

FAMU CREST (34%):

Florida A&M University is a proud recipient of the National Science Foundation's Center for Research Excellence in Science and Technology (CREST) grant in the amount of $5,302,797 for developing advanced manufacturing technologies under the title "Center for Complex Materials Design for Multidimensional Additive Processing" (Award no: 1735968). Dr. Dev is one of the five Principal Investigators working on this grant. The custom designed as well as commercially available multidimensional additive manufacturing equipment and materials (environmentally friendly polymers) will be used for the manufacturing of the arial drone swarms and underwater drone schools. A conservative estimate of the resources utilized from this grant adds up to at least one-third of the resources in terms of equipment, salaries and student stipends will be used directly for the development and use of materials needed for this project. The remaining performance period of this grant is two years and one-third (34% percent) of the resources are estimated to be spent on the above-mentioned activities thus providing a match of $300,500/year for two years.

FAMU CSER (30%)

FAMU School of the Environment has successfully received the support of USDA Forest service from the RESTORE Act for the Center for Geospatial Ecology and Restoration. The staff employed under this project will spend 30% of their time in programming and developing geospatial algorithms for automation of the drome operations as well develop AI-based solutions for real-time analysis and decision making using the drone data. This grant has a remaining performance period of three years. Therefore, 30% of the salaries budgeted in this project is considered a direct match to this grant. Based on the annual budgeted salaries under this $62,500, $75,000 and $67,625 respectively for 3 years.

USDA NRCS Mississippi State (50%)

This is a research project funded by USDA NRCS Mississippi State for assessing water quality and soil health using spectroscopic techniques that can be used in real-time decision making. The systems and techniques developed for this grant are directly applicable to the real-time underwater drone schools to collect and assess water quality in the proposed aquaculture systems in the Triumph Gulf funded project. Since the scope of the proposed Triumph Gulf Project is limited to water quality, we consider that 50% of the grant funds expended would be a direct match to this project. This project has an estimated performance period of three years and this amounts to $86,500/year for the next three years

NSF HDR (50%)

FAMU is a subaward recipient in the amount of $525,000 of the total award of $1.5M from the National Science Foundation (NSF) for the Harnessing the Data Revolution (HDR) under the grant titled AI across the statewide curriculum (NSF Award Number 2123440). This will grant pay a stipend (up to $5000/semester) for all the students trained in the AI applications of the Triumph Gulf project as well as provides supplies for training the students on the same. This will enable recruitment and training of under-represented students from the eight disproportionately

affected counties served by the Triumph Gulf. It is estimated that at least 32 students will be trained under this grant, of which 50% of the students enrolled to receive this stipend will be from the disproportionately affected counties and 50% of the products (algorithms and protocols) developed by the students and faculty in grant from the FAMU subaward will be directly applicable to the AI based aquaculture production systems. This grant has an estimated performance period of three years starting 01/01/2022. Therefore, an estimated match of $87,500 is expected from this grant.

Projected Matching funds for years 2-8

This proposed Triumph Gulf project is an enormous undertaking and it required contribution from members of the university (researchers, scientists, technicians, faculty and students) beyond the funds requested from Triumph Gulf to successfully train the hundreds of students as proposed in the project. Moreover, Triumph Gulf does not provide the overhead expenses borne by the university that is involved in successfully conducting this project. Therefore, any paid time spent by any university member (not explicitly paid for in this proposed budget) is paid by some other research grant and/or the state funds provided for education and general.

As noted in the budget a minimum of $241,625 (not including this projected match) will be contributed from other research grants in terms of salaries, infrastructure, equipment and student stipends during the first three years of this grant performance period. As the research team working on this project would continue to write other research grants and secure extramural funds for projects that would directly and indirectly contribute to the goals of this grant proposal, a conservative estimate of being able meet at least two-third of this match in future years is included as $150,000 (rounding off to the lower end) has been added. For example, one of the extramural research funds include underwater 3D, 4D and 5D printing. Although aimed to mitigate rising sea-levels, it has direct implications to the infrastructure for marine aquaculture. Another project on 3D printing of carbon-negative hurricane resilient structures will also directly benefit this proposal, hence the justifying the projected minimum matching funds.