The following document contains summaries of CTSA projects that were active during 2017. Please note: projects funded under the CTSA FY16 Plan of Work commenced recently and do not yet have significant findings to report. They are not included in this report.

1. Development of Practical Local Feeds to Support Sustainable Aquaculture in Hawaii and Other Pacific Islands, Years 1 and 2 .......................................................... 3

2. Establishment of Milkfish Fry Production in Palau to Reduce Dependency on Imported Fry, Years 1 & 2 ...................................................................................... 5

3. Increasing Production and Improving Food Safety for Hawaii’s New Bivalve Industry, Years 1 & 2 .................................................................................................. 7

4. Establishing Coral Grouper (Plectropomus leopardus) Production in Palau through the Application of Intensive Copepod Production Technology, Years 1 & 2 ........................................................................................................... 9

5. Potential of Black Soldier Fly as a Feed Ingredient to Support Hawaiian Aquaculture, Years 1 and 2 ........................................................................................................ 11

6. Utilization of Local Agri-processing by-products to Produce Fungal Protein for Aquatic Feed Production, Years 1 and 2 ................................................................. 13

7. Aquaculture of Opihi, Years 3 and 4 ................................................................................................................................. 15

8. Integrated Multi-Trophic Aquaculture of Shrimp and Sea Cucumbers for Nutrient Recycling, Sludge Reduction, and Creation of Additional Revenue Streams, Year 1 ................................................................................................................................. 17

10. Assuring Oyster Seed Supply for Hawai‘i and the West Coast, Year 2 ......................... 21

11. Improving Rabbitfish Seed Production Capacity in Palau, Year 1 .............................. 23

12. Improving Nursery and Grow-Out Culture of Mangrove Crab by Minimizing Cannibalism and Developing Feed Supplements .................. 25

13. Development of Cost-Effective Aquatic Feeds Using Locally Sourced Ingredients .......................................................... 27

14. Aquaculture Information Service for the Pacific Region ........................................ 29
Development of Practical Local Feeds to Support Sustainable Aquaculture in Hawaii and Other Pacific Islands

Funding Level: $195,609 (2 Years)
Lead Institution: Oceanic Institute of Hawaii Pacific University
Principle Investigator: Zhi Yong Ju, Ph.D.
Status: Completed on December 31, 2016

Summary
There is currently no local feed production for aquaculture in Hawaii and the Pacific regions. This project classified available ingredients in the region and determined those which can be successfully used in local aquaculture feeds through the formulation of several diets. Utilization of local ingredients or by-products analyzed through this project will help local aquaculture become independent of imported feeds/ingredients. In addition, the knowledge gained from this project will be useful for research on tropical aquatic feed production.

Target Audiences
Aquaculture farmers, feed industry, agriculture producers, agriculture administration agencies, scientists or researchers from institutes or universities.

Objectives
Objective 1: Create a database of local ingredients including levels of nutrient and nutrient digestibility (for selective ingredients) evaluated in tilapia (Year-1) and Pacific threadfin (Year-2).
Objective 2: Develop scientifically sound feed formulations based on local ingredients for tilapia (Year-1) and Pacific threadfin (Year-2).
Objective 3: Develop a calibration library of nutrient information for Near-infrared spectroscopy system (NIRS) as a fast and inexpensive tool to measure nutritional parameters in local ingredients or feeds.
Objective 4: Organize workshops to provide training and research updates on local feeds production for farmers, producers or researchers in Hawaii (Year-1) and Guam (Year-2).
Objective 5: Technology Transfer: Publish results in Regional Notes by CTSA, present findings at Aquaculture meetings and publish papers in peer reviewed journals or aquaculture magazines.

Project Accomplishments
- A nutritional database has been built in the OI FeedServer data center. This database holds all nutritional and digestibility results for the analyzed local ingredients. Analyzed local ingredients include local fish meals, defatted haematococcus, spirulina, copra meal, cassava, duck weed, azolla, salvinia, taro, papaya, wheat bran, black-soldier fly and dehydrated food waste etc.
- Several feed formulas using over 90% local ingredients were developed and tested for tilapia.
- Inclusion of local major ingredients (RMI fish meal and defatted hematococcus) in a diet for shrimp generated similar or better production efficiency compared to control feed.
- Results from feeding trials demonstrate the great potential for making tilapia and shrimp feeds using local ingredients.
Outputs & Outreach

Under the auspices of this project, nutritional databases for local tropical ingredients, local formulated diets and commercial feeds have been established. In addition, local formulated feeds using over 90% local ingredients were tested and established for Tilapia. A calibrated library for local major feed ingredients and formulated feeds was established for the NIRS.

Outreach conducted under this project included two local feed workshops. One took place at the Oceanic Institute of Hawaii Pacific University, and the second took place in August 2016 in the Republic of the Marshall Islands (RMI). Both workshops were held in conjunction with other related CTSA projects.

Outcomes & Impacts

The local feed formula including over 90% local ingredients showed similar or better production effects than a formulation based on imported ingredients in the tilapia trial; it will soon be tested on white shrimp. The results suggest great potential for using local ingredients in feed production. The information included in the local ingredient database can be utilized by the feed industry, as well as researchers in feed production research. The NIRS will benefit our local industries by providing quick monitoring on feed/ingredient quality.

The overall results of this project demonstrated the potential of local feed production, though some challenges still exist including the limited production of local ingredients and lack of a feed production facility. The results of this project can also benefit national and international researchers regarding feed formulation research.

Publications & Presentations

A poster “EVALUATION OF LOCALLY SOURCED FEED INGREDIENTS FOR PACIFIC WHITE SHRIMP Litopenaeus vannamei” was presented in AQUACULTURE 2016 conference in Las Vegas, Nevada, February 22 - 26, 2016.

A poster “NUTRIENT COMPOSITION OF LOCAL INGREDIENTS & THEIR DIET ON GROWTH OF TILAPIA IN FRESHWATER & SALTWATER” was presented by AQUACULTURE 2016 conference in Las Vegas, Nevada, February 22 - 26, 2016.

A manuscript “Effects of microalgae-added diets on growth performance and meat composition of tilapia (Oreochromis mossambicus)” was accepted by Aquaculture Research in February 2017.

Two additional manuscripts “Local algae-added diet on growth, survival and meat quality of pacific white shrimp (Litopenaeus vannamei)” and “Effects of low and high n-3 fatty acid diets on n-3 fatty acid contents in meat, liver & eggs of tilapia (Oreochromis mossambicus)” are in preparation.
Establishment of Milkfish Fry Production in Palau to Reduce Dependency on Imported Fry

**Funding Level:** $128,810 (2 Years)  
**Lead Institutions:** Palau Community College  
**Principle Investigators:** Miguel Delos Santos  
**Status:** Completed on June 30, 2017

**Summary**  
Milkfish (*Chanos chanos* Forskall) farming is becoming a fast growing aquaculture industry in Palau. Currently, there are five milkfish farms that operate nationwide and annually about 25 million milkfish fry are needed to cater to the high production requirement for milkfish (both as food fish and live tuna bait). However, due to the limited supply of milkfish fry from the wild, milkfish farmers in Palau have been importing the seedstock from neighboring countries. Although some milkfish farmers consider it convenient to import the milkfish fry to satisfy their production requirement, concerned individuals consider this an issue because of the possible negative impact such as the introduction of pathogens that comes along with the live organism to the aquatic environment. This two-year project was conducted to verify and adapt available technology on the breeding and seed production of milkfish in Palau.

**Target Audiences**  
The target audiences include milkfish fish producers, the general public and policy makers in Palau and the Pacific region.

**Objectives**  
*Objective 1:* To collect sexually matured milkfish and establish at least two broodstock facilities that will be monitored for natural spawning in captivity.  
*Objective 2:* To document the egg production performance of captive milkfish broodstock in Palau condition.
Outcomes & Outreach Activities
At least four milkfish farm technicians, two private hatchery technicians and three PCC staff have been trained and able to experience the actual operation of milkfish broodstock management and larval rearing. Two major milkfish farms in Palau were able to stock about 148,000 high locally produced milkfish fry for grow-out in their farms. Eight milkfish farm technicians have experienced the grow-out of milkfish on farms in Palau.

A training workshop on local production of milkfish fry was conducted for various participants in Palau. Four articles in three local news journals and one international aquaculture magazine were published. Two oral presentations highlighting the status of the milkfish project were delivered during a local workshop and at a national aquaculture conference. A detailed hatchery manual is in final production.

Outcomes & Impacts
People in Palau have become aware of PCC’s ongoing project on the establishment of milkfish broodstock and the effort to address the unavailability of locally produced milkfish fry to support the growing milkfish farming industry in the country.

Local farmers, traditional leaders and concerned government agencies support this project, and have encouraged PCC to continue their efforts to improve the milkfish egg production. They do so by allowing the project work group to utilize some areas of their farms and their farm-grown broodstock to enhance the quality of spawners for research.

Publications & Presentations
Highlights on aquaculture research and extension projects in the Republic of Palau at the National Aquaculture Extension Conference held in Boise, Idaho on June 6-8, 2017

PCC Aquaculture Research and Extension Project in Palau presented during the Palau Aquaculture Workshop: Supporting Palau’s Food Security and Community Livelihood held at PCC Continuing Education Room on September 27-29, 2017

Milkfish farming manual is forthcoming
Increasing Production and Improving Food Safety for Hawaii’s New Bivalve Industry

Funding Level: $83,306 (2 Years)
Lead Institutions: University of Hawaii at Hilo
Principle Investigators: Maria Haws, Ph.D.
Status: Completed on August 31, 2017

Summary
Bivalve shellfish aquaculture is distinguished from other forms of aquaculture in that sanitation is fundamental to producing safe products and molluscan sanitation is the most complex and costly form of sanitation for aquaculture products. While bivalve shellfish are amongst the healthiest food sources, their filter feeding habitats can cause pathogenic bacteria, viruses, heavy metals and radiation to accumulate in their tissues, representing serious threats to human health and safety. Shellfish sanitation is therefore the key issue confronting the new Hawaii bivalve industry. A second major obstacle to further development of the shellfish industry is the current remote reliance on being forced to buy large oyster seed due to the lack of remote setting capability and nursery systems. This project successfully addressed these issues through the design of a new model of depuration tank, design of a solar-powered FLUPSY for use under typical conditions found at Hawaiian fishponds, and the development of testing capacity at two laboratories (DOH and UH) for Vv and Vp.

Target Audiences
Bivalve farmers in Hawaii and students.

Objectives
Objective 1: Design, develop and test depuration units that are suitable to local conditions, cost-effective and in compliance with the unique Hawaii DOH regulations. Year 1.
Objective 2: Determine if depuration affects oyster quality and determine if salting enhances the lepto-organic properties of oysters grown in Hawaiian fishponds. Year 1.
Objective 3: Quantify Vibrio vulnificus and V. parahaemolytus in pond water and in oyster tissues before and after depuration. Year 1-2.
Objective 4: Design, build and test a nursery system that is suitable for conditions found in Hawaiian fishponds. Year 1-2.
Objective 5: Train farmers in two critical industry topics: 1) depuration and food safety; 2) and setting and nursery methods. Year 1-2.

Project Accomplishments
- Researchers designed and built a new depuration system to provide increased ease of handling for the bivalves being subjected to depuration and to increase capacity. The new unit can be used to depurate up to 1000-1500 oysters at a time.
- Results from DOH testing show that the depuration tank was effective in maintaining coliform levels and Vibrio levels (Standard Plate Counts-SPC) at well below acceptable levels.
- Researchers also designed and built a Floating Upweller System (FLUPSY) to provide oyster nursery capacity for Hawaiian fishponds. The new FLUPSY houses five oyster bins each of which can hold approximately 200,000 oyster spat. The water flow rate is 1100 gallons/hr. The estimated cost is $2,500.
Outputs & Outreach

Two new equipment models were designed and tested. These included a FLUPSY and depuration tank. Monitoring and laboratory methods were developed at two laboratories to test for $V_v$ and $V_p$, including one federally validated method. This capacity is required for regulatory and practical purposes.

Two oyster farming teams (Molii and He`eia) were involved in this work and received training and additional knowledge of depuration, nursery and handling methods. Twelve students at the PACRC were involved in the research and design phases of the FLUPSY development.

Outcomes & Impacts

Outcomes include an improved depuration tank model, information on vibrio presence in growing areas and depuration tanks, a FLUPSY nursery model suited for fishpond conditions, and determination of whether salting during depuration affects taste and quality. Capacity at two laboratories was developed to test for $V_v$ and $V_p$ in water and oyster meats; this will be required for regulatory and food safety reasons.

Farmers now have access to improved farming equipment and have new knowledge of methods to improve food quality and safety. This work may lower costs and increase efficiencies for farmers, as well as leading to improved food safety.

The finding that He`eia pond can serve as an excellent nursery site is important given the need for large spat in Hawaii and because it can now supply both farms and water quality remediation projects with large spat.

Publications & Presentations


Manuals on the design of the FLUSPY and Depuration Unit are in preparation.
Establishing Coral Grouper (Plectropomus leopardus) Production in Palau through the Application of Intensive Copepod Production Technology

Funding Level: $297,400 (3 Years)
Lead Institutions: Oceanic Institute of Hawaii Pacific University
Principle Investigator: Chatham Callan, Ph.D.
Status: Year 3 Ongoing
Report on Activities from October 2016 to September 2017

Research Purpose
The culture of high-value marine fish (such as grouper) is rapidly expanding in Asia where the value of grouper production is nearly $200 million annually. In SE Asia, groupers have been cultured for over 30 years. However, current culture methods still face very low hatchery survival (~1%) in some of the most commercially important species, such as the coral grouper (Plectropomus leopardus), largely due to inadequate larval feed items. Therefore, a significant need remains for development of intensive hatchery technologies to meet the ever-increasing demand for product. This project is aiming to further strengthen and support the ongoing coral grouper (Plectropomus areolatus) work on Guam (previously funded by CTSA) by establishing coral grouper culture in Palau and effectively create a regional working group on these species.

Anticipated Benefits
If successful, the project will establish the necessary infrastructure and technical capacity for the culture of coral grouper in Palau. The direct benefit would be the production of coral grouper fingerlings for subsequent grow-out in the region.

Target Audiences
The target audiences are fish producers in Palau and the Pacific region.

- Production of coral grouper juveniles is ongoing at PCC. Some of the coral grouper broodstock have been relocated to OI facilities so that more intensive hatchery trials can be completed and documented in Year 3.

- At OI, the research team is achieving over 10% survival through larval rearing during each run, and is now conducting weaning trials. The fish are currently on copepods until day 14; the goal is to wean them sometime between days 7 and 10.

- Oceanic Institute staff traveled to Palau several times in 2017 to assist in training and production activities at PCC.
Objectives

Objective 1: Establish and maintain broodstock populations of coral grouper and monitor egg production at BMR and PCC facilities.

Objective 2: Establish cultures of *Parvocalanus* copepods at PCC hatchery for use in testing on grouper larvae.

Objective 3: Optimize and refine culture methods for suitable species of copepods for testing on grouper.

Outputs & Outreach

At the conclusion of Year 2, researchers successfully produced thousands of post-settled juvenile grouper in Palau, but encountered challenges in weaning the fish to formulated feeds resulting in almost complete mortality of the juveniles. Therefore, the hatchery methodology will continue to be refined in Year 3 and planned training will be conducted more towards the end of the project year.

The fish relocated to OI have been spawning regularly since July 2017 and have been supplying researchers with sufficient numbers of high-quality eggs for research and larval runs. A workshop on Marine Finfish Aquaculture Technology was held with stakeholders in Palau in April 2017.

Outcomes & Impacts

The change in knowledge that occurred was continued and improved understanding of microalgae production requirements and methods for expanding copepod production. This resulted in new methods (some outdoor culture) being immediately implemented at the PCC hatchery facilities. In addition, hatchery methods are being refined to improve larval survival and determine feeding requirements.

Publications & Presentations

None to report
Potential of Black Soldier Fly as a Feed Ingredient to Support Hawaiian Aquaculture

Funding Level: $173,174 (2 Years)
Lead Institutions: Oceanic Institute of Hawaii Pacific University
Principle Investigator: Zhi Yong Ju, Ph.D.
Status: Year 2 Ongoing
Report on Activities from November 2016 to Sept. 2017

Research Purpose
Production of local feeds is the key for future aquaculture in Hawaii and other island communities; however, these communities have limited farming resources including available land, fresh water, and energy. These restrictions pose a challenge to grow ingredients for local feed production. Therefore, searching for sustainable and locally available ingredients is one of the critical issues for developing sustainable aquaculture for island communities. On the other hand, food waste is one of the major wastes deposited in landfills and could cause environmental pollution if not properly treated. In Hawaii, only a small proportion of food waste has been used for pig feed or fertilizer. Therefore, this project aims to utilize and convert food waste into feed ingredients through cultivation of Black Soldier Fly, thereby providing the local feed industry with a viable alternative, while helping to address the challenge of a diminishing global nutrient supply and increased pollution of the environment.

Anticipated Benefits
The outcomes of this project will benefit the local aquaculture industry, restaurants and ingredient producers, as well as feed researchers. Utilizing food waste to produce BSF will benefit the local environment too. The information will also provide a baseline evaluation for utilization of BSF ingredients and processing methods for aquafeed production. Production of local feed with BSF ingredients will benefit aquaculture farms and open the feed market to local industries including agriculture, biofuel and fisheries. This project is expected to have national and international impacts because BSF ingredient is of global interest in aquaculture.

- Defatted BSF was prepared by extracting lipid with hexane from original BSF larvae biomass according to the method developed in previous research year. Table 1 in the full report (appendix) shows proximate contents for the defatted BSF in comparison with original BSF biomass.

- The defatted treatment decreased crude lipid content from 33.3% in BSF larvae biomass to 12.7% in defatted BSF meal; while crude protein content increased to 49.4% in defatted BSF meal from 40.9% in BSF larvae biomass.

- A feeding trial was conducted to replace fishmeal in shrimp diets with defatted BSF meal. BSF ingredient has been defatted to gradually replace fish meal (0, 25, 50 and 75% replacement) in four test diets. The 25% BSF diet displayed better results for final weight, growth, estimated FCR and yield among all diets.
**Target Audiences**
The target audiences are researchers, feed manufacturers and fish producers in Hawaii.

**Objectives**

*Objective 1*: Compare the nutritional composition, processing efficiency, shelf life and physical quality of raw and processed BSF larvae.

*Objective 2*: Determine the palatability and digestibility of BSF in fish or shrimp.

**Outputs & Outreach**
Aside from the nutritional data obtained for Black Soldier Fly larvae, this project has produced a method for defatting BSF larvae in the lab using hexane as the solvent, allowing for the defatted BSF meal to be safely used in aquaculture feeds. The method is beneficial because without defatting the BSF larvae lipid content would be too high for use in aquatic feeds. Feeding trials showed high shrimp palatability and growth performance by BSF diets.

**Outcomes & Impacts**
The data obtained thus far will be very helpful in evaluating Black Soldier Fly’s potential as a feed supplement for local aquaculture feed production in Hawaii. The defatting method developed will also be useful for defatting many oil seeds in Pacific Islands to produce protein seed cakes.

**Publications & Presentations**

Utilization of Local Agri-processing By-products to Produce Fungal Protein for Aquatic Feed Production

Funding Level: $198,277 (2 Years)
Lead Institutions: University of Hawaii and Oceanic Institute of HPU
Principle Investigator: Samir Khanal, Ph.D. and Zhi Yong Ju, Ph.D.
Status: Year 2 Ongoing
Report on Activities from October 2016 to Sept. 2017

Research Purpose
Microbial protein such as fungal biomass production on low-cost feedstocks has gained significant attention due to cost effectiveness and a long-term sustainability. Fungal process is a low-cost and simple process for animal feed production, as fungi are known to grow extensively on diverse organic feedstocks under optimal conditions. Hawaii produces large quantity of fruit and food by-products which may have the potential to be upgraded into protein enriched value-added products. The overarching goal of this project is to develop a fungal-based protein substitute for imported aquatic feed by using locally available agriculture by-products such as damaged papaya, molasses, and taro waste, and to conduct feeding trials with the new fungal-based protein.

Anticipated Benefits
The local production of inexpensive aquatic feed ingredients from locally-available agriculture by-products will have significant impacts on aquaculture industries in Hawaii by reducing the state dependency on imported aquatic feed ingredients, lowering the production costs of aquaculture, and improving the long-term sustainability of local aquaculture farming.

Target Audiences
Researchers, aquafarmers and students interested in aquaculture and aquatic feed production.

Project Progress
- Researchers have been able to grow fungus on molasses, damaged papaya, and brewers yeast. Results to date have found brewers yeast to be the most promising substrate, as the fungus grows well and the product is a waste product that local brewers must currently pay to dispose of.
- The UH team has optimized the growth of fungal biomass in 20-L fermentor using both molasses and damaged papaya+seed. They are currently developing a 40-L bioreactor.
- At the end of the first year, OI received 1.0 kg of fungal dry biomass for a small shrimp feeding trial. A larger amount of biomass will be delivered in April 2018 for a larger trial.
- The sample of the fungal biomass tested negative for mycotoxins, but the fiber content is too high, likely due to chitin.
**Objectives**

*Objective 1*: Maximize the yield of edible fungus, *R. oligosporus*, on molasses, damaged papaya and taro wastes, and develop a cost effective fungal biomass production process.

*Objective 2*: Characterize the nutritional quality of fungal biomass and develop test feed formulations with fungal protein for tilapia or shrimp.

*Objective 3*: Conduct feeding trials of newly formulated fish or shrimp feeds by an 8-week growth trial compared to commercial and control diets at Oceanic Institute.

*Objective 4*: Conduct an economic analysis of fungal-based protein as a fishmeal substitute.

*Objective 5*: Technology transfer.

**Outputs & Outreach**

With successful overcoming of challenges, researchers have been able to grow fungus on molasses, damaged papaya+seed, and brewers yeast. Molasses is currently being treated with sulfuric acid (0.2%), which hydrolyzes sucrose into its monomeric sugars.

The proximate contents of the fungal biomass sample were analyzed in Nutritional Biochemistry lab of OI. The *R. Oligosporus* sample was found to have around 38.1% crude protein and 6.4% crude lipid and 15.3% ash. This indicated that the fungal sample had high protein content after fungal fermentation, and may be a viable ingredient for shrimp feed.

**Outcomes & Impacts**

Data from this project has found that molasses, papaya slurry, papaya seed and brewers yeast could serve as promising substrates for fungal biomass production. This is the first study ever reported on fungal protein production and provides new opportunity for low-cost aquatic feed production.

**Publications & Presentations**

None to report
Aquaculture of Opihi, Years 3 and 4

Funding Level: $100,000 (2 Years)
Lead Institutions: Oceanic Institute of Hawaii Pacific University
Principle Investigator: Zhi Yong Ju, Ph.D.
Status: Year 2 Ongoing
Report on Activities from October 2016 to Sept. 2017

Research Purpose
Opihi is a high value seafood in Hawaii, with prices reputed to be $100-200 gallon shell on. An established niche market exists bolstered by the need for opiihi at Hawaii gatherings. Demand for opiihi exceeds the level that the wild caught fishery can supply because of overfishing. While some highly academic marine biology studies have been conducted, a concerted aquaculture research effort had never been attempted until recently, when CTSA supported a two-year project to initiate work on closing the life cycle. The giant opiihi (C. talcosa) initially showed the greatest aquaculture potential as it lives below the waterline, and therefore eliminates the expense associated with trying to mimic waves in the aquaculture enclosure. However, the current project changes its focus to closing the life cycle of the yellow foot opiihi, Cellana sandwicensis because this species lives in shallow water and is less dangerous to collect yet it has been found to thrive stagnant water therefore have simple habitat needs.

Anticipated Benefits
The current project will have both direct and indirect benefits for the aquaculture industry at large. The direct benefits are transfer of technology to farm opiihi from broodstock spawning to larval rearing and juvenile grow-outs. Other direct benefits include formulas for maturation diets and grow-out diets, which are essential for farming opiihi. The indirect benefits include presenting information that will be accessible to the public, which will serve to educate those about the industry.

Target Audiences
The primary target audience is local farmers that want to culture opiihi, commercially. However, cultural practitioners are also being strongly considered as a target audience to transfer this technology for stock enhancement purposes or use in loko i’ā, or Hawaiian fishpond systems.

Objectives
Objective 1: Collect wild, yellowfoot opiihi and determine their nutritional profiles and gonadal somatic index (GSI).
**Objective 2**: Induced maturation and spawning through dietary manipulation and hormone injection gonadotropin releasing hormone (GnRH).

**Objective 3**: Develop laboratory protocol for opihi larvae rearing.

**Outputs & Outreach**
Researchers collected mature animals in August 2017, which indicates that spawning can occur year-round. In fact, animals from this collection spawned in tanks under stressors from the tank environment. Researchers have setup a new indoor lab at the University of Hawaii, where the graduate student responsible for much of the work is completing his degree, and are successfully holding animals and awaiting the next round of spawning trials.

The work group has yet to perform outreach to the intended end users. They have, however, done other forms of outreach including school visits to report on recent findings/discoveries (i.e. hermaphroditic mode of reproduction). The graduate student has also participated/volunteered his time to work on the “Opihi Partnership Intertidal Expedition 2017” at Papahanaumokuakea Marine National Monument to collect genetic and intertidal data

**Outcomes & Impacts**
The current year’s development of an indoor facility has allowed for direct comparison between indoor vs. outdoor culture of opihi. There are pros and cons to both set-ups. Researchers suggest using indoor facilities to overcome heat during hot summer months, as well as hatchery work, and using outdoor facilities to conduct any captive maturation trials in spawning season. Researchers have learned about a new factor that appears to affect opihi health (carbon dioxide), and have learned that temperature by itself is not sufficient to keep animals in a reproductive state (and would suggest that photoperiod does not either). The research team has yet to conduct spawning trials, but in-house algae production and novel settlement system will improve future trials and hopefully allow them to close the lifecycle of opihi. The success in the new facility will allow researchers to evaluate potential impacts to industry.

**Publications & Presentations**


Mau, A. and Jha, R. The protein to energy ratio requirement of yellowfoot limpet (Cellana sandwicensis Pease, 1861) in a novel grow-out system (In Review)

Mau, A. Bingham, J., Soller, F., and Jha, R. The captive maturation, spawning, and larval rearing of yellowfoot limpet (Cellana sandwicensis Pease, 1861) (Submitted)

Mau, A., Fox, K., and Bingham, J. The yellowfoot limpet (Cellana sandwicensis Pease, 1981) caught in the middle of a sex-change. (Accepted)
Integrated Multi-Trophic Aquaculture of Shrimp and Sea Cucumbers for Nutrient Recycling, Sludge Reduction, and Creation of Additional Revenue Streams

Funding Level: $79,102 (2 Years)
Lead Institutions: Oceanic Institute of Hawaii Pacific University
Principle Investigator: Dustin Moss
Status: Year 2 ongoing
Report on Activities from October 2016 to Sept. 2017

Research Purpose
Feed typically represents the single largest operating expense for aquafarmers and one of the greatest inefficiencies on many farms is waste of valuable nutrients from feed. Furthermore, many aquaculture farms incur costs to treat and/or dispose of nutrient-rich sludge generated from production systems. A promising area of aquaculture research that directly addresses these inefficiencies is Integrated Multi-Trophic Aquaculture (IMTA) where “waste” nutrients from a “fed” species is taken up and incorporated into the biomass of another commercially valuable “extractive” species. Such a management strategy improves nutrient use efficiency, reduces waste volume and disposal costs, and creates an additional revenue stream. The current project is investigating an IMTA approach using sea cucumbers to digest waste produced from shrimp production systems.

Anticipated Benefits
The potential benefits of this project to regional shrimp farmers are improved nutrient use efficiency, reduced sludge treatment/disposal (reducing environmental and cost concerns), and the creation of an additional revenue stream (i.e. the sea cucumbers). Other potential benefits include contributing to a knowledge base that would help to support a new sea cucumber farming industry, providing an opportunity to apply culture techniques to enhance natural sea cucumber stocks, and to provide basic data that would support pursuit of other funding to further develop this technology.

Target Audiences
Existing shrimp farmers in USAPI and those in the region interested in farming shrimp and/or sea cucumbers. In addition, results from this project

- A high-density (250 shrimp/m²) RAS shrimp trial was conducted to obtain sludge for the sea cucumber trials.
- Researchers have confirmed that the selected species of sea cucumber can survive in captivity under stressful conditions, and they will eat sludge as well as prepared feeds.
- It has been difficult to measure the growth of the species using the wild harvested adults; it would be better to work with juveniles, and hatchery development is the next logical step in local sea cucumber production.
- There is also a third potential species that may be worth exploring further during the next collection effort.
may be of interest to extension agents and regulatory officials involved in aquaculture.

**Objectives**

*Objective 1*: Identify, determine availability, collect, and screen for shrimp pathogens for a minimum of two commercially-valuable species of sea cucumber that naturally occur in Hawaiian near-shore waters.

*Objective 2*: Conduct replicated sea cucumber culture experiments to quantify growth, survival, nutrient flow, and sludge (produced from shrimp RAS) processing capability.

*Objective 3*: Conduct two IMTA demonstration trials: 1- sea cucumbers fed sludge from a shrimp RAS while reared in a separate culture system and 2-polyculture of shrimp and sea cucumbers in a traditional open pond.

*Objective 4*: Disseminate research results to interested stakeholders in the USAPI and to a broader aquaculture community.

**Outputs & Outreach**

Several sea cucumber collections were conducted along Oahu’s south and southeastern shores, and quarantined at OI. A high-density (350 shrimp/m²) RAS shrimp trial was carried out to provide sludge for sea cucumber trials. Based on proximate analysis, sludge dry matter was determined to be slightly lower in crude protein and energy content compared to typical aquaculture growout feed. Trials were initiated using two sea cucumber species (*H. atra* and *A. mauritiana*), and three feeding treatments (Algamac, Sludge, and Unfed). After eight weeks the trials were terminated. Average survival rates for *H. atra* and *A. mauritiana* were 43.8% and 4.2%, respectively. This determined that *H. atra* are more suitable for culture than *A. mauritiana* (based on results from wild-caught adults). *H. atra* was feeding on RAS sludge, though determining growth was problematic. To better understand the potential of *H. atra* (or other species) to convert RAS waste into biomass (via feeding and growth), future research should use hatchery-produced juveniles (as juveniles cannot be collected in sufficient numbers).

Preparation of a factsheet and an article (peer-reviewed journal/or trade magazine) are planned for Year 2. In addition, findings will be presented at an upcoming Hawaii Aquaculture and Aquaponics meeting.

**Outcomes & Impacts**

Initial plans to use wild-collected sea cucumber specimens for research trials were found not to be ideal, as only adults of *H. atra* and *A. mauritiana* could be collected in sufficient numbers. It was concluded that future research should focus in-part on the collection, spawning, and larval rearing of local species (*H. atra*, *H. whitmaei*, and *A. mauritiana*) to juvenile stage to be used for trials.

**Publications & Presentations**

None to report
Development of Marine Finfish Aquaculture, Aquatic Feeds, and Training in the RMI for Sustainability and Food Security

**Funding Level:** $297,236 (3 Years)
**Lead Institutions:** Rongelap Atoll Local Government
**Principle Investigator:** Mayor James Matayoshi
**Status:** Year 2 Ongoing

*Report on Activities from October 2016 to Sept. 2017*

**Research Purpose**
The dependency on imported goods and low agricultural production translate into a high level of malnutrition and food insecurity in the Republic of the Marshall Islands. Due to limited land and fresh water availability, and the risk of overfishing, the local government identified marine aquaculture as the main sector to support food security. However, there are two barriers to developing sustainable aquaculture in the RMI: lack of skilled labor and the need to import aquatic feeds. The local labor drain (mobility of skilled Marshallese) remains high due to easy entry into the U.S. and limited employment opportunities in the RMI. Furthermore, as with most remote or island locations, the cost of transportation of feed ingredients or prepared feeds is very expensive. This three-year project is aiming to develop and transfer aquaculture technology in the RMI, particularly the manufacturing of locally-sourced feeds and fish farming of Moi (*Polydactylus sexfilis*) and Rabbitfish (*Siganus spp*), with an emphasis on training local technicians.

**Anticipated Benefits**
The outputs from this project will increase knowledge of fish husbandry and feed manufacturing. It will encourage the connection of land-based farms with aquaculture production, and result in less waste and more agricultural inputs and outputs (feeds, fish). If successful, there will also be an increase in agricultural activities and the number of small farms, resulting in increased production of fish for local and commercial consumption, less dependency on imported goods and fuel, improved self-reliance and food security. This work will also result in a locally trained workforce with an increased income.

*Project Progress*

- The feed developed during Year 1 has been modified to meet the nutritional requirements of rabbitfish.

- The research group finished the second feeding trial and completed analysis of four diets (with the consultation of Dr. Dong-Fang Deng), and found that protein replacement with 100% copra meal is not possible.

- 235 juvenile rabbitfish were collected from the wild for the feed trial.

- The rabbitfish broodstock are currently spawning twice per month; larval rearing has not gone past day 7, but it improves slightly with each trial. It is hypothesized that the broodstock just needs to mature a bit more.

- The project is currently, harvesting and selling 300-400 pounds of moi per week in Majuro.
Target Audiences
Marshall Island Marine Resource Authority (MIMRA), general public, local vendors, and trainees.

Objectives
Objective 1: Feed Development: To collect and analyze local ingredients, and develop five (5) locally sourced feed rations for Moi trials.
Objective 2: Fish Trials: To test five (5) locally-sourced feed rations in Moi fish trials to establish the most optimal locally sourced feeds.
Objective 3: Outreach/Technology Transfer: To train local workforce on feeds and fish production.

Outputs & Outreach
The experimental design and results obtained with the initial feed developed through this project did not provide sufficient results. Therefore, the research group redesigned the feed formulation for the project. They have conducted six larval rearing trials with rabbitfish, but have not yet had a successful larval rearing trial past 5 days post hatch. There is a possibility that egg quality is a factor in the lack of success. The broodstock spawned twice in October with good fecundity and better fertilization rates; researchers will continue to do trials.

Aside from the local aquatic feed, the most significant outputs for this project to date are the training of the staff and additional trainees participating in the project. To achieve a high-quality staff, trainings have been demanding and not all of the local population is equipped for this work. The current staff and trainees have shown great potential to lead hatchery and growout husbandry in the RMI beyond this project.

Outcomes & Impacts
Feed formulation and manufacturing of feed is key to the success of aquaculture in the RMI and the region. Researchers have proven that they can produce a quality local feed to sustain a fisheries industry.

The project impact is strongly based on the successes of qualified trained personnel, who will hopefully continue beyond this project and lead the future of aquaculture in the RMI. Staff members are at the point where they have enough knowledge and experiences to train additional local trainees.

Publications & Presentations
None to report
Project Progress

- Dr. Ximing Guo made a second trip to Hawaii in March 2017 to assist with improving the tetraploid induction results and assist with improving the flow cytometry methods.

- Researchers have wrapped up tetraploid inductions and were able to achieve good results. There are now 25 groups of spat with high percentages of tetraploidy.

- Cytochalsin B (CB) was used effectively to induce spawning, resulting in two cohorts with 80% and 30% triploidy. However, it is a dangerous chemical and the team has switched to using 6-DMAP, which proved to be effective and is safe.

- New inductions will need to be done to ensure a healthy balance of males and females. However, it is a very expensive process and the team is looking into ways to cut costs while maintaining quality seed.

Assuring Oyster Seed Supply for Hawaii and the West Coast

Funding Level: $100,000 (2 Years)
Lead Institution: University of Hawaii at Hilo, PACRC
Principle Investigator: Maria Haws, Ph.D.
Status: Year 2 ongoing
Report on Activities from October 2016 to Sept. 2017

Research Purpose
The oyster industry on the West Coast and Hawaii suffers from a lack of high quality and readily available triploid oyster seed. Until recently, methods to produce the tetraploid broodstock as well as the tetraploid broodstock itself were under patent. With expiration of the patent, new tetraploids can now be made to avoid inbreeding and allow hatcheries to be more self-sufficient. Additionally, tetraploids and triploids can now be integrated into selective breeding programs. Accordingly, this project aims to enable Hawaii and West Coast stakeholders to develop more reliable and less expensive methods to produce triploids and tetraploids without having to rely on outside entities.

Anticipated Benefits
Availability of new tetraploid lines will facilitate production of triploids at hatcheries. This will benefit multiple farms in Hawaii and on the West Coast since triploids are the only oysters which can be harvested year around.

Target Audiences
The principle target audiences are hatchery operators and recipients of the eventual triploid stock.

Objectives
Objective 1: Conduct innovative research to improve production methods for triploid and tetraploid Pacific Oysters and refine and clarify published methods to suit conditions of local hatcheries.
Objective 2: Develop a pool of tetraploid specimens to be used as broodstock for Hawai`i’s hatcheries and farms. This will also support ongoing efforts to selectively breed an improved oyster line(s) for Hawai`i conditions. Each farm will maintain its own tetraploid reserve which can
serve as the foundation for selective breeding of lines suited for individual farms’ conditions. This will also benefit West Coast farms since Hawai‘i can generate and supply broodstock more rapidly and at any time of the year. **Objective 3:** Conduct outreach to farmers, hatchery operations, students and other stakeholders. Publish clear and complete guidelines for production of triploids and tetraploids oysters allowing stakeholders access to the protocols. Although a wealth of scientific literature exists for these topics, none of it is sufficiently complete or detailed to allow others to reliably replicate the stated methods.

**Outputs & Outreach**

During the reporting period, work continued to develop methods to produce tetraploid oysters using a diploid male by triploid female cross with treatment with 6-DMAP. Researchers completed tetraploid inductions, and were able to achieve good results with two cohorts of 80% and 30% tetraploidy.

The research group conducted two training workshops with Drs. Ximing Guo and Anu Frank-Lawale in 2017, in which 30 people were trained. A manual is now under production.

**Outcomes & Impacts**

Researchers have demonstrated and are making public how to produce tetraploids, which should help reduce the scarcity and improve the quality of triploid oysters. Increasing the availability and the quality of tetraploid and triploid lines will have significant economic impacts on hatcheries and farms. Additionally, new and necessary research can now include the use of 4N and 3N since nearly anyone can now utilize the methods developed under the project. This may be particularly important since development of new disease resistant strains can take advantage of the 4N to introduce a higher percentage of DNA in crosses.

**Publications & Presentations**

None to Report
Improving Rabbitfish Seed Production Capacity in Palau

Research Purpose
Stakeholders in the Western Pacific region have identified rabbitfish as a top candidate for aquaculture. However, more work is needed to develop a reliable and sustainable supply of fingerlings to support the growing interest in farming of this highly valued seafood commodity. Traditionally, the farming of these species has relied heavily on the collection of juveniles from near shore environments for grow-out. Recently, methods for producing juveniles from hatchery-reared larvae have been demonstrated in Palau through a CTSA funded project. However, unreliable egg supply and poor survival during the hatchery phases continue to limit production. This project aims to improve upon the recent successes by incorporating the latest developments in larval rearing approaches used for other marine reef species, and to also improve egg production and egg handling procedures so that egg supply is no longer a limiting factor.

Anticipated Benefits
Through improved egg and larval production and nursery rearing techniques, large quantities of juveniles can be produced for grow-out testing in facilities currently rearing milkfish, yielding valuable data on the economic feasibility of this approach. Also, through the development of improved hatchery protocols, local farmers and other stakeholders in the region will receive training at the Palau Community College Multispecies Hatchery on all aspects of rabbitfish culture, effectively transferring these methods directly to the local industry.

Target Audiences
The target audience includes existing and potential aquaculture farmers, students, women’s group, traditional leaders, government officials and policy makers who are interested on the farming of rabbitfish in Palau.

Funding Level: $92,268 (2 Years)
Lead Institutions: Palau Community College
Principle Investigators: Miguel Delos Santos
Status: Year 1 Ongoing
Report on Activities from September 2016 to Sept. 2017

- Researchers developed new protocols for managing rabbitfish broodstock, properly handling eggs and improving the hatching rate of larvae for stocking in larval rearing.

- Result of a small experiment also revealed that feeding the rabbitfish larvae with rotifers alone is enough to support their early larval development.

- Researchers have been producing an average of 3,000 viable rabbitfish fry per hatchery run for distribution to farmers.
Objectives

Objective 1: Refine broodstock holding and egg handling techniques for *Siganus lineatus* to facilitate more reliable egg supply and hatchery production.

Objective 2: Improve larval rearing protocols for *Siganus lineatus* to increase larval survival and production of juveniles.

Objective 3: Scale up production of *Siganus lineatus* and to provide sufficient number of juveniles for subsequent grow-out at local farms.

Objective 4: Provide onsite training to local stakeholders on Rabbitfish broodstock handling and hatchery production methods.

Outputs & Outreach Activities

During the first-year of the project, researchers have been able to develop better feeding protocols and handling of broodstock for spawning and egg collection, which resulted in better quality eggs. Researchers also developed a better method to incubate the eggs resulting in a very good hatching rate. A preliminary larval rearing trial using 10ton capacity tanks, following a protocol similar to what has been established for Moi at the Oceanic institute in Hawaii with the addition of copepod nauplii during their onset of feeding, resulted in an improved survival rate of the larvae after 21 DPH. The feeding experiment using 50L container revealed that rotifers alone could be sufficient to nourish the rabbitfish larvae during their early larval stages.

Three rabbitfish farmers in have benefitted from the juveniles that were produced. These juveniles were stocked in one of their fish cages for grow-out. Additional outreach was conducted at a local workshop.

Outcomes & Impacts

Rabbitfish broodstock management, egg collection, hatching and larval rearing have become more practical and easy since the commencement of this project. More and better-quality eggs are being harvested, and hatching rate has been significantly improved (close to 100%).

Publications & Presentations

Highlights on aquaculture research and extension projects in the Republic of Palau at the National Aquaculture Extension Conference held in Boise, Idaho on June 6-8, 2017

PCC Aquaculture Research and Extension Project in Palau presented during the Palau Aquaculture Workshop: Supporting Palau's Food Security and Community Livelihood held at PCC Continuing Education Room on September 27 -29, 2017
Improving nursery and grow-out culture of mangrove crab by minimizing cannibalism and developing feed supplements

Funding Level: $43,093
Lead Institutions: Oceanic Institute of Hawaii Pacific University
Principle Investigators: Zhi Yong Ju, Ph.D.
Status: Ongoing
Report on Activities from January 2017 to Sept. 2017

Research Purpose
Farming the mangrove crab (Scylla serrata Forskall) has become popular in Palau due to its high market demand and lucrative price. Hatchery techniques have been successfully established through a mangrove crab seed production project funded by CTSA in recent years. However, production of juvenile crabs is insufficient to support the needs of the farmers. This is due, in large part, to low survival during the nursery phase of production, which is mostly a result of cannibalism. Cannibalism is likely caused by high stocking density, absence of shelter, elevated temperatures, or artificial diets. The objectives of this one-year project are to improve nursery and grow-out performance of mangrove crabs in Palau by reducing cannibalism and developing nutritive feed supplements.

Anticipated Benefits
The current project will have both direct and indirect benefits for the crab farms in Palau. The direct benefits include the development of an improved nursery rearing technique that would support the seed requirement of the mangrove crab farmers and provide effective feeds. Existing local mangrove crab farmers would also avail hatchery produced juveniles for stocking in their farms. The indirect benefits include presenting information that will guide mangrove crab farmers on how to initiate and manage a mangrove crab farming project that will not only be accessible in Palau but also to other Pacific Islands.

Target Audiences
Existing and prospective local mangrove crab farmers. The knowledge surrounding culturing crab in tank systems, nutrient information of local feed ingredients and the imported feeds will help them in the operation of their grow-out farms.
Objectives
Objective 1: Test the effects of different types of shelters on survival rates to market size for mangrove crab juveniles in grow-out facilities.
Objective 2: Identify and secure local feed ingredients for nutritional analysis and prepare nutritive feed supplement pellets and a functional feed supplement to be applied to imported shrimp feeds.
Objective 3: Improve culture performance of juvenile mangrove crabs by combination of imported shrimp feed with nutrient and functional feed supplements.

Outputs & Outreach Activities
Four local mangrove crab farms received a total of 2020 crablets for stocking in their crab pens and ponds from April to September 2017. Results of the larval rearing trials and feeding experiments were mentioned in the monthly status report on mangrove crab activities to the office of the Palau Community College (PCC) president and during the Aquaculture Workshop that was conducted at PCC in September 2017.

Outcomes & Impacts
The availability of local ingredients or by-products (such as that from the processing of deboned milkfish) gives an idea that local farm produced formulated feeds for the mangrove crabs can be developed. People producing the raw materials used as feed ingredients are hoping to make extra income once these products will be utilized in making feeds. Local mangrove crab growers were able to stock their existing farms with hatchery produced crablets and become interested in learning how to make their own feed for mangrove crabs.

Publications & Presentations
None to report.
Development of Cost-Effective Aquatic Feeds Using Locally Sourced Ingredients

Funding Level: $116,000  
Lead Institution: Oceanic Institute of Hawaii Pacific University  
Principle Investigator: Zhi Yong Ju, Ph.D.  
Status: Ongoing  
Report on Activities from January 2017 to Sept. 2017

Summary
Commercial aquaculture farmers in Hawaii and the U.S.-affiliated Pacific islands are dependent on imported feed to sustain their businesses, as there are no commercial feed mills in the region. This situation has created a huge financial burden to the farmers and has significantly limited the expansion of local agriculture and aquaculture to enhance food security and island sustainability. The Oceanic Institute of Hawai’i Pacific University (OI) has constructed a Feeds Research and Pilot Production Facility in Hilo, Hawaii, which is expected to be operational shortly. Successful operation of the new feed mill is dependent on research to support large-scale, commercial production of cost-effective feeds using locally sourced ingredients. This project will use computer software to formulate tilapia feed based on the following criteria: 1) nutrient requirement of the target species; 2) nutritional quality of local ingredients; 3) unit price of protein and carbohydrate ingredients; and 4) requirements for practical feed processing.

Anticipated Benefits
This project will produce practical tilapia feeds with extruder in newly-built feed mill in Hilo. The outcomes of this research activities will directly or indirectly benefit local tilapia farming, ingredient producers and aquaculture industry. The information will also provide baseline methods for formulated feeds, feed processing and tilapia culture in Hawaii or the Pacific regions in the future. Production of local feed will open the feed market to local industries including agriculture, biofuel and fisheries.

Target Audiences
Aquaculture farmers, feed industry, agriculture producers, agriculture administration agencies, scientists or researchers from institutes or universities.

Project Progress
- The Hilo Feed Mill construction has met some challenges and delays. Nonetheless, the feed processing equipment installation has been completed and the final commissioning of the feed mill is taking place during the months of November/December of 2017.
- The Hilo Feed Mill is being commissioned and ingredients, such as soybean meal and whole wheat kernels, are being run through the conveyors and equipment with no apparent concerns.
Additional Project Participants

Dr. Fabio Soller
Oceanic Institute of Hawaii
Pacific University

Dr. Gerry Cysewski
Cyanotech Inc

Objectives

Objective 1: Formulate cost-effective tilapia feeds using local ingredients using feed formulation software and update the local feed ingredient database.

Objective 2: Optimize processing conditions to produce floating tilapia feed at commercial scale at OI’s Feeds Research and Pilot Production Facility.

Objective 3: Test feed performance on tilapia growth and survival and product quality at OI’s Makapu’u laboratory and at UH-Hilo’s PACRC facility.

Objective 4: Test feed performance on tilapia growth and survival and product quality at local tilapia farms on Oahu and the Big Island.

Objective 5: Evaluate the fish performance, feed efficiency and the economic benefits from tilapia trials at the commercial tilapia farms and the research labs.

Objective 6: Organize a workshop for local farmers and other industry stakeholders to share results.

Outputs & Outreach

Nutrient composition of local feed ingredients, commercial feed ingredients, and commercial feeds have been analyzed for tilapia feed production. High amounts of local feed ingredients have already been purchased for tilapia feed production in new Feed Meal in Hilo. Their proximate contents have been analyzed.

The feed mill is nearly ready to start operations. The delay was due to electrical failure of some equipment. Once operational, the research group will conduct two feeding trials, and will test the feeds with local tilapia farmers. At least 50% of the ingredients in the feed will be locally sourced.

Outcomes & Impacts

The work on feed formulation and processing and the feeding trial will impact local ingredient production and tilapia aquaculture. The research will establish an extrusion method to produce floating tilapia feed pellets in the new Feed Mill.

Publications & Presentations

None to report
Aquaculture Information Service for the Pacific Region

Funding Level: $58,481  
Lead Institution: Oceanic Institute of Hawaii Pacific University  
Principle Investigators: Cheng-Sheng Lee, Ph.D. & Meredith Brooks  
Status: FY2014 Completed; FY2016 Ongoing  

Research Purpose
The “Aquaculture Information Service” project was implemented several years ago (under a different title) because CTSA determined that one of the impediments to the development of a viable aquaculture industry in the Pacific is the lack of access to pertinent scientific information. The purpose of this project is to produce and disseminate publications containing this information, which includes project results from CTSA and other RAC’s, to stakeholders in the region and beyond. The work is carried out by CTSA’s Information Specialist. The project assistant also conducts literature searches for regional stakeholders (in place of the terminated PRAISE project).

Anticipated Benefits
Activities conducted through this project will update stakeholders on the progress of CTSA work, provide essential data to researchers, and help farmers improve production (through the application of disseminated information).

Target Audiences
Farmers, researchers, students, and other aquaculture stakeholders in the CTSA region and beyond.

Objectives
- **Objective 1**: Inform industry members, educators, and other key individuals of pertinent aquaculture information, and update them on the status of regional aquaculture through various media.
- **Objective 2**: Inform the aquaculture community and interested parties of the progress of CTSA and other Regional Aquaculture Center (RAC)
projects in relation to our mission through the dissemination of our own and other publications.

Outputs & Outreach
The primary purpose of the project is to conduct outreach to CTSA stakeholders. The largest mechanisms of outreach are the monthly e-newsletter and the website www.ctsa.org, which is regularly maintained by the Information Specialist.

The videos “Sustainable Aquaculture Development in the Republic of the Marshall Islands” and “Aquaculture in Palau: Sustainability Within Reach” were filmed, produced and released during the reporting period. The videos highlight CTSA-funded aquaculture projects and activities in each location. Two other videos were filmed during the reporting period and are currently in production, to be released in 2018.

Furthermore, all of the CTSA reports submitted to the USDA are completed through this project, including the REEport for each CTSA grant, and the Annual Accomplishment Report for all ongoing supported projects. The Information Specialist is also responsible for organizing and conducting (along with CTSA Executive Director Dr. Lee) a bi-annual conference call with the PI of each ongoing project to discuss objectives, results, and outreach.

Outcomes & Impacts
The information dissemination activities under the Publications project have helped extend CTSA and other RAC research to industry stakeholders and interested parties throughout the region by providing essential information on new and existing technologies. The video series has provided an opportunity for worldwide promotion of regional aquaculture activities, and several videos have been featured at international conferences and symposiums. The publications produced as a result of the project are beneficial to potential and existing aquaculture farmers in Hawaii and the U.S. Affiliated Pacific Islands.

Publications
Oral presentation “Opportunities and challenges for aquaculture extension in the Pacific Islands” at the National Aquaculture Extension Conference held in Boise, Idaho on June 6-8, 2017.

 Twelve issues of Regional e-Notes were produced and released during the reporting period.

The Information Specialist assisted in the preparation of manuscripts and other publications associated with ongoing CTSA projects.