ctsa

CENTER FOR TROPICAL AND SUBTROPICAL AQUACULTURE

Project Impacts

2022

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Letter from the Board of Directors

Aloha,

Thank you for taking the time to learn about CTSA and the RAC program's impact on **aquaculture** in the Pacific Region! This publication is a follow up to the CTSA Project Impacts report released in 2013, and highlights the projects and activities that CTSA has funded over the past decade.

Aquaculture is growing in popularity with each passing year, as it presents many opportunities to simultaneously address **food security** and **climate change**. Furthermore, a genuine interest in establishing a consistent, safe food supply with minimal environmental impact has emerged among the general public, and has been declared a priority by the National Institute of Food and Agriculture (NIFA). CTSA is capitalizing on this momentum and making lasting and valuable contributions to aquatic food production and marine conservation across the Pacific region and beyond.

Guided by industry and under the expertise of various technical advisors, the Regional Aquaculture Centers (RACs) produce annual programs of directed research that **target industry priorities**. Our Industry Advisory Council offers an open forum through which aquaculture stakeholders can provide comments, suggestions and advice on industry needs, with the goal of **increased profitability**. The Council helps develop the annual Plan of Work together with our Technical Committee, which evaluates the scientific merit and suggests technical improvements for projects, while the Board of Directors is responsible for approving the Plan of Work and overseeing the programmatic functions of the Center.

We appreciate your interest in our work, and hope this publication contains information that is useful and of value to you.

Mahalo,

CTSA Board of Directors

CTSA BOARD OF DIRECTORS

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THE GROWING ROLE OF AQUACULTURE

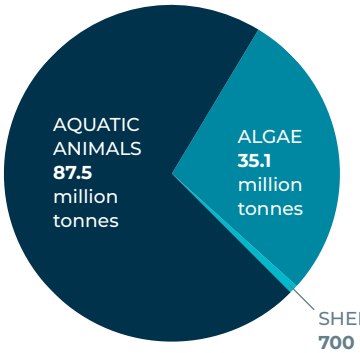
Aquaculture, the production of aquatic organisms in controlled environments, has been practiced in many forms around the world for thousands of years.

Globally, aquaculture's role has become increasingly important. As a result of overfishing, pollution, habitat destruction, and human reluctance to consider marine life an exhaustible resource, traditional capture fisheries are no longer able to meet global demand.

As aquaculture expands rapidly across the globe, its positive impacts are becoming more evident and urgently needed. Aquaculture's contributions to society and the environment range widely and include improving food security, creating economic opportunities, and restoring ecosystem balance.

Often times, aquaculture provides a combination of these benefits.

2020 GLOBAL AQUACULTURE PRODUCTION



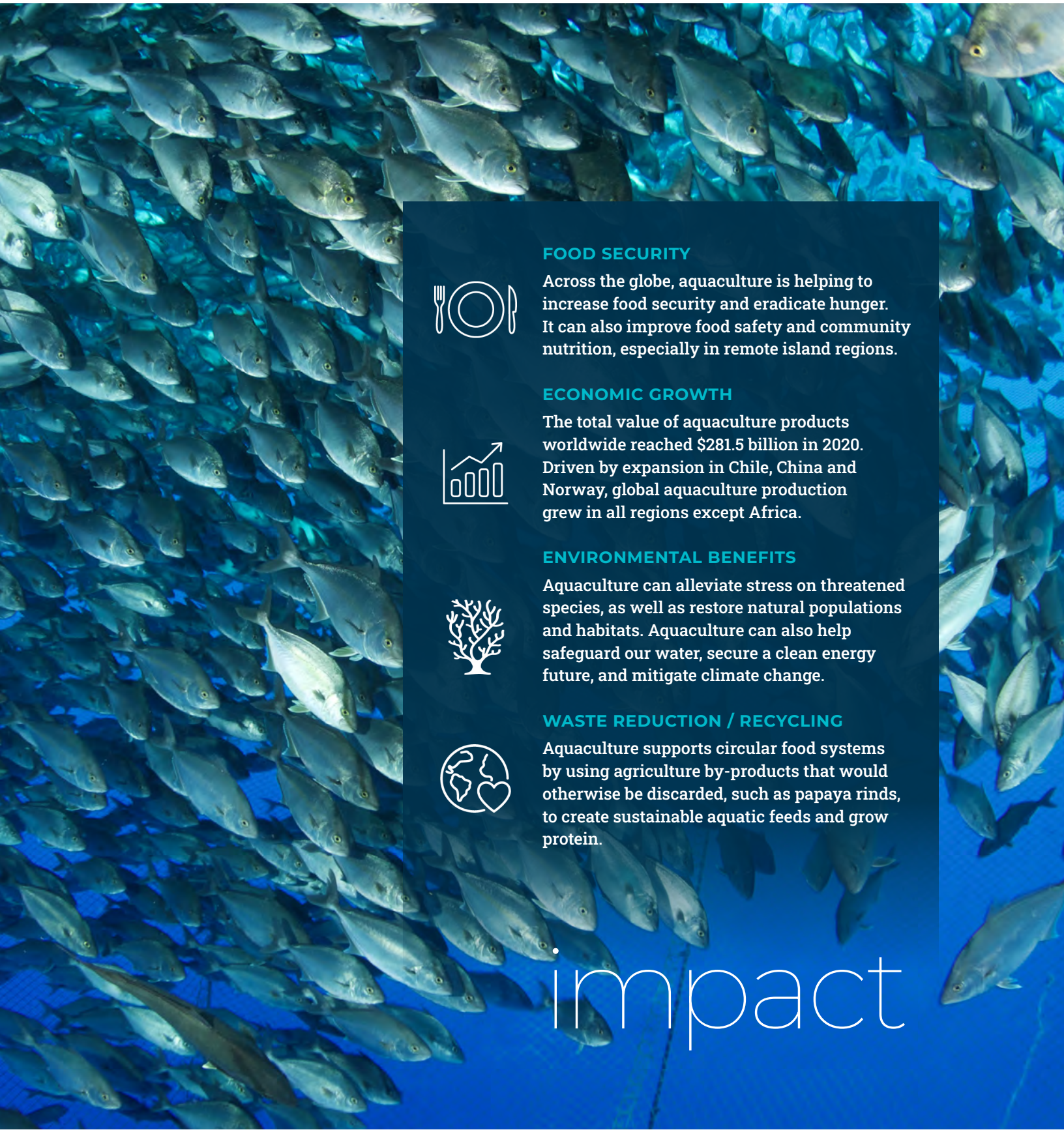
TOTAL PRODUCTION 2020:

122.6 MILLION TONNES

5.5% GROWTH FROM 2018

Global aquaculture production continued to grow in 2020 amid the worldwide spread of the COVID-19 pandemic.

The total aquaculture production comprised 87.5 million tonnes of aquatic animals mostly for use as human food, 35.1 million tonnes of algae for both food and non-food uses, 700 tonnes of shells and pearls for ornamental use, reaching a total of 122.6 million tonnes in live weight in 2020. This represents an increase of 6.7 million tonnes from 115.9 million tonnes in 2018.



FOOD SECURITY

Across the globe, aquaculture is helping to increase food security and eradicate hunger. It can also improve food safety and community nutrition, especially in remote island regions.

ECONOMIC GROWTH

The total value of aquaculture products worldwide reached $281.5 billion in 2020. Driven by expansion in Chile, China and Norway, global aquaculture production grew in all regions except Africa.

ENVIRONMENTAL BENEFITS

Aquaculture can alleviate stress on threatened species, as well as restore natural populations and habitats. Aquaculture can also help safeguard our water, secure a clean energy future, and mitigate climate change.

WASTE REDUCTION / RECYCLING

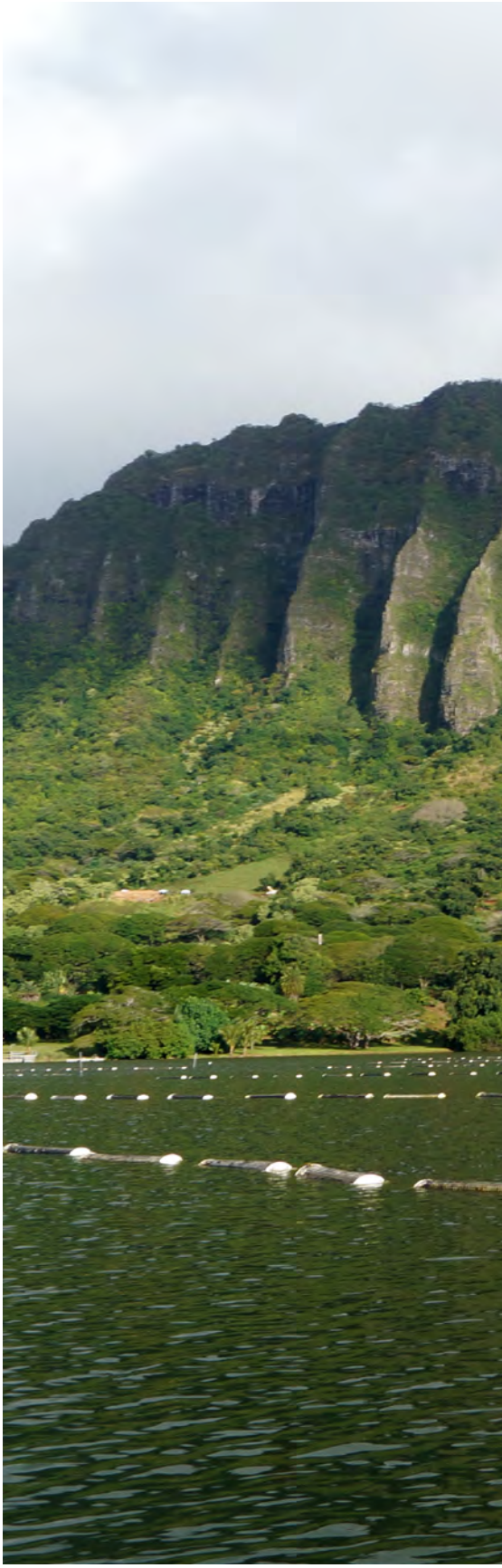
Aquaculture supports circular food systems by using agriculture by-products that would otherwise be discarded, such as papaya rinds, to create sustainable aquatic feeds and grow protein.

impact

AQUACULTURE IN THE PACIFIC REGION

The Pacific Islands have rich traditions in farming and harvesting food, especially seafood. Many island cultures had some form of historical aquaculture systems, typically coastal ponds used to raise fish. The most prominent example is the traditional Hawaiian fishponds (loko i'a), which have been an integral part of food production in Hawai'i for centuries. As one of the oldest and most efficient systems of aquaculture, the fishponds have long been places for fish and other aquatic species to be captively cultured in harmony with the environment, by and for the benefit of the community. There are many varieties of fishponds throughout the islands but they were commonly built along the shoreline and expertly designed to naturally recruit juvenile fish such as mullet, awa (milkfish), and other species through sluice gates called makaha. Though the use of fishponds declined with increased western contact, there has been a growing resurgence in recent decades to restore and utilize the fishponds for cultural, educational, and food security purposes. CTSA has funded several projects aimed at increasing aquaculture production in fishponds across the islands, particularly work on bivalves, milkfish, and macroalgae.

Like most of the Pacific Islands, Hawai'i currently imports the majority of its food supply including seafood. Aquaculture can help address this serious issue. CTSA is funding efforts to increase local supplies of sustainable seafood and simultaneously restore ecosystems, relieve pressure on wild fisheries, and educate the next generation of environmental stewards across the Pacific region.



As one of the oldest and most efficient systems of aquaculture, coastal fishponds have long been places for fish and other aquatic species to be captively cultured in harmony with the environment, by and for the benefit of the community.

loko iʻa

About Regional Aquaculture Centers (RACs)

In the United States, the U.S. Department of Agriculture has established five Regional Aquaculture Centers (RACs) with a common mission: to support aquaculture research, development, demonstration, and education to enhance viable and profitable U.S. aquaculture production for the benefit of consumers, producers, service industries, and the American economy.

Supported through a grant from the National Institute of Food and Agriculture (NIFA), most of the RACs work within defined geographical regions in North America. However, the Center for Tropical and Subtropical Aquaculture (CTSA) is quite different from the other four RACs. The CTSA "region" encompasses tropical and subtropical species *wherever* they're cultured in the United States.

The RACs serve as a mechanism for assessing needs, establishing priorities, and implementing regional research and extension programs. The focus of the RACs on requiring multi-institutional cooperation in their projects provides the best solution for the growth of this industry.

The Center for Tropical and Subtropical Aquaculture

The CTSA "region" includes Hawai'i and the American Insular Pacific (American Samoa, the Commonwealth of the Northern Mariana Islands, the Federated States of Micronesia, Guam, the Republic of Palau, and the Republic of the Marshall Islands), though CTSA research has had impacts on aquaculture in other areas of the U.S. and beyond. The Center's projects tap the region's extensive resource base to meet the needs and address the concerns of the tropical aquaculture industry.

CTSA projects develop and transfer knowledge about new food and non-food products, technologies, quality improvements, new applications, and/or value-added processes that enhance domestic and international market opportunities for aquaculture products.

Administered by the University of Hawai'i (UH) College of Tropical Agriculture and Human Resources (CTAHR), CTSA was established in 1986 and operates from the University of Hawai'i Manoa campus.

PERCENTAGE OF TOTAL CTSA FUNDING BY LOCATION

LOCATION	TOTAL FUNDING	PERCENTAGE OF CTSA FUNDING
American Samoa	$291,336	1%
Northern Mariana Islands	$595,668	3%
Other	$1,050,887	5%
Palau	$965,618	5%
Guam	$1,218,607	6%
Marshall Islands	$1,155,858	6%
Federated States of Micronesia	$1,539,530	8%
Hawai'i	$13,260,915	66%

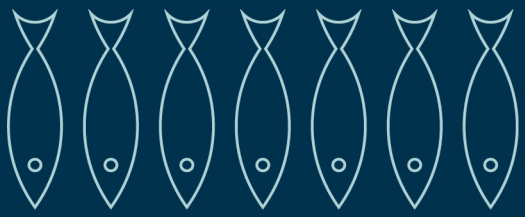
ctsa regional map

AQUACULTURE:

A Path to Food Security in the Pacific Region

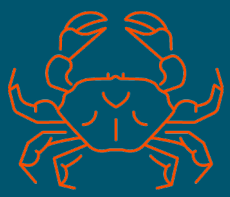
Food security requires consistent availability of sufficient, safe, nutritious food to maintain a healthy and active life.

Globally, fish provides more than 3.3 billion people with almost 20 percent of their average per capita intake of animal protein, and 4.3 billion people with 15 percent of such protein



Aquaculture is projected to reach 100 million tonnes for the first time in 2027 and 106 million tonnes in 2030.

By 2030, aquatic food production.is forecast to increase by 15 percent, mainly by intensifying and expanding sustainable aquaculture production.



Asia is the leading continent for aquaculture production and is responsible for 92 percent of the global aquaculture production of fish, crustaceans and mollusks. According to the most recent Fisheries of the United States report, the U.S. ranks 17th in aquaculture production.

Just to maintain this level of per capita utilization, an additional ~47.5 million tons of food fish will be needed in 2050, according to FAO projections

Over 50% of the seafood consumed worldwide comes from aquaculture, and the percentage is even higher when aquatic plants are included

U.S. aquaculture production in 2019 was **658 million** pounds with a value of **$1.5 billion**

Seafood is rich in vital nutrients and is an essential part of a healthy diet. Studies have shown the omega-3 fatty acids found in a variety of seafood reduce the risk of cardiovascular disease. Omega-3s can help decrease triglyceride levels, slightly lower blood pressure, decrease the growth rate of plaque in blood vessels, and decrease the risk of heart arrhythmias. Omega-3 fatty acids also contribute to healthy neurological development of children.

AQUACULTURE:
Opportunities for Economic Growth

The impacts of aquaculture can span far beyond the industry, from local communities to global economic interests. With a recent heightened focus on investing in sustainability, the U.S. government is creating significant opportunities for aquaculture to increase its impacts on the American economy.

Imports continue to be the major source of seafood for U.S. consumers, highlighting the need for investment in American aquaculture. In 2019, the total import value of edible and nonedible seafood for the U.S. was $39.7 billion, while edible fisheries imports were valued at $21.4 billion.

- The U.S. seafood trade deficit surpassed the $10 billion mark for the first time in 2010 and reached $17 billion in 2020, representing 1.5 million tons of seafood.
- While aquaculture only accounts for 7 percent of total domestic seafood production, the focus on high value products means that 24 percent of the value of U.S. seafood products comes from aquaculture.
- There is room for growth in U.S. aquaculture production, which reached a value of $1.5 billion in 2019. 38% of U.S. production is from the west coast / Pacific region.
- In Hawai'i, 2021 aquaculture sales totaled $79.7 million, up 20% from 2020. Algae contributed $36.7 million and accounted for 46% of the total sales. Ornamentals accounted for $3.62 million of total sales.

JOBS OF THE FUTURE

More than 20 million people are employed by the global aquaculture industry. It is estimated that in 2020, women accounted for over 28% of those directly engaged in aquaculture. In addition to a growing amount of traditional industry jobs, aquaculture accelerators and incubators are recruiting more entrepreneurs and their innovative technologies into aquaculture, creating critical new opportunities for revenue streams, supply chains, and jobs. Many of these new ventures are focused on utilizing aquaculture to produce valuable products while mitigating climate change and other environmental problems.

AQUACULTURE: PREVENTING EXTINCTION OF WILD STOCKS

For centuries, Pacific Islanders and other coastal residents have depended on fish as their main dietary protein source. **The security of fish as a dietary staple is in jeopardy.**

According to the FAO, fishery resources continue to decline due to overfishing, pollution, poor management and other factors. The fraction of capture fishery stocks within biologically sustainable levels decreased to 64.6 percent in 2019, 1.2 percent lower than in 2017.

While the number of landings from biologically sustainable stocks is on the rise, global capture fisheries' output has mostly leveled off and aquaculture has grown to help meet burgeoning demand for edible seafood. Aquaculture in the Pacific Region can help islanders restore a sustainable food supply and cut down on the need to import food. It can also help rural communities by providing tools and resources to create new revenue streams and jobs.

Aquaculture is a practical way to attain **food security, self-reliance, and economic gain**.

The remoteness of the islands served by CTSA makes it difficult and expensive to import food, energy, and other necessary commodities. Therefore, CTSA places much emphasis on sustainably utilizing the natural resources of the remote islands it governs to establish effective, environmentally conscious means of producing food locally with consistent yields.

CTSA has sharpened its focus on research, demonstration and extension that is in line with 'regenerative' aquaculture, which is the idea of simultaneously producing food, reducing waste and providing beneficial environmental impacts. This includes the farming of low maintenance and/or non-fed species such as macroalgae, bivalves, sea cucumbers, and mangrove crabs, as well as research to convert products that might otherwise be considered waste into useable feed ingredients.

regenerative

CTSA SUPPORTS...

U.S. Shellfish Farming Expansion

Oysters, shrimp, and other shellfish are among the most popular seafood products in the U.S. Ensuring their safe and reliable supply is important to national food security and the economy. However, the increasing impacts of climate change have interrupted the life cycles of many species, including oysters. An unexpected solution to oyster supply has emerged from Hawai'i, thanks in part to CTSA-funded projects. Also, efforts to develop local feed resources for shrimp farming and establish aquaculture of a highly desired species of limpet have been amplified.

Strengthening the Oyster Industry

CTSA has supported two decades of the necessary groundwork to establish bivalve farming in Hawai'i, which has grown into one of the most essential industry suppliers for mainland oyster growers who are facing ocean acidification. In addition to providing technical assistance to growers, research accomplishments include more reliable and less complicated methods to produce triploids and tetraploids (faster-growing sterile oysters). Researchers also found a way to use rice starch as a cost-effective supplemental feed for oysters.

Increasing Capacity for Aquaculture of Opihi, a Hawaiian Cultural Treasure

Opihi is culturally important seafood with a high market value. Wild populations of opihi have dwindled in recent decades and, thus, become more dangerous to harvest - many 'opihi pickers' have lost their lives while gathering the limpets along Hawai'i's rocky shorelines. To address this issue, CTSA funded years of research to produce opihi for local food security, conservation, and community safety purposes. While researchers were not able to establish hatchery production of the elusive opihi, results from the work are necessary to achieve the next steps in aquaculture of opihi.

Producing Polychaetes to Support Shrimp Farming

Shrimp farmers depend on polychaete worms as an essential food item for the maturation of shrimp broodstock. Frozen polychaetes are costly to import to the islands and carry risks of pathogen transmission, so a series of CTSA projects aimed to investigate the potential of farming them in Hawai'i. Researchers identified that a local species *Marphysa sanguinea* is an excellent maturation feed for female *L. vannamei* broodstock, and that the worms can be cultured at a commercial scale in locally available sediment. Additional work is underway to realize the full potential of this species in the shrimp farming industry.

CTSA SUPPORTS...

Circular Food Systems

Limited land space contributes greatly to the Pacific region's reliance on imported goods. Nearly all food —for humans and animals— is shipped into the Islands. Meanwhile, nutrient-rich "waste" products from local terrestrial farming, fishing, and food manufacturing are underutilized and often discarded. CTSA has funded several projects to address this imbalance and create circular food systems. This includes research to convert products that might otherwise be considered 'waste' into usable ingredients for aquatic feeds. This type of research aims to create alternative protein sources for aquaculture while reducing the burden on island waste streams.

Repurposing Tofu Processing Waste Into a Protein-Rich Feed Ingredient

Researchers investigated locally available, low-cost agriculture wastes including taro and soy byproducts to create a fungal protein ingredient. Soy whey was found to be the most promising substrate for growth of the fungal protein. The whey is normally discarded in wastewater during the production of tofu; finding another use for it can decrease the effluent load on island sewage facilities. Researchers found that the fungal protein ingredient could replace 25% of fishmeal protein in feed without affecting shrimp growth performance.

Turning Off-Grade Papaya Into a Replacement for Fishmeal

Another project conducted a small-scale feasibility study of converting off-grade and damaged papayas into a protein-rich ingredient for aquatic feed. The project developed a low-cost fermentation method to convert unmarketable papayas into a protein-rich yeast meal. The yeast meal was added to experimental diets for hybrid tilapia, and results found that the ingredient can replace up to 25% of fishmeal in an aquatic feed.

Improving the Nutrient Content of Black Solider Fly Meals

Black solider flies (BSF) are natural composters that can repurpose kitchen waste into useable nutrients in the form of larvae. However, high fat content discourages their use in aquatic feeds. Two CTSA projects have focused on investigating the potential of BSF larvae meal as a replacement for fishmeal. Under the first project, researchers concluded that up to 50% of fishmeal could be replaced by defatted BSF meal without affecting shrimp growth performance. The second project is developing BSF meals with improved nutritional values by employing a similar yeast fermentation process as used in the papaya project to increase protein content while reducing fat and chitin contents. As a result of the work, the protein content of black soldier fly meal increased to over 40%.

CTSA SUPPORTS... Aquaculture Health Management

Worldwide, aquaculture disease outbreaks cost billions of dollars each year in lost products. Biotic and abiotic environmental conditions are the main causes of disease outbreaks. Keeping the CTSA region favorable and healthy for aquaculture is a top priority for the program. From disease prevention to helping the aquaculture industry import and export desired species, aquatic health services are critical to aquaculture farming in the region. Researchers address disease issues that impact small, medium and large scale farmers alike, including the international Specific Pathogen Free (SPF) shrimp industry.

Maintaining Pathogen-Free Shrimp Production in Hawai'i

SPF shrimp are the foundation of global shrimp farming, and Hawai'i is the home of the breeding technology and the largest suppliers of SPF broodstock. To protect Hawai'i's SPF shrimp industry, researchers are investigating potential vectors for pathogens in commodities, including other frozen seafood and commonly-used shrimp feeds. Also, a recent CTSA project identified and developed farming techniques for a local polychaete worm so that shrimp broodstock can eventually rely on local food, thereby reducing the risk of disease transmission from imported feeds. The research groups regularly share their findings with producers, researchers, and other stakeholders in the shrimp health sector.

Addressing Tilapia Import and Export Regulations that Impact Island Farmers

For many years, farmers were unable to export tilapia from Oahu to other Hawaiian Islands due to concerns over the transmission of the harmful disease *Francisella noatunensis* subsp. *orientalis* (*Fno*). A CTSA project helped reverse the HDOA export moratorium by determining that Fno is present in tilapia and natural bodies of water on other islands, including Maui and Kauai. The project also confirmed the presence of a highly regulated species in Hawai'i streams that farmers were previously banned from importing due to concerns over escapement. The CTSA study proved that the fast-growing *O. niloticus* and its hybrids are already prevalent in streams on Molokai, Maui, and the Big Island. Information from this study resulted in a status change for the species from *total ban* to *conditional importation*.

Servicing the Aquatic Animal Health Needs of the Regional Aquaculture Industry with a USDA-certified Disease Lab

Hawai'i aquaculture famers seeking disease diagnosis have limited options and must send samples to labs on the U.S. mainland for analysis, which takes considerable time. In an effort to speed up the diagnosis process in consideration of our regional aquaculture industry, CTSA supported a series of projects to create a much-needed USDA-approved disease laboratory in Hawai'i. While the future of the lab is up to the State of Hawai'i to determine, the protocols now exist to locally test for OIE listed diseases.

CTSA SUPPORTS...

Preservation of Wild Stocks

Hawai'i and the Pacific Region are home to some of the most beautiful, exotic species of tropical fish on the planet. Many of these fish play important roles as herbivores in reef ecosystems. They are also highly desired in the aquarium trade. However, impacts from overharvesting and climate change have negatively impacted wild populations. Citing a sharp decline in natural populations, Hawai'i enacted a ban on the collection of the popular Yellow Tang. While the ban is positively impacting wild populations, it is having negative impacts on the local economy and ornamental fish exporters. This puts a spotlight on the critical opportunity for aquaculture to supply the aquarium industry while supporting conservation of natural stocks.

Reducing Fishing Pressure on Coral Grouper

Coral grouper, a desired food and ornamental species, is overharvested and difficult to find in the waters of the Western Pacific islands. CTSA has supported several years of research to meet consumer demands and reduce fishing pressure on wild stocks of Coral Grouper. The established hatchery technology provides a solution to increase natural recruitment if Pacific Island governments desire to replenish local stocks. Building on progress in hatchery production, the most recent project is focused on improving grow-out performance and further refining overall farming technology. The project results will be critical in determining the economic feasibility for commercial aquaculture of this species.

Preserving Wild Stocks of the Popular Aquarium Fish, Yellow Tang

Following their successful closing of the yellow tang life cycle, a Hawai'i research group utilized CTSA funding to improve the survival of Yellow Tang larvae during critical periods post-hatch. The research group is aiming to increase the total yield of juveniles to achieve commercial production targets in conjunction with Biota Inc., a private aquaculture company that produces fish and invertebrates for ornamental and food security purposes in Palau. This unique partnership demonstrates the benefits of leveraging public and private investments to achieve progress in aquaculture production. More importantly, it brings us one step closer to providing highly desired aquarium fish from the hatchery and preserving natural stocks.

CTSA SUPPORTS...

Economic and Food Security in the Western Pacific Islands

Located in the Western Pacific Ocean and isolated from other major continents, the U.S. affiliated Pacific Islands are burdened by the high cost of importing goods and lack of economic opportunities. The Ocean is the most significant and valuable natural resource in the region. Sustainable aquaculture in waters surrounding these islands can be a valuable tool to produce food and create revenue streams in the remote Western Pacific. CTSA proudly supports the capacity building necessary to transfer aquaculture technology throughout this unique region, with a focus on food security and increasing local resources to conserve culturally important species and ecosystems.

Creating Aquaculture Capacity in the Marshall Islands

Pacific threadfin (moi) is a highly valued marine fish across the Pacific Islands and Asia. Many wild populations of moi have been overfished to the point of near extinction. In an effort to increase the availability of moi and simultaneously transform the Marshall Islands (RMI) from an international fishing hub into a fish-farming hub, CTSA has supported nearly a decade of work to bring aquaculture to the remote atolls of the RMI. The project established commercial moi farming using local feeds and trained a Marshallese workforce in a variety of aquaculture skills, creating opportunities for new revenue and improved livelihoods. Several batches of moi have been harvested and marketed locally, as well as exported off island.

Replenishing Mangrove Crab Populations

Mangrove crab is a highly favored seafood in Palau; so much so that it has been harvested beyond sustainable yield and must now be imported to meet demand. To mitigate a myriad of threats facing regional mangrove crab populations, researchers in Palau have established site-specific hatchery technologies to produce large quantities of crablets. Hundreds of thousands of crablets have been distributed to local residents for farming and wild restoration purposes. Researchers have also determined the existence and population structure of *S. serrata* crabs among four locations within the CTSA region and verified the non-existent status of pathogens of concern. This knowledge is helpful to farmers and resource managers, particularly in limiting disease introductions to farm populations.

Farming Rabbitfish for Island Food Security

Rabbitfish is a highly desirable food fish and there is a growing interest in farming the species throughout the Western Pacific. CTSA supported the establishment of rabbitfish hatchery production in Palau, where researchers improved upon existing rabbitfish culture technologies with the main objectives of increasing hatchery survival and fingerling production. They also hosted a 3-day virtual workshop on rabbitfish hatchery and grow-out that helped spur development across the region. CTSA is now funding rabbitfish work in the Marianas Islands and the Marshall Islands.

CTSA SUPPORTS...

Sustainable Aquaculture Workforce Development

To secure the future of sustainable seafood, there must be concerted investments in education that inspires interest in aquaculture and develop the workforce of the future. CTSA has supported numerous projects to educate and train students of all ages across the region, including in-house projects that developed curricula. CTSA research projects also often support graduate students and other young researchers to conduct essential work while increasing their knowledge and skills to serve in the aquaculture workforce.

Inspiring The Next Generation of Pacific Island Aquaculture Researchers

Although the primary purpose of the macroalgae project is to increase the number of native Hawai'ian species in cultivation, the project is also making important impacts in education. In addition to developing the 'limu in a bucket' activity to grow macroalgae in the classroom or at home, the project directly trained university student interns from American Samoa and the Marshall Islands in macroalgae production. These students brought this training back to their home islands, where they are now applying their new knowledge as experts in the cultivation of important macroalgae species.

Teaching K-12 Students About Aquaculture

Multiple CTSA projects have incorporated aquaculture into K-12 classrooms. Recently, a two-year CTSA education project aimed to inspire students to consider careers in aquaculture or related fields, and provided them with information about educational choices that can help them fulfill those career aspirations. The project developed, conducted, and evaluated a three-day aquaculture workshop for twenty-two high school students. Participating students rated the workshop favorably, with many expressing interest in pursuing marine-related careers.

Hands-on Training

As reported in other Impacts sections, several CTSA projects have emphasized the importance of training a local workforce. The RMI finfish project trained over 30 technicians to produce local feed, run the hatchery, and manage grow out cages. In addition to training commercial oyster producers how to improve hatchery production, the Bivalves project trained numerous students who have gone on to become researchers and aquaculture technicians for large operations. Similarly, recent projects on disease diagnostics and barcoding DNA provided intensive training for future researchers and technicians. Many of the projects in Palau have emphasized hands on training with technicians, particularly in culturing algae, as well as farmers to improve production and yields.

CTSA SUPPORTS...

Aquaculture Information Dissemination

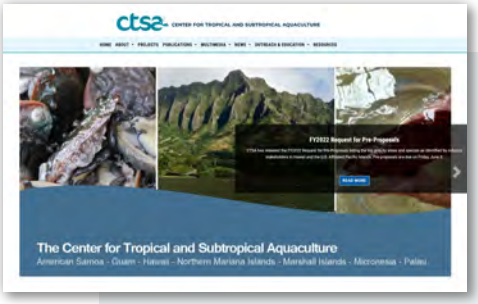
Access to relevant information is a critical component for aquaculture development in Hawai'i and the U.S.-affiliated Pacific Islands. CTSA works with research teams to disseminate project results and other pertinent aquaculture information to interested and affected parties throughout its region using a variety of media, including articles, videos, and workshops. Activities conducted through the ongoing 'Information Services' project help to update stakeholders on the progress of CTSA work, provide essential data to researchers, and help farmers improve production through the application of disseminated information.

■ The Information Services project produces and distributes the online newsletter *Regional e-Notes* each month to over 600 subscribers. *Regional e-Notes* features CTSA videos, regional announcements, and project updates prepared together with PIs, including the following articles:

- *CTSA Project Breakthrough: 'Yellow Tang' Project Produces F2 Juveniles, Successfully Closing Life Cycle of Hawai'i's Most Popular Ornamental Reef Fish*
- *CTSA Project Update: Molecular Stomach Content Analysis of First Feeding Larval Fish*
- *CTSA Project Update: Polychaete Culture in Hawai'i - A Potentially Valuable Feed for Shrimp Hatcheries*
- *CTSA Project Summary: Presence of Oreochromis niloticus and Francisella noatunensis subspecies orientalis (Fno) in feral populations of tilapia in Hawai'i*

■ The CTSA video series has reached over 75,000 unique views, providing an opportunity for worldwide promotion of regional aquaculture activities. Several videos have been featured at international conferences and symposiums.

In 2017, the Information Services project produced the video "Aquaculture in Palau," highlighting the activities from multiple CTSA-funded projects in Palau and their impacts on local farmers and business owners.



The CTSA website was redesigned and re-launched in March 2021. The site includes regional announcements, news stories, and other pertinent information for regional aquaculture farmers, researchers, and stakeholders.

www.ctsa.org

■ CTSA worked together with project PI's to produce the following publications (since 2013):

- *CTSA #166. McDermid, Karla . 2022. Limu in a Bucket: Grow Your Own Sea Grapes.*
- *CTSA #165. Callan, C., M. Delos Santos, E. Pereira, R. Touse, P. Harrison, E. Groover, S. Davis, A.I. Burgess, K.E. Hiew & A.A. Corley. 2019. Leopard Coral Grouper, Plectropomus leopardus, Hatchery Manual.*
- *CTSA #164. Haws, M., F. Petersen, D. Wilkie, B. Koval, D. Nisbet and X. Guo 2019. Producing Polyploid Pacific Oysters (Crassostrea gigas Thunberg). The story of a private-public partnership to improve Pacific Oyster seed quality and availability.*
- *CTSA #163. Ito, M. 2018. Hatchery Manual for Sea Cucumber Aquaculture in the U.S. Affiliated Pacific Islands.*
- *CTSA #162. Tamaru, C. 2015. Differences Between Cultured or Captured Kāhala in Hawai'i.*
- *CTSA #161. Ako, H. 2014. How to Build and Operate a Simple Small-to-Large Scale Aquaponics System.*

CTSA SUPPORTS...

Innovative Approaches to Aquaculture Development

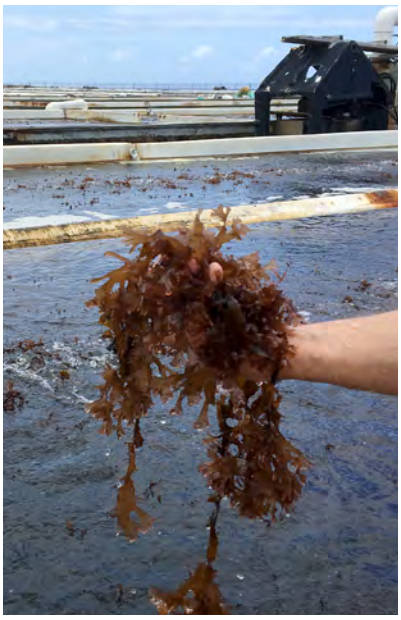
When it comes to aquaculture development, the CTSA region has very unique conditions compared to other locations. Limited land space and natural resources coupled with a limited amount of aquaculture researchers drives our industry to seek inter-disciplinary solutions to regional challenges. Innovations in aquaponics, improved harvesting techniques, and other new technologies are making it easier than ever to farm larger amounts of crops in small spaces using fewer resources. CTSA encourages researchers in different fields to participate in our research and demonstration efforts to investigate cutting edge technologies that have potential to improve farming opportunities in the Pacific region.

Using Fungi to Harvest Microalgae

Microalgae are a critical feed item used widely in aquaculture. They are easy to incubate in large-scale bioreactors and open ponds, but very difficult to harvest due to their small size. Energy and harvesting costs can account for up to 50% of total production cost on a farm that uses conventional methods. There is a demonstrated need for economical and environmentally friendly methods to harvest microalgae to meet the demands of the booming algae market. CTSA is funding innovative work to design and test fungal filters to isolate targeted commercial microalgae. Researchers will develop a sustainable and economical BioCube system to harvest microalgae using the fungal filters.

Developing Local Macroalgae Aquaculture Technology

Macroalgae (limu) is an important staple of the Hawaiian diet. Establishing aquaculture methods for native macroalgal species will provide nutritious food sources, maintain unique traditions, and provide opportunities for industry development. Researchers are currently developing reliable culture methods for *Caulerpa lentillifera*, *Codium edule*, *Asparagopsis taxiformis* (limu kohu), and *Halymenia hawaiiana* (limu lepe-o-Hina). Making progress towards large-scale culture of limu kohu and creating new methods for the other species will add high value options for aquaculture farmers in Hawai'i and other Pacific islands.



Integrating Biochar and Nanobubbles into Aquaponics

A new CTSA project is developing a state-of-the-art aquaponic system that will combine two innovative technologies: nanobubbles and biochar. Researchers hypothesize this combination could significantly increase plant and fish yields. As part of the one-year proof-of-concept project, a cost benefit analysis of the proposed prototype will be conducted and findings will be disseminated to stakeholders.

Research Acknowledgements Index

The following CTSA-funded projects are highlighted in this publication

Project	Lead Institution	Page
FY13 / FY14 / FY17 / FY18 Developing Bivalve Farming in Hawai'i	University of Hawai'i at Hilo	14
FY14 / FY17 Aquaculture of Opihi	Oceanic Institute (FY14) / University of Hawai'i (FY17)	14
FY12 / FY17 Culture of a Local Marine Polychaete, *Marphysa sanguinea*, for Use as a Shrimp Maturation Feed	Oceanic Institute	14
FY20 Design of a Harvesting System for the Marine Polychaete, *Marphysa sanguinea* (Phase 1)	Oceanic Institute	14
FY14 Utilization of Local Agri-processing by-products to Produce Fungal Protein for Aquatic Feed Production	University of Hawai'i at Manoa	15
FY17 Improving Cost-effectiveness of Producing Local Aquatic Feed from Papaya Fruit Wastes via Innovative Bioprocessing	University of Hawai'i at Manoa	15
FY14 Potential of Black Soldier Fly as a Feed Ingredient to Support Hawaiian Aquaculture	Oceanic Institute	15
FY19 Upgrading Black Soldier Fly Larvae Meal for Aquatic Feeds Using a Sustainable Microbial Process	University of Hawai'i at Manoa	15
FY16 *Francisella noatunesis subsp. Orientalis* (Fno) incidence and genetic assessment of feral Tilapia populations in Hawai'i	University of Hawai'i at Manoa	16
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FY19 Examination of Parasitic Infections in Shrimp Populations in Hawai'i and Detection of Pathogens in Commonly-used Shrimp Feeds	University of Hawai'i at Manoa	16
FY20 Advancing Aquatic Animal Health Diagnostic Testing in Hawai'i	University of Hawai'i at Manoa	16
FY17 Improving the commercial aquaculture feasibility for Yellow Tang *(Zebrasoma flavescens):* Resolving early bottlenecks to improve culture yield	Oceanic Institute	17
FY13 Establishing Coral Grouper *(Plectropomus leopardus)* Production in Palau through the Application of Intensive Copepod Production Technology	Oceanic Institute	17
FY16 Testing the feasibility of Open Ocean Cage Culture of Grouper in Palau	Palau Aquaculture Cooperative Association	17
FY18 Optimizing coral grouper *(Plectropomus leopardus)* culture to promote rapid commercialization in the U.S.-Affiliated Pacific Islands	Oceanic Institute	17
FY13 Development of Marine Finfish Aquaculture, Aquatic Feeds, and Training in the Republic of Marshall Islands (RMI) for Sustainability and Food Security	Rongelap Atoll Local Government	18
FY18 Establishing cost-effectiveness and efficiency of locally produced feeds and Moi farming technology in the Republic of Marshall Islands	Rongelap Atoll Local Government	18
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FY16 Disease Prevalence Survey of Wild Mud Crab Populations in the US-Affiliated Pacific Islands	Oceanic Institute	18
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FY20 Improving Forktail Rabbitfish *(Siganus argenteus)* Production in the CNMI and the Micronesian Region	Northern Marianas College	18
FY18 Cultivation of *Caulerpa, Codium,* and *Asparagopsis:* Trying to tame three Hawaiian Macroalgae	University of Hawai'i at Hilo	19
FY17 Aquaculture Workshop at Oceanic Institute for Students of Waianae High School's Aquaculture Program	Oceanic Institute	19
FY18 What's in the gut? A Metabarcoding Approach to Examining Diet in First Feeding Larvae	University of Hawai'i, Hawai'i Institute of Marine Biology	19
FY14 / FY16 / FY17 / FY18 / FY19 / FY20 / FY21 Aquaculture Information Service for the Pacific Region	Oceanic Institute / University of Hawai'i	20
FY21 Developing a biofiltration system with fungal filters for sustainable and economical harvesting of microalgae	University of Hawai'i at Manoa	21
FY21 Development of a state-of-the-art aquaculture and aquaponic system: Integrating biochar filtration and nanobubble technology	University of Hawai'i at Manoa	21
FY21 Next Steps in Culture of Native Hawaiian Macroalgae: Scale-up and Market Analysis	University of Hawai'i at Hilo	21

CTSA PROJECT IMPACTS: 2013 - 2022

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Pg. 15: Papaya; Jess Loiterton from Pexels
Pg. 17: Yellow Tang and Coral Grouper; Dr. Chatham Callan, Oceanic Institute of HPU

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