Swette Center for Sustainable Food Systems
Arizona State University

Carly Wyman and Katie Crowe offer participants fish samples at a blind taste test held at the Pāpa‘aloa Country Store & Cafe on Hawai‘i Island in May, 2024.

Welcome to the

Enhancing Hawai‘i's Food

Security through Aquaculture
Newsletter

Tuesday, July 30th, 2024

- Sharing current Hawai‘i seafood market and supply chain research.
- Brought to you by the Hawai‘i Team of the Swette Center for Sustainable Food Systems, Arizona State University. Hawai‘i serves as a significant model in examining sustainable food systems, including seafood. Our team is dedicated to offering insights and suggestions to enhance sustainability in our food systems via in-depth research and community collaboration.
- *Funding for Enhancing Hawai‘i's Food Security through Aquaculture Newsletter was made possible by the U.S. Department of Agriculture’s (USDA) Agricultural Marketing Service through grant AM22LFPPAZ1104. Its contents are solely the responsibility of the authors, and do not necessarily represent the official views of the USDA.*

Research Updates
Blind Taste Test Results: Tilapia and Mullet
Preliminary Data

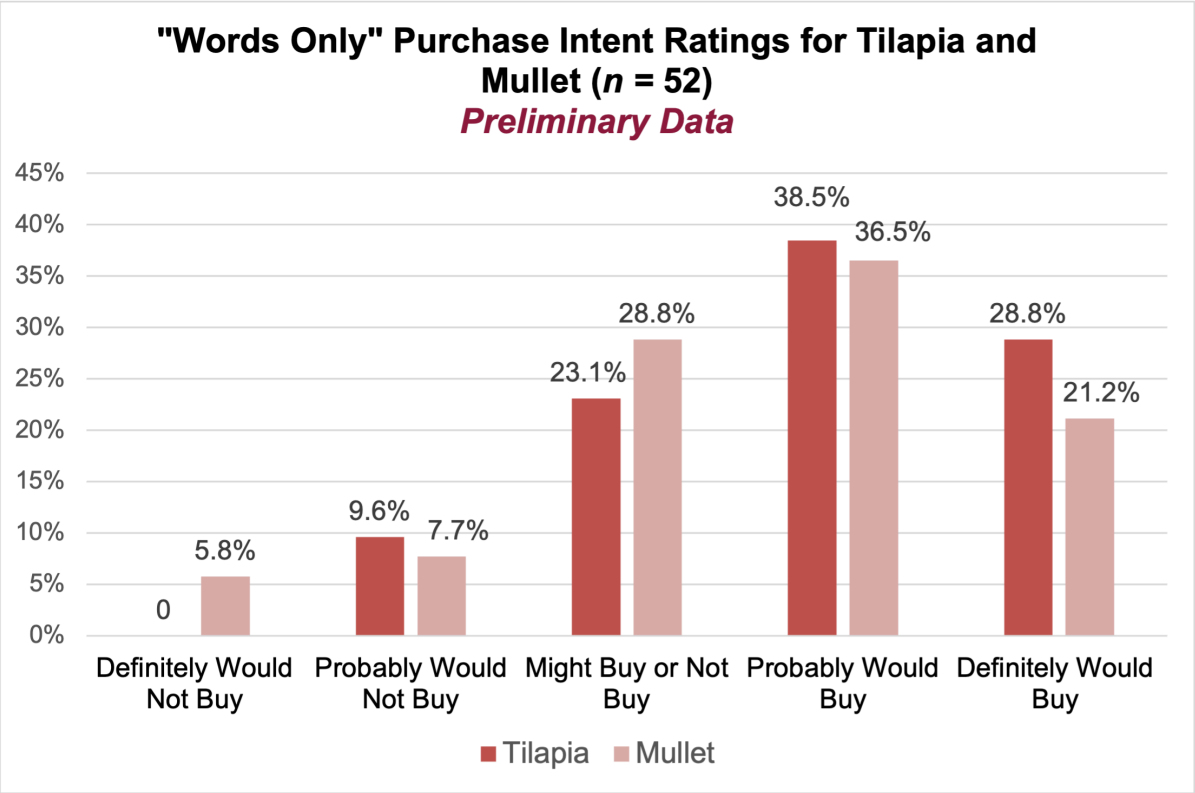
In May 2024, on Hawai‘i Island, researchers conducted a blind taste test to evaluate consumer preferences and market potential for tilapia and mullet, two species suitable for aquaculture in Hawai‘i. While we attempted to acquire local mullet for several months, we were ultimately unsuccessful in finding the amounts needed. Instead, fresh wild-caught New Zealand mullet was used along with farm-raised tilapia from Hawai‘i Island. Fish samples were prepped into portions, uniformly baked, and lightly seasoned with salt and pepper.

Fifty-two participants tasted both samples without knowing the species. Participants cleansed their palates and filled out surveys on tablets or computers after completing the tasting. The survey included a 5-point Likert scale for measuring purchase intent, a question on comparative purchase choice, and a 9-point Hedonic scale for

likeability (taste, texture, aroma, and overall preference). Data was collected and analyzed using Qualtrics software, and paired t-tests, ANOVAs, and a z-test were used to determine statistical significance.

Purchase Intent Ratings

The graph below shows the “words only” purchase intent ratings.



Mean Purchase Intent Ratings

The scale was also converted into numbers, where 1 = definitely would not buy, 3 = might buy or might not buy, and 5 = definitely would buy. A higher mean indicates higher purchase intent.

- Tilapia: Mean = 3.87
- Mullet: Mean = 3.60
- Statistical Difference: Not significant

Comparative Purchase Choice

(If both samples were priced the same, would you buy Sample A, B, or neither?)

- 59.6% chose tilapia over mullet (40.4%)
- Statistically Significant at $p < 0.001$

Likeability Ratings

The 9-point Hedonic Liking Scale was converted into numbers where 1 = extremely

dislike, 5 = neither like nor dislike, 9 = like extremely. A mean likeability score over 7 indicates acceptable sensory quality.

- Taste: Tilapia mean = 7.00, Mullet mean = 6.73
- Texture: Tilapia Mean = 6.83, Mullet Mean = 6.77
- Aroma: Tilapia Mean = 6.42, Mullet Mean = 6.02
- Overall Preference: Tilapia Mean = 7.13, Mullet Mean = 6.73
- Statistical Significance: Only aroma showed a significant difference, where tilapia was rated higher than mullet ($p = 0.013$)

Implications

Taken together, we found that tilapia was slightly preferred over mullet in our sample. A mean taste and overall preference likeability rating of 7+ indicates its market acceptability. On most measures, mullet scored just under 7, indicating it also has market potential.

Tailored marketing strategies may optimize consumer reach for these species. For example, emphasizing tilapia's favorable aroma and highlighting culinary applications that downplay mullet's aroma. Additionally, broad marketing campaigns could promote mullet's sustainability and cultural importance in Native Hawaiian fishponds.

Limitations include a non-representative sample of the Hawai'i's population and 1-2 day variability in the freshness of the fish. Further research with a more representative sample is suggested to replicate and expand these findings.

The Swette Center's Hawai'i Team would like to sincerely thank Gary of Mitch's Fish Market and Sushi Bar, Jamiesen of Hilo Fish Company, and Wayland Lum of Puna Aquafarms for their help sourcing the fish, as well as Galahad and Mike of Pāpa'aloa Country Store & Cafe for their help preparing the fish and hosting the taste test.

Research Updates Continued

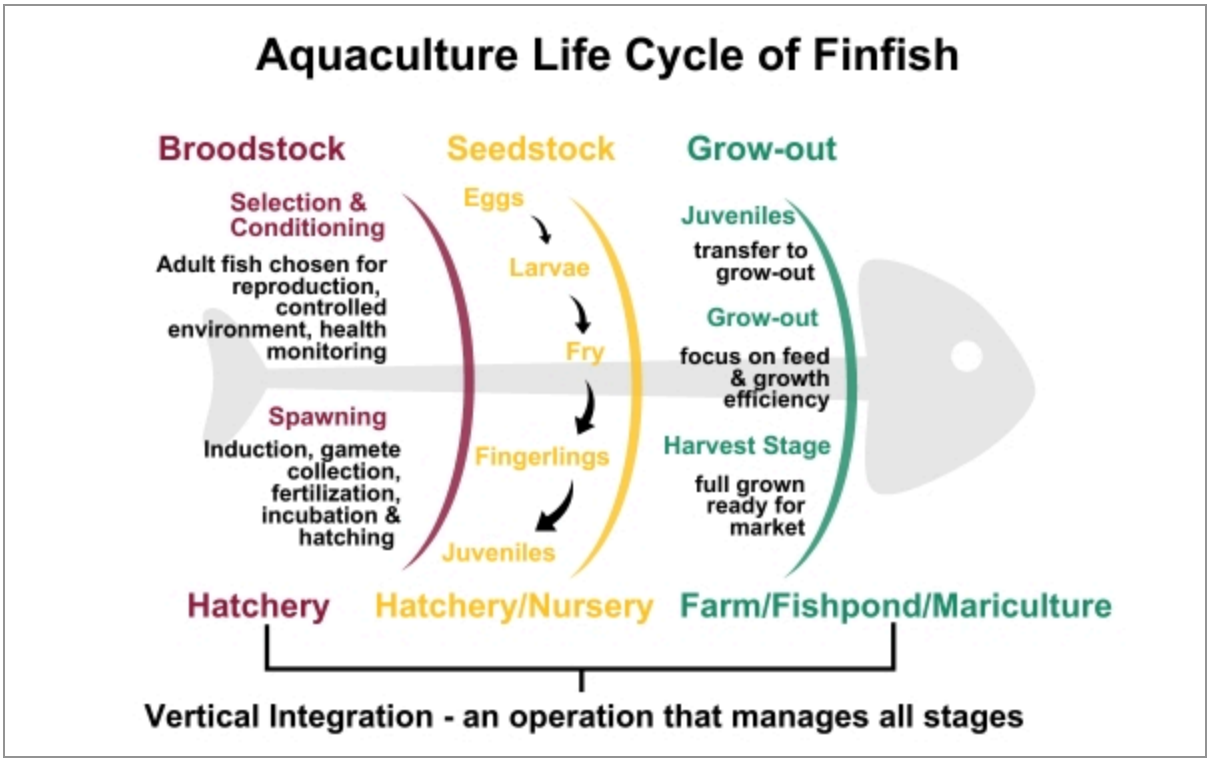
Perceived Supply Chain Challenges: Broodstock and Seedstock

Preliminary Data

Goal and Definitions

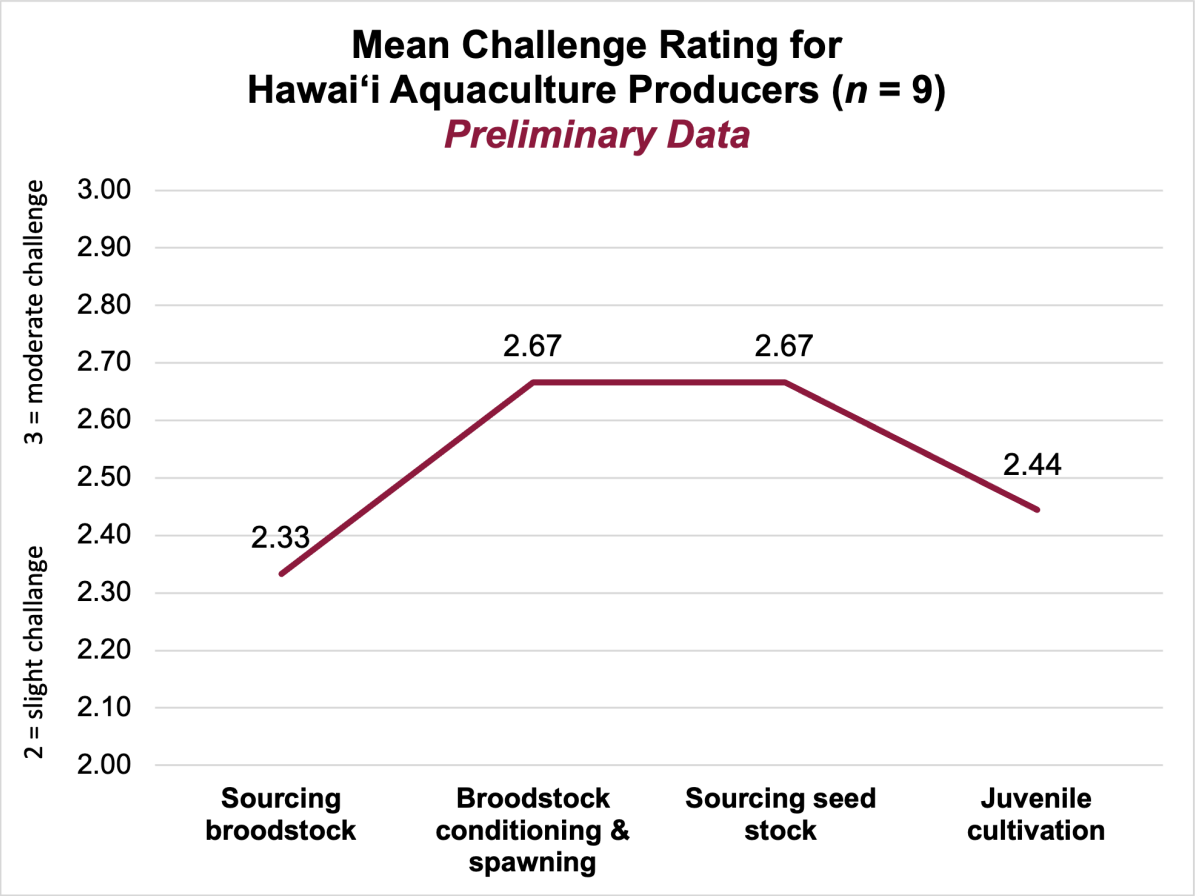
One main goal of this research project is to examine supply chain inefficiencies in Hawai'i aquaculture. Each stop along the supply chain is affected by our unique geographical location, including climate, shipping costs, and shipping time frames. In this portion of our newsletter, we focus on challenges with acquiring broodstock and seedstock. To describe the industry terms used, we developed an infographic that

displays the life cycle of an aquacultured finfish.



Findings from the Commercial Aquaculture Producer Survey

In 2023-2024, we invited Hawai‘i commercial aquaculture producers to participate in an online survey about supply chain challenges. Nine businesses responded (response rate 23%). To address gaps and inefficiencies in the aquaculture supply chain, we asked participants, “How challenging are these topics for your operation currently?” They were given a list of possible supply chain challenges, which they rated on a “words only” scale from “not a challenge at all,” “slight challenge,” “moderate challenge,” “major challenge,” and “extreme challenge.” For analysis, this was converted into a numerical 1-5 scale to achieve mean challenge ratings for each subject.



Results suggest that all of the topics mentioned above are challenges. Both broodstock conditioning and spawning, as well as sourcing seedstock, were rated as near moderate challenges (2.67 for both). This suggests that efforts to improve the aquaculture supply chain should include methods aimed at increasing the availability and viability of affordable seedstock and broodstock.

Interested to learn more about our research findings?

Stay tuned for research updates in our final reports, which will be released later this year.

Subscribe for updates

The Current State and Future of Hawai‘i Hatcheries

Our research, including surveys and interviews with producers, indicates that sourcing broodstock, conditioning and spawning broodstock, and sourcing seedstock are challenges for Hawai‘i producers. Depending on the species, the time needed to grow a fish to market from egg to maturity can take over a year, prolonging the time

and resources that growers must spend to bring a fish to market. It is often not feasible, manageable, or profitable for companies to vertically integrate and establish their own hatchery operations. Yet, the lack of commercial, wholesale hatcheries in Hawai‘i leaves producers with the decision of importing seedstock or raising it themselves. Other related challenges for producers include obtaining import permits, the cost of importation, and losses during transport. Therefore, additional support for private or state-managed hatcheries is critical to supporting food security in Hawai‘i through local aquaculture.

The recent recommendations for improving the Aquaculture Development (ADP) Program Strategic Plan for Hawai‘i by HATCH found similar results in their assessment. The authors describe insufficient hatchery and breeding programs for native and other locally farmed species, highlighting the need for a "stock enhancement program including a state of the art multi-species modern hatchery (seaweed, shellfish, and finfish) for stock enhancement recovery especially for loko i‘a and small-scale farmers."

A look at the current state of Hawai‘i hatcheries

Only a few hatcheries exist on the islands. The majority are research or education-based and do not advertise the sale of seedstock.

The Oceanic Institute at Hawai‘i Pacific University on O‘ahu restocks mullet (*‘ama‘ama*) fingerlings from their hatchery to *loko i‘a* (Native Hawaiian fishponds). They have also developed culture techniques for other fish, such as milkfish (*awa*) and Pacific threadfin (*moi*).

The Department of Land and Natural Resources's Ānuenue Research Center, produces catfish and trout for stocking public fishing areas. This center also conducts experiments with the release of mullet fingerlings on Hawai‘i Island and moi juveniles on O‘ahu.

The UH Hilo Pacific Aquaculture & Coastal Resource Center (PACRC) operates bivalve and fish larval hatcheries. They conduct research and commercially supply oyster seedstock to Hawai‘i and California farms. Currently, the larval facility is focused on ornamentals, but in the future, they aim to create a broodstock facility for *moi*, *nebeta* and *āholehole*.

Because of the lack of available seedstock, many aquaculture businesses are vertically integrated, having both a grow-out and a hatchery on-site. Both the Waiahole Nursery and Garden Center on O‘ahu and Island Aquaponics & Tilapia Hatchery on Hawai‘i Island advertise the sale of tilapia seedstock online. Puna Aquafarms often has tilapia fingerlings for purchase, although they are not advertised online. It is possible that several small to medium businesses sell seedstock locally but do not advertise to the public.

Blue Ocean Mariculture operates a hatchery at NELHA (Natural Energy Laboratory of Hawai‘i Authority) on Hawai‘i Island for their branded Hawaiian Kanpachi. The fish are naturally spawned, transferred into nursery tanks, and then to a net in the open ocean. Hawai‘i Fish Company, breeds and raises their signature North Shore Tilapia. This model may work well for some aquaculture operations, but it is not without its challenges. For example, Kaua‘i Sea Farms operates an off-grid hatchery run off of 100% renewable energy. This leaves their operation vulnerable to outages, including weather events.

Is there a future for Hawai‘i-based hatcheries?
According to the previously mentioned recommendations in "*Improving the Aquaculture Development Program (ADP) Strategic Plan for Hawai‘i,*" Oceanic Institute is best positioned to serve as a “de facto” Hawai‘i state hatchery due to its existing infrastructure and expertise. Still, there are other opportunities and challenges for the future of Hawai‘i’s hatcheries. Ocean Era, a research and development operation located at NELHA, aims to produce *nenue* (sea chub) fingerlings in the near future to stock fishponds.

One problem that hatcheries and fishponds noticed is that the hatchery fish don't respond well to being transferred directly into fishponds. They need an intermediate nursery setting to grow larger and have a smoother transition to their end habitat

(salinity, bacteria, food, etc).

Hawai‘i Sea Grant partnered with Waikalua Loko, a fishpond in Kāne‘ohe Bay, to create a land-based nursery using integrated multi-trophic aquaculture. Hatchery raised mullet are grown in on-shore tanks using water pumped from the fishpond. There, the young fingerlings can receive a controlled diet and acclimate to the water to have a better chance at survival in the wild. Naturally occurring *limu* (seaweed) in the tanks creates a transition diet, and naturalized manila clams from the fishpond help improve the water quality.

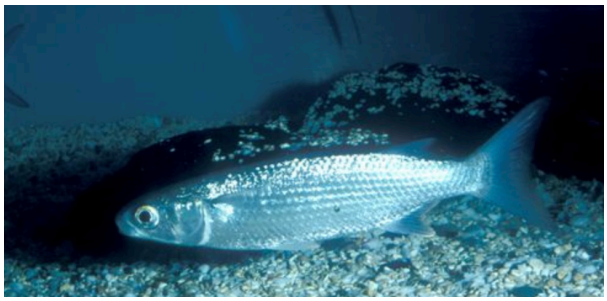
Pictured: A portion of the nursery facility with Waikalua Loko in Kāne‘ohe Bay. Photo credit: Voice of the Sea Season 11, Episode 1: Raising Pua, Raising Community.

In 2023, Wai‘anae High School’s Marine Science Learning Center partnered with Oceanic Institute and received funding to spawn mullet and create a hatchery at the high school to raise the juveniles. This spurred the introduction of Senate Bill 2329 in the 2024 Hawai‘i legislative session to support the continuation of this project and other similar efforts. SB2329 would have provided funding for mullet production for release in fishponds and stock enhancement. It also delineated funding for new positions, equipment, maintenance, and operating costs. The original bill specifically recognized the Ānuenue Research Center in Honolulu and the Wailoa Fisheries Research Station in Hilo as spaces for the mullet to grow prior to their release. While this bill passed in both the Senate and the House (with amendments), it ultimately was deferred in conference committee.

There is clearly growing interest and involvement in hatchery-supported aquaculture.

Years of trial and error and research by various private and educational organizations are leading the state toward a more sustainable future for seafood. These initiatives can reduce reliance on imported seedstock and increase the resilience and self-sufficiency of the aquaculture sector, especially by promoting the commercial development of native and low-impact species. However, to make a significant and timely impact on our food security, Hawai‘i needs direct support, funding, leadership, and organizational collaboration to support hatcheries.

Some Fun Facts About *‘Ama‘ama*



- Scientific name: Mugil Cephalus
- Common name: Stripped Mullet
- Hawaiian words for mullet: juvenile mullet are *pua ‘ama*, adult, mature mullet are *‘ama‘ama,* sexually mature mullet are *‘anae*

- Habitat: Calm waters close to shore, estuaries, around mouths of streams and inlets, and brackish bays and harbors. Traditionally raised in Native Hawaiian fish ponds, many of which had smaller, protected ponds for the *pua*.
- Fishing methods: Usually harvested with nets; it is hard to catch with pole and line, but will take baited seaweed or bread.
- Seasonality: Spawn December - February. Closed season in Hawai‘i is December 1st to March 31st.
- School Habits: Mature fish tend to jump singly (instead of in unison).
- Culinary Characteristics: High oil content, white firm, and juicy flesh. Aromatic. Rich, nutty taste. Frozen shelf life is 90 days.

Resources:

DLNR Fishing In Hawai‘i
Mullet Species in Hawai‘i, DLNR
Bishop Museum
Honolulu Civil Beat

TV Break! Hatchery-Raised Mullets: Keys to the Future of Hawaiian Fishponds

This 3-minute video discusses a NOAA-funded project aimed at improving traditional Hawaiian fishpond aquaculture by raising hatchery-produced Hawaiian Striped Mullet (*ʻamaʻama*).

It takes viewers from the hatchery at Oceanic Institute to the Heʻeia Fishpond, where mullet fingerlings are released, raised, and monitored. The goal of this initiative is to help kiaʻi loko (fishpond caretakers) achieve a vision where fishponds are once again part of a sustainable and local food source for the islands.

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Wednesday, September 4th, 2024

- Sharing current Hawai‘i seafood market and supply chain research.
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Correction

Aloha, in our last Newsletter, dated Tuesday, July 30th, we included an article entitled "*The Current State and Future of Hawai'i Hatcheries*" describing some of the efforts to raise broodstock and juveniles. We would like to correct this as we have since been provided with the most up-to-date information from the UH Hilo Pacific Aquaculture & Coastal Resource Center (PACRC), Oceanic Institute, and the Department of Land and Natural Resources' (DLNR) Ānuenue Research Center.

PACRC operates bivalve and fish larval hatcheries. It currently has Pacific threadfin (*moi*) and Hawaiian flagtail (*āholehole*) broodstock, and fingerlings are available to users. It has already distributed these species to numerous stakeholders in Hawai'i. Additionally, PACRC is also producing native bivalves, sea cucumbers, and other aquaculture specimens for community use. Furthermore, it has mullet (*'ama'ama*) broodstock and will conduct a hatchery run this fall, 2024.

Pictured: Aquaculture Technician setting algae flow rates in the larval fish rearing room. Photo Credit: UH Hilo

In terms of edible species, Oceanic Institute currently raises Pacific White Shrimp (estimated 2,000,000/year) into the postlarvae stage for R&D purposes and to supply local farmers. Additionally, they are producing: 1) striped mullet juveniles, *'ama'ama* (estimated 20,000/year) for release into fishponds and possible stock enhancement, 2) *āholehole* juveniles (estimated 500/year) for public/private aquaria, possible stock enhancement, and 3) giant trevally, *ulua* (estimated 1,000 juveniles/ year) for stock enhancement.

Pictured: Grow-out tanks at Oceanic Institute located in Waimanalo on Oʻahu. Photo Credit: UH Hilo

Lastly, the Ānuenue Research Center under the DLNR currently raises trout juveniles (approximately 25,700 in 2024) to stock the Puʻu Lua Reservoir in Kōkeʻe State Park on Kauaʻi. During open season the park offers recreational rainbow trout fishing to anglers who have a valid State of Hawaiʻi Freshwater Game Fishing License. The remainder of the Ānuenue Research Center's work focuses on restorative aquaculture.

Pictured: Rainbow trout fishing at Kōkeʻe State park on Kauaʻi. Photo Credit: Department of Land and Natural Resources

In summary, this is a snapshot of the current hatchery efforts in the Hawaiian Islands based on the most up-to-date information we received from these operations.

Interested to learn more about our research findings?

We are close to concluding this comprehensive supply chain and market analysis for Hawaiʻi aquaculture, including a separate companion analysis specific to Native Hawaiian fishponds (*loko iʻa*). If our readers want to share any other information with us, please email us at kaitlyn.crowe@asu.edu.

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