The State and Economic Contribution of Connecticut's Aquaculture Sector

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HIGHLIGHTS

Connecticut aquaculture is a valued component of the state's agriculture sector.

The aquaculture sector contributed $33.6 million to the state economy and supported 481 commercial jobs statewide in 2022.

The Connecticut fish hatchery system produced 618,000 pounds of trout and salmon for stocking valued at $4,635,000 above and beyond the state's commercial production value.

By species, the shellfish subsector, combining clam and oyster production, is the main contributor to the Connecticut aquaculture industry.

Aquaculture lease fees generate $670,318 in revenue for the state.

Connecticut ranks in the top five of all shellfish producing states, and third along the Atlantic coast of the United States.

The state also has an emerging seaweed sector, a land-based Recirculating Aquaculture System (RAS) producing sea bass, businesses that produce freshwater fish and baitfish for anglers, marine ornamental species for aquarium use, and three state salmonid hatcheries.

INTRODUCTION

Aquaculture, the process of cultivating aquatic organisms, is a valued component of Connecticut's agriculture sector. Connecticut aquaculture is a centuries-old industry, and the state was one of the first to codify aquaculture as agriculture (Connecticut General Statutes §22-11C). Overall, commercial aquaculture production contributed $33.6 million to the state economy and supported 481 jobs statewide in 2022. These figures do not include the state fish hatchery system which produces $4,635,000 worth of trout and employs an additional 35 workers (Connecticut Department of Energy & Environmental Protection).

The 2022 Census of Agriculture (USDA, 2024) placed aquaculture as the fifth highest valued agricultural food production subsector in terms of sales in Connecticut. Table 1 lists the reported production by product grouping. It should be noted that the U.S. Census of Agriculture tends to undervalue Connecticut aquaculture due to underreporting. Notwithstanding, since the census was last published, production has declined considerably and now represents only 3% of the agriculture economy (Figure 1). The primary reasons include a significant decrease in clam production and business consolidation within the shellfish sector.

By species, the shellfish subsector, combining clam and oyster production, was the main contributor in the Connecticut aquaculture industry. Connecticut ranks in the top five of all shellfish producing states, and third along the Atlantic coast of the U.S. (East Coast Shellfish Growers Association, personal communication 2024). The shellfish production industry contributed $26.4 million to the state economy and supported 379 jobs statewide in 2022. Although the sales of oysters have been more stable, particularly since 2017, the sales of clams declined by 84% between 2016 and 2023[1] in nominal dollars (from $11.4 million to $1.8 million), driving total aquaculture production and sales down in the state (Figures 2, 3).

Over the last reporting year (2023), the overall number of aquaculture farms in Connecticut decreased by four. While new businesses were gained, six shellfish businesses and one finfish business closed their doors permanently.[2] During that period, the total shellfish area under cultivation decreased by 1,000 acres.

[1] The economic analysis, which takes into account total aquaculture economy, is based on 2022 figures as this is the most recent year for which the state has data for all species. However, as more recent sales data is available for shellfish production it has been used in this report to show trends over time.

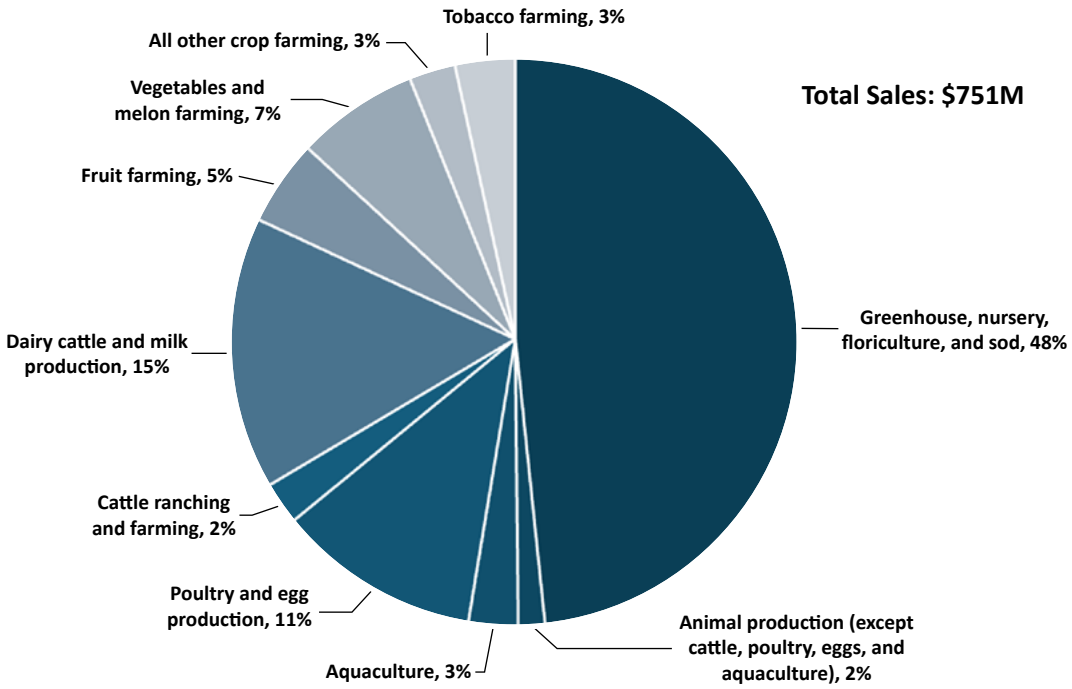
[2] This business closed after the period of the economic analysis.

Table 1. Connecticut aquaculture farm statistics in 2017 and 2022.

	2022		2017	
Item	Farms	Value ($1,000)	Farms	Value ($1,000)
Catfish	-	-	3	(Z)
Trout	7	2,815	9	3,169
Other food fish	7	1,536	5	(D)
Mollusks	40	17,356	49	19,834
Ornamental fish	3	70	6	(D)
Sport or game fish	1	(D)	2	(D)
Other aquaculture product*	5	(D)	-	-

Source: 2022 Census of Agriculture (USDA, 2024). (-) Represents zero. (D) Withheld to avoid disclosing data for individual farms. (Z) Less than half the unit shown.
**Other aquaculture products include but are not limited to kelp production.*

Figure 1. 2022 Sales of agricultural products by commodity groups in Connecticut.



Source: IMPLAN (2024), 2022 Census of Agriculture (USDA, 2024), Connecticut Department of Agriculture (2024).

AQUACULTURE PRODUCTION

Shellfish Production

Connecticut has a long history in shellfish production. A series of laws beginning in the mid-1800s helped to facilitate the commercialization of the oyster industry and, ultimately, to the state becoming a world leader in aquaculture. In 1881, the State Shellfish Commission, which eventually became the Connecticut Department of Agriculture's Bureau of Aquaculture (DOAG BA) and the lead agency for aquaculture, was established. During peak production in the late 1800s, the industry employed 1,024 workers and operated 453 harvest vessels (Connecticut Bureau of Labor Statistics, 1890). The traditional "bottom culture" method involved gathering small seed oysters from public natural beds and planting them within privatized areas of the seafloor. The state's foresight in protecting its natural oyster beds is the reason that they remain the primary source of seed for the industry. Most of the clam production businesses are also reliant on seeds originating from natural beds. In contrast to wild capture fisheries, however, cultivation and harvest must occur within privately leased areas. Innovation in hatchery technology and availability of wire and plastic culture containers in Connecticut have led yearly increases in the number of permits for this gear. However, even though half of the industry now uses these gear types, most of the production still arises from traditional bottom culture.

Today, Connecticut remains a major player in the U.S. shellfish market. The primary species cultivated include the Eastern oyster (*Crassostrea virginica*) and the Northern quahog (*Mercenaria mercenaria*). In addition, softshell clams (*Mya arenaria*), Atlantic surf clams (*Spisula solidissima*), blue mussels (*Mytilus edulis*), and bay scallops (*Argopecten irradians*) are cultivated

on a small-scale and experimental basis. Figure 2 and Figure 3 show the production and nominal dollar sales of clams and oysters, respectively, by producers in Connecticut for 2016 - 2023. Although the sales of oysters have been more stable, particularly since 2017, the sales of clams declined by 84% between 2016 and 2023 in nominal dollars (from $11.4 million to $1.8 million), driving total aquaculture sales down in the state. Both clam and oyster sales experienced their lowest rates during 2020, the year of the pandemic, when stay-at-home orders and consumers' fear of COVID infection closed restaurants and other marketing channels that local shellfish producers rely on. With a downturn in 2020, oyster sales have been remarkably stable since 2017, unlike clams, and close to the average for the 2016 - 2023 period.

There are 40 shellfish businesses with a total farm area that encompasses 61,626 acres across both town and state jurisdictions. There are also approximately 17,000 acres of public oyster beds and 10,000 acres of recreational beds. Collectively, these areas represent more than 20% of the Connecticut portion of Long Island Sound. Unlike adjacent states, much of the leased or franchised area is used for bottom culture along with transplanting activity that changes with season. As a result, not all the acreage is actively farmed at a given time. Further, much of the farming occurs in protected near-shore areas subject to runoff. As such, shellfish are moved offshore to approved waters for depuration (cleansing) prior to harvest. There is a trend towards the use of container culture (for example bags, cages, trays, etc.), though this is still a relatively small part of production in terms of volume, in contrast to most other states in the region.

There are 673 state franchise oyster grounds totaling 22,412 acres and generating annual revenue of $88,768. In the early 20th century, the state transitioned to a leasing program for shellfish grounds. There are 315 state shellfish leases totaling 24,942 acres generating $581,550 in annual revenue (CT DOAG 2024). A minimal amount of revenue is also generated from the leasing of municipal shellfish grounds, though the amount is not formally reported to the state.

"Today, Connecticut remains a major player in the U.S. shellfish market."

Figure 2. Connecticut shellfish production 2016 - 2023*.

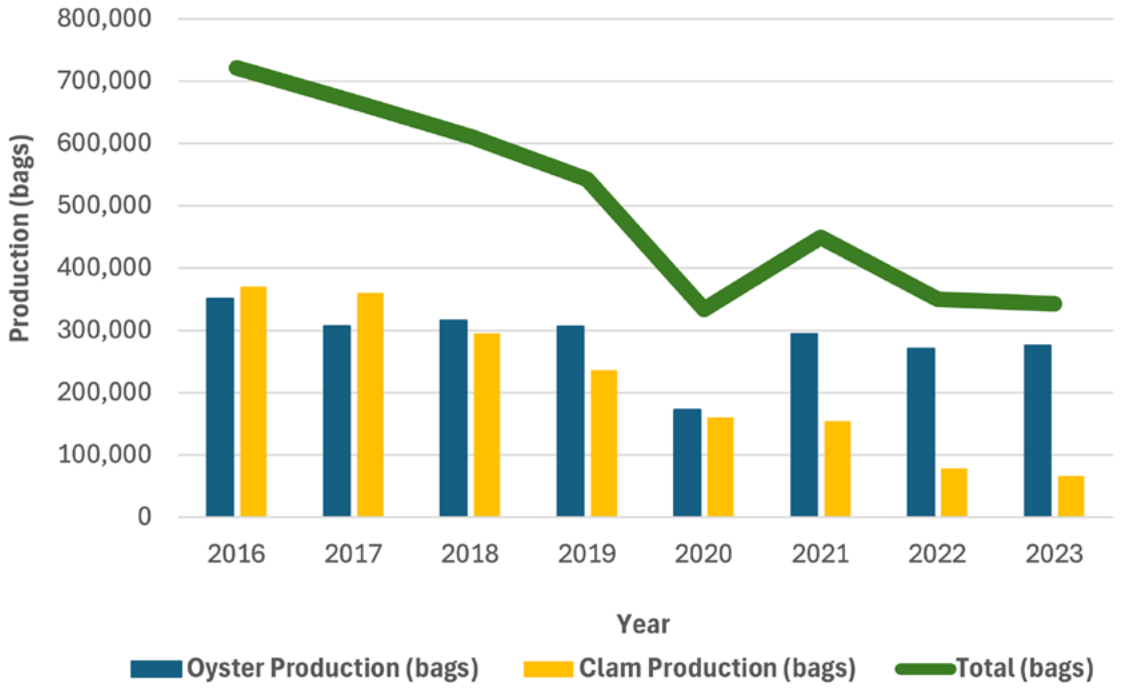
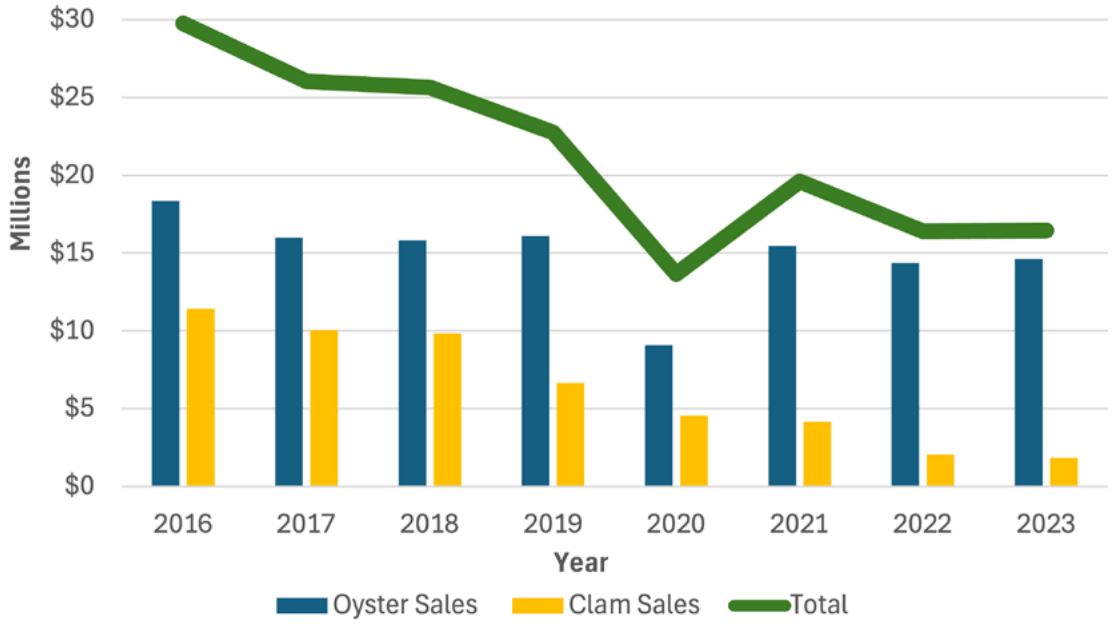


Figure 3. Connecticut shellfish aquaculture sales 2016 - 2023*.



***Source: Connecticut Department of Agriculture (2024).**

Finfish Production

The finfish aquaculture production sector is relatively small, though it also has a long history in Connecticut.[3] In 1866, the state Fisheries Commission, which would eventually become the Connecticut Department of Energy and Environmental Protection (CT DEEP), was established and tasked with rebuilding shad and salmon stocks, and eventually bass and other species (CT DEEP 2024). The first fish hatchery was established in 1899 at Windsor Locks, and over the next century, three more hatcheries were built.

"In 2022, the finfish sector contributed over $7M to the Connecticut economy."

The cultivated species include several varieties of trout including rainbow (*Oncorhynchus mykiss*), brook (*Salvelinus fontinalis*), brown (*Salmo trutta*), hybrid tiger (*Salmo trutta x Salvelinus fontinalis*), and Palamino (a mutated rainbow trout with a golden color); Atlantic salmon (*Salmo salar*); European seabass (*Dicentrarchus labrax*); large mouth bass (*Micropterus salmoides*); channel catfish (*Ictalurus punctatus*); triploid grass carp (*Ctenopharyngodon idella*); bluegill (*Lepomis macrochirus*); fathead minnows (*Pimephales promelas*); and golden shiners (*Notemigonus crysoleucas*). Aquaculture operations use a variety of cultivation systems including ponds, tanks, raceways, and recirculating systems to cultivate these species.

Today there are six commercial finfish operations. In 2022, fish sales were reported at $4,351,000 (USDA 2024). Economic data for this industry is not collected by the state but reported voluntarily through the U.S. Census of Aquaculture. In 2022, the finfish sector contributed over $7 million to the Connecticut economy and supported 101 jobs. Finfish operations produce for sale to fish and game clubs, conservation organizations, municipalities, lake and watershed associations, trout derbies, and private lakes and ponds, restaurants and grocery stores in Connecticut.

The state operates three of the original fish hatcheries, which produce a variety of trout to support recreational fishing, as well as Atlantic salmon for stock restoration. The Quinebaug hatchery annually produces about 520,000

[3] After eight years in operation, a marine finfish aquaculture business closed in 2024.

pounds of fish with an estimated value of $3,900,000. The Burlington facility annually produces about 80,000 pounds of fish with an estimated value of $600,000. The operation at Kensington annually produces about 18,000 pounds with an estimated value of $135,000. At $7.50 per pound, the total value of the fish produced by the state is $4,635,000.

Seaweed Production

The seaweed aquaculture industry is still considered in its infancy in Connecticut. Sugar kelp (*Laminaria saccharina*) is the only commercially cultivated species. Kelp reproductive tissue (called sorus) is harvested from the wild, and placed in tanks containing spools of string that spores attach to. The spools are later wound around horizontal ropes called long lines that are anchored in open water. Kelp production has been low, fluctuating from a few hundred to a few thousand pounds per year until 2024, when the availability of seedstring increased significantly (Figure 4). Preliminary reports estimate a more than 10-fold increase (CT DOAG 2024, personal communication). The kelp sector produces raw products for food consumption and is diversifying into other products that are more stable, allowing farmers to extend the marketing season. A number of other agricultural products are under research and development including extracts, additives, biostimulants, and compost. Other species, such as the red alga (*Gracilaria tikvahiae*), have not shown promise for open water cultivation.

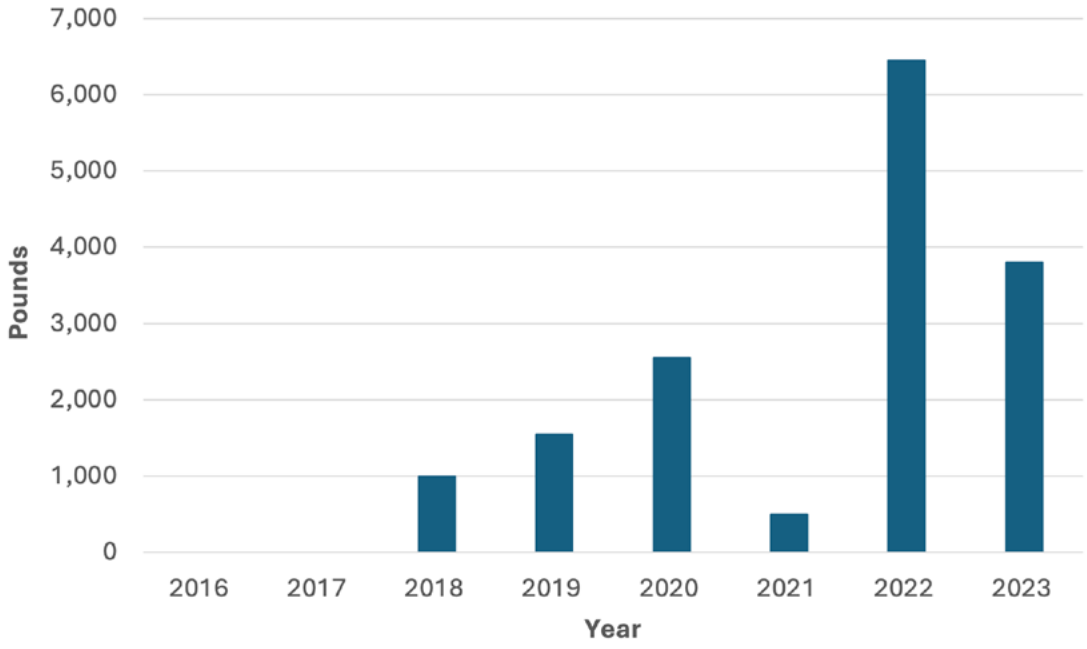
Hydroponic & Aquaponic Production

Hydroponic and aquaponic production is a small component of the aquaculture sector, which mainly produces green leafy vegetables, sprouts, and some other vegetables and fruits. Businesses are not typically licensed (except in the case where fish would be sold as food rather than being used as a source of nutrients for production systems). Production is not currently tracked through the state, nor is this type of production accounted for in the aquaculture census for Connecticut. There are currently eight businesses that identify themselves online as being farmers/suppliers of hydroponic or aquaponic products, and many equipment suppliers in Connecticut.

Marine Ornamental Production

The marine ornamentals subsector comprises mainly pet and aquarium stores that sell several species of hard and soft corals, fish, anemones, and shrimp grown for the aquarium trade. Economic data for this industry is not collected by the state but reported voluntarily through the U.S. Census of Aquaculture. In 2022, sales were reported at a mere $70,000, and the Census reported that there were three active farms (Table 1), though there are currently 12 businesses that identify themselves online as being farmers/suppliers of marine ornamentals in Connecticut.

Figure 4. Connecticut kelp aquaculture production 2016 - 2023.



Source: Connecticut Department of Agriculture (2024).

ECONOMIC IMPACTS OF THE CONNECTICUT AQUACULTURE PRODUCTION INDUSTRY

To gain deeper knowledge of the economic importance of the Connecticut aquaculture industry and its impacts on the state economy and employment, we conducted an input-output analysis using the IMPLAN (2024) software. This information helps policymakers make informed decisions with respect to programs and projects related to this industry. We conducted the impact analysis for aquaculture in 2022, for which data is most complete, and for the shellfish industry from 2016 through 2023, for which data is more available due to State of Connecticut reporting requirements for obtaining a license in this segment of the industry.

“ Connecticut ranks in the top five of all shellfish producing states, and third along the Atlantic coast of the U.S.”

Data and Methodology

Following Lipton et al. (2019), we define aquaculture as including NAICS codes for finfish (112511), shellfish (112512), and other aquaculture production and hatcheries (112519). For Connecticut, the economically relevant species include clams and oysters for shellfish, trout and branzini raised in finfish farms, and other rather minor categories that include ornamental fish, sport and game fish, and other categories that are unreported because of confidentiality or lack of significant commercial sales, such as aquatic plants (e.g., kelp and algae). We utilize IMPLAN sector 14 (Animal Production, except cattle, poultry, and eggs), which includes aquaculture NAICS codes 112511, 112512, and 112519. In Connecticut, sector 14 consists mostly of aquaculture.[4] We utilize shellfish data from the Connecticut Department of Agriculture (2024) and finfish farm data from the 2022 Census of Agriculture (USDA, 2024).[5]

This study relied on the IMPLAN model, which looks at incremental impacts as a sector increases or decreases in activity via built-in multipliers based on input-output tables of the state economy. These multipliers express the change in the level of state output and jobs associated with a one-unit change in direct sales in a specific sector or industry of the economy.[6] We estimate two indicators of the economic importance of the aquaculture production sector:

- Total economic impact, whose value is measured by statewide sales.
- Total impact on state employment, which includes full- and part-time jobs generated.

Total impacts are the sum of direct, indirect, and induced impacts.[7] For example, the economic importance of the oyster production industry in Connecticut is not limited to the $14.37 million worth of oysters sold in 2022 by that sector (the direct impact). That sector’s impact extends to other sectors of the economy (e.g., transportation, utilities, suppliers, equipment dealers, and repair) because oyster producers buy goods and services from those other sectors (the indirect impact). Also, employees of oyster production likely spend a major portion of their earnings buying goods and services from firms within the state (the induced impact).[8]

Economic Impact of Connecticut's Aquaculture Production

Table 2 shows the economic impact of aquaculture for 2022 (the year of the Census of Agriculture with full species information). Figures 5-7 show the impacts of the shellfish aquaculture subsector, oysters, and clam production from 2016-2023. In 2022, the aquaculture production industry contributed $33.6 million to the state economy and supported 481 jobs statewide as reported in Table 2.[9] By species, the shellfish subsector, combining clams and oyster production, was the main contributor in the Connecticut aquaculture industry. The shellfish production industry contributed $26.4 million to the state economy and supported 379 jobs statewide in 2022.[10] Most of the economic and job impact came from oyster production. Finfish farms, particularly those raising trout, contributed $7 million to the state economy, supporting 101 jobs statewide. Given their importance, it is surprising that state data collection and attention have not extended to this subsector.

The IMPLAN model used has an output multiplier of 1.61, meaning that a dollar in direct sales generates an additional 61 cents in the state economy, or an overall contribution of $1.61 to the economy, including direct sales. At the same time, for every million dollars in direct sales in production aquaculture, approximately 23 jobs are supported in the state economy, including direct, indirect, and induced jobs.

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[4] Sector 14 includes many animals not raised in the state, such as pigs and hogs, mohairs, buffalo, crickets, frogs, turtles, laboratory animals, birds, and llamas. Some animals in this sector, such as goats, sheep, and lambs, are raised in Connecticut on selected small farms. Aquaculture sales accounted for 65% of the total sales in IMPLAN sector 14 in 2022 and over 90% of the sales in 2017.

[5] A limitation of our approach is that we do not use detailed expenditures on inputs, in part due to low survey responses, and that we use an IMPLAN multiplier that includes aquaculture, but not exclusively. Note that shellfish growers are required to comply with sales reporting, while responding to the Census of Agriculture or Aquaculture is voluntary. Non-shellfish growers are not required to report sales. Taking the Connecticut Department of Agriculture sales as a benchmark, in 2022 the Census over-reported shellfish growers' sales by 6% ($17.36M vs. $16.40M, but in 2017 it under-reported them by 31% ($19.83M vs. $26.03).

[6] An important feature of the IMPLAN model is that it focuses on "supply" to an industry, treating the sector of interest as the point of final "demand." For example, using this model, the impact of the oyster production sector on downstream industries, such as seafood packing and restaurants, would be minimal (except through indirect and induced impacts, as defined above). Note that cash and bartering transactions are not officially reported, resulting in reported direct sales underrepresenting a sector's value of production and, therefore, the corresponding impacts.

[7] Because we have more reliable sales numbers, we estimate impacts from sales rather than reported employment.

[8] For consistency with previous studies using surveys and studies of similar sectors over time, we used the 2021 IMPLAN model with 2022 data to estimate the numbers reported in Table 2. For instance, in 2022 IMPLAN's sector 14 output multiplier was 1.19, while in 2021 it was 1.61, more in line with previous studies of the industry, particularly those relying on detailed cost and survey data (e.g., Cole, Langston, and Davis (2017): 1.66 for Maine aquaculture; Augusto and Holmes (2015): 1.79 for Massachusetts shellfish; Broughton and Quagrainie (2013): 1.60 for Indiana aquaculture; Newfoundland Fisheries and Aquaculture (2014): 1.57 for aquaculture; and Lopez et al., (2017): 1.65 for Connecticut aquaculture).

Table 2. Economic impact of aquaculture production in Connecticut, 2022.

Species	Sales	Economic Impact	Direct Employment	Employment Impact
	$ Million	$ Million	Jobs	Jobs
Clams	2.03	3.27	41	47
Oysters	14.37	23.14	288	332
Finfish farms	4.35	7.00	87	101
Ornamental fish	0.07	0.11	1	1
Total aquaculture production	**20.82**	**33.52**	**417**	**482**
Multiplier per $ million in Sales	1.00	1.61	20.0	23.2

Note: Other categories excluded for confidentiality reasons include sport and game fish, and other aquaculture products such as aquatic plants. However, these categories are likely to account for very small commercial sales relative to shellfish and fish farms. Direct employment is estimated via the IMPLAN model, while direct sales were observed.

Economic Impacts of the Connecticut Shellfish Industry, 2016-2023

This section focuses on the evolution of the sales and economic impacts of Connecticut shellfish production from 2016 to 2023. Shellfish has been the dominant component of aquaculture in the state since the 1800s.[11] Reliable sales data for the 2016 to 2023 period is available and includes the great collapse of clam production in the state in the last few years.[12] To make the values comparable over time (particularly with respect to inflation in this period), we convert all economic impact values to constant 2023 dollars.

Figure 5 shows the combined clam and oyster economic impacts from 2016 to 2023, in 2023 dollars. While in 2016 the economic impact was valued at nearly $55M, by 2023 the impact had dropped to nearly $28M. As important, however, the impact in constant dollars has been rather stable since 2017 despite the decline in clam production and the economic shock of the pandemic in 2020, which resulted in the lowest overall impact in this period. In 2016, the industry supported 752 jobs statewide, which declined to about 337 jobs by 2023. Interestingly, the number of jobs supported reached a low of 314 in 2020—a decline of 180 jobs from 2019—but nearly all these jobs were recovered by 2021.

[9] Using the IMPLAN model, direct jobs in the Connecticut aquaculture industry were estimated at 41 for clams, 287 for oysters, 87 for finfish, and one for ornamental fish, for a total direct employment of 416, not to be confused with the total employment impact of 481 that also includes 66 additional jobs due to indirect and induced effects. Only the total employment impacts by species are reported in Table 2.

[10] Using the IMPLAN input-output model, total direct jobs in shellfish production were estimated at 328 in 2022, with 88% of those jobs coming from oyster production.

[11] In 2022, shellfish accounted for 69% of the commercial sales of the aquaculture industry in the state, the lowest on record due to the drastic decline in clam production. In 2017 and earlier years on record, shellfish accounted for at least 90% of aquaculture sales.

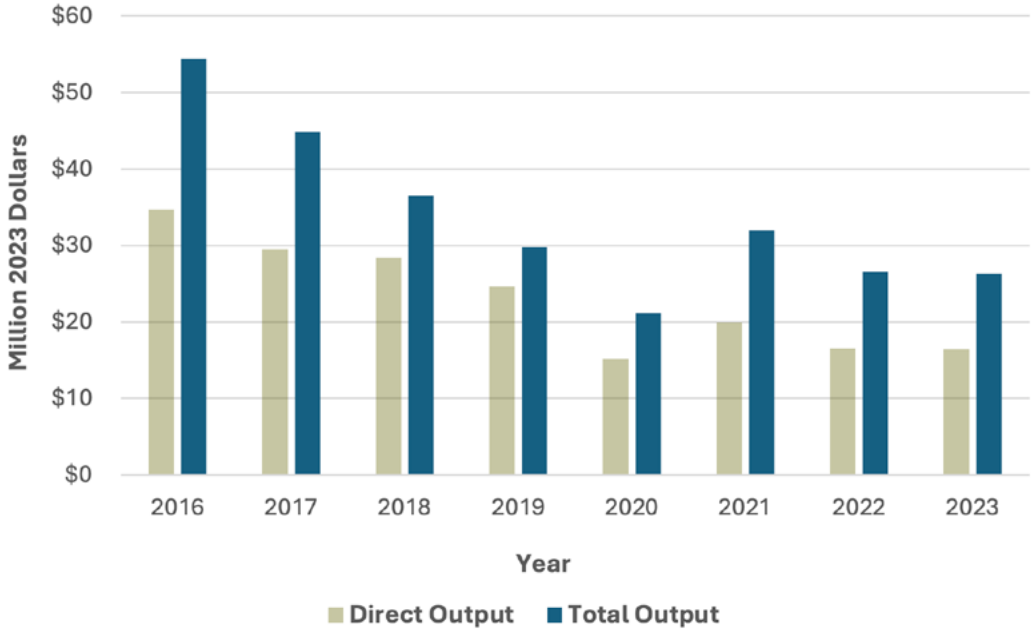
[12] Consistent with the decline in clam harvesting, NOAA (2024) reported a 26.5% decline in pounds of commercial fish landings in Connecticut between 2017 and 2022, with similar trends in other Northeastern states.

"With some ups and downs, the (oyster) sector has been remarkably stable since 2017."

Figure 6 shows that although the economic impact of oysters has declined since 2016, this sector has been more resilient than clams. In 2016, the impact was estimated at $33.5M (in 2023 dollars), while in 2023 it was only $23.4, a 30% decline, in constant dollars. The good news is that the sector rebounded from its lowest point in this period, the year 2020, during the pandemic. In fact, by 2021, sales and economic impacts were comparable to those in 2017. With some ups and downs, the sector has been remarkably stable since 2017. In terms of employment impacts, the oyster production sector supported 464 jobs in 2016, dropping to 335 by 2023, slightly more than those supported in 2022.

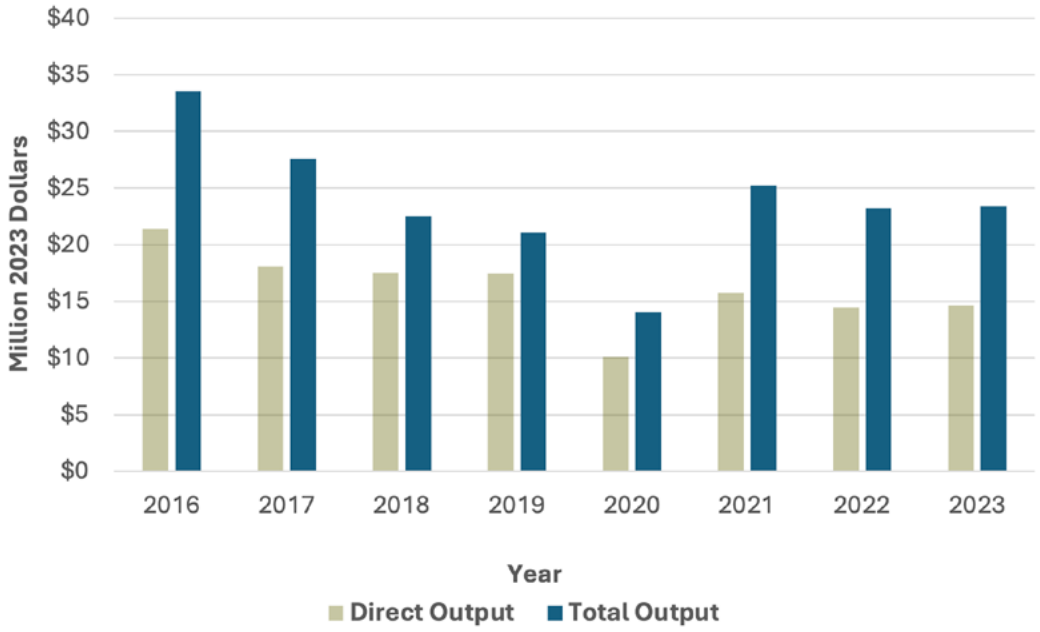
Figure 7 shows the economic impacts of clams between 2016-2023 in constant 2023 dollars. While clam harvesting contributed approximately $21 million to the Connecticut economy in 2016, by 2023 it contributed approximately $3 million (in 2023 dollars), with a marked decline between 2016 and 2019. The evolution of the impacts of clam production on jobs shows a similar trend, from supporting 288 jobs in 2016 down to supporting 42 jobs by 2023. This drastic decline, mainly due to a collapse of production, calls for renewed attention to this industry to further investigate and address the reasons for this decline and to explore the desirability of programs to mitigate the culprit factors.

Figure 5. Economic impact of shellfish aquaculture production in Connecticut, 2016-2023.



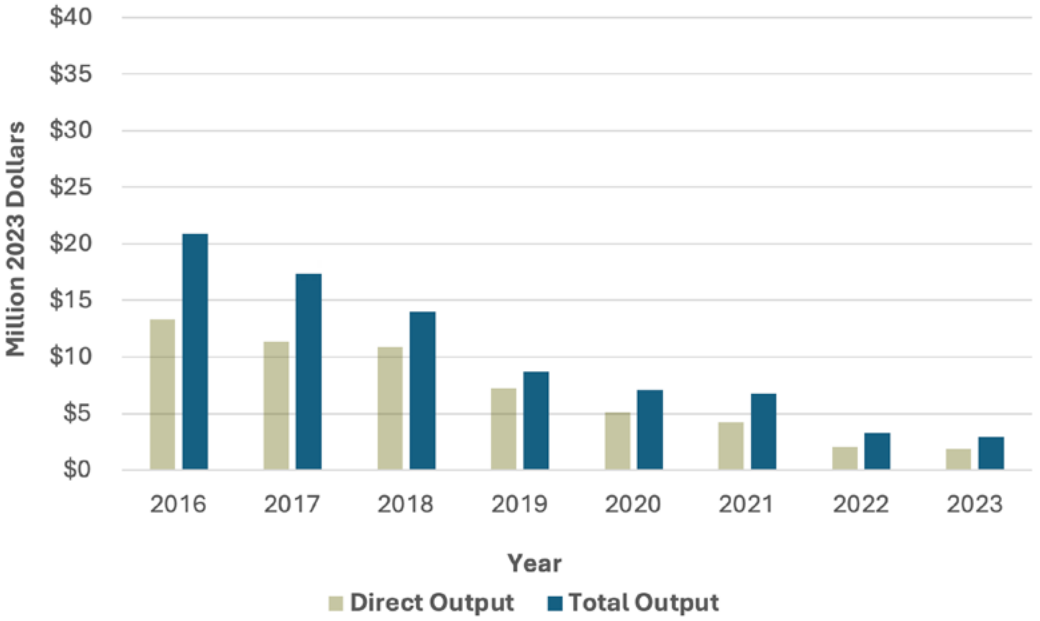
Source: IMPLAN (2024), 2022 Census of Agriculture (USDA, 2024), Connecticut Department of Agriculture (2024).

Figure 6. Economic impact of oyster aquaculture production in Connecticut, 2016-2023.



Source: IMPLAN (2024), 2022 Census of Agriculture (USDA, 2024), Connecticut Department of Agriculture (2024).

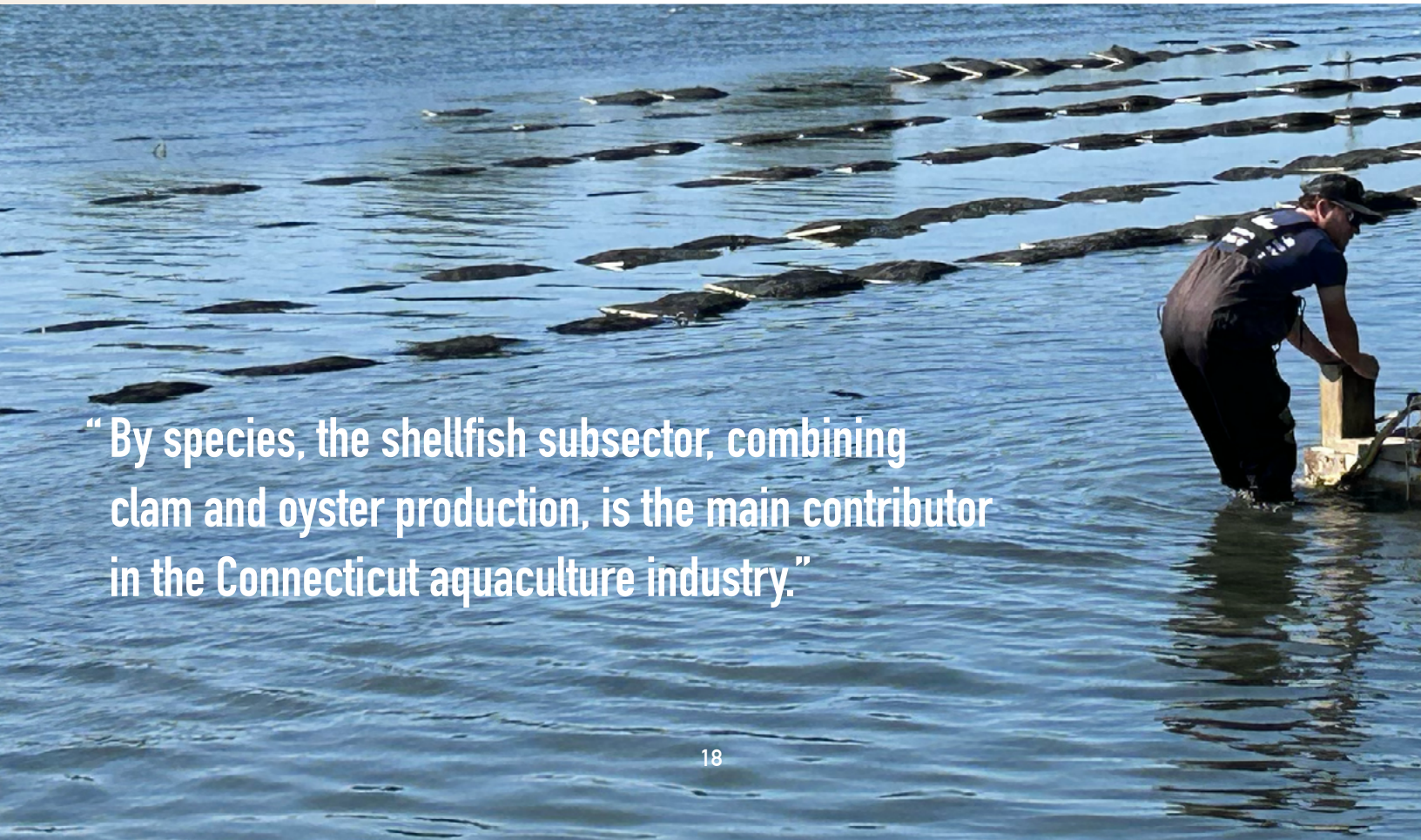
Figure 7. Economic impact of clam aquaculture production in Connecticut, 2016-2023.



Source: IMPLAN (2024), 2022 Census of Agriculture (USDA, 2024), Connecticut Department of Agriculture (2024).

Trends in Shellfish Production in 2016-2023

- Shellfish production in 2016 was 753,072 bags and 342,512 bags in 2023.
  - The number of oyster bags produced decreased from 350,615 to 275,602.
  - The number of clam bags produced decreased from 402,457 to 66,910.
- Shellfish sales in 2016 were $29,753,806 and $16,438,648 in 2023.
  - The total oyster sales value decreased from $18,345,500 to $14,606,929.
  - The total clam sales value decreased from $11,408,306 to $1,831,719.
- The total number of shellfish businesses in 2016 was 42 and 40 in 2023.
  - There were 13 companies harvesting only oysters in 2016. There were 21 companies harvesting only oysters in 2023.
  - There were 18 companies harvesting only clams in 2016. There were 9 companies harvesting only clams in 2023.
  - There were 11 companies harvesting oysters and clams in 2016 and 10 companies harvesting oysters and clams in 2023.
  - Connecticut has added and lost companies since 2016 with significant consolidation within the industry, and a shift towards harvesting oysters due to a decline in the clam populations (personal communication, CT DOAG BA).



- Oyster production summary
  - Oyster production is stable with signs of growth.
  - There is steady enrollment in the shellfish farming certificate course offered through Connecticut Sea Grant, UConn Extension, and the CT DOAG BA.
  - There has been an increase in the number of applications and permitted operations for new lease areas and gear permits.
- Clam production summary
  - Clam production is declining, with a downward trajectory for a decade or longer.
  - There has been a decline in both harvest and sales.
- The total number of shellfish lease acreage in 2016 was 61,116 and 61,626 acres in 2023.
- The total number of shellfish companies with aquaculture permits in 2016 was 52 and 31 in 2023. The decrease in companies with aquaculture permits is partly due to industry consolidation, ceased operations, and the experimental nature of the permit (CT DOAG BA).

EMERGING ISSUES AND CRITICAL NEEDS

Shellfish

- Threats to the industry include business consolidation; declining clam production due to yet unknown circumstances; lack of suitable coastal access, land, and infrastructure; and increasing extreme rainfall events that introduce contaminants from land and cause shellfish harvest area closures.
- Many growers have transitioned from exclusively wholesale markets to direct sales and owning their own raw bars and farm stores, necessitating a workforce skilled in direct, web-based, and social media marketing.
- Shell substrate is critically needed to maintain the natural oyster beds, but shell recycling services have been slow to develop.
- Researchers are currently investigating the following:
  - An oyster breeding center to establish disease-resistant oysters that are resilient under current and changing environmental conditions
  - Oyster larval transport to help inform future oyster bed management
  - Oyster disease within both farmed and restored populations
  - Status of the northern quahog population as related to the downward production trend
  - The interaction of shellfish cultivation gear with eelgrass beds

Seaweed

- Bottlenecks include inconsistent seed supply, a short marketing season due to short shelf life, limited processing infrastructure, and a lack of a variety of established products for the market.
- Researchers are investigating the following:
  - A kelp seed bank that will give farmers a reliable head start to the growing season and reduce dependence on wild kelp populations
  - Cryopreservation of kelp spores to provide more consistent annual seed supply
  - Identification of kelp strains that will perform better with a changing climate and tolerate offshore conditions
  - Use of kelp extracts to extend shelf life of other agricultural products
  - Use of kelp as food additives, biostimulants, and compost

Land-based and Freshwater Aquaculture

- Bottlenecks include the high cost of utilities and labor, lack of a highly skilled and trained workforce, and limited state extension services.

Marine Ornamentals

- Bottlenecks include lack of state extension services and lack of production data due to no business registration or regulatory process.
- Research needed into new candidate and high value species of fish, corals, and other invertebrates.

Hydroponics/Aquaponics

- Bottlenecks include limited state extension services and lack of production data due to no business registration or regulatory process.

Aquaculture Workforce Development

- Aquaculture workforce development is strong with three specialized high schools and a network of agriculture science and technology centers, new undergraduate courses, and Extension certificate courses, though there are gaps in post-secondary pathways, especially the connection with training in trade skills.
- Researchers are conducting a statewide education demand and supply study that involves employers identifying skills and training needs, and educators identifying current and potential future education and training offerings.

“Aquaculture workforce development is strong with three specialized high schools and a network of agriculture science and technology centers...”

CONCLUSIONS

The Connecticut aquaculture sector includes diverse species, products, systems, and facilities. The shellfish subsector produces the most important aquaculture food product in the state, while marine ornamentals are the most highly valued on a weight basis. The sector was extremely resilient during the COVID pandemic, adapting to changing sales strategies and market distribution channels, and not losing a single business. While some subsectors show promise assuming further research and development (e.g., oysters, kelp, marine ornamentals), some are in decline (e.g., clams), and yet others remain stagnant (e.g., freshwater finfish and marine fish grown in recirculating aquaculture systems). The high cost of utilities and labor and lack of a highly skilled and trained workforce may limit future growth in the latter, though innovation may change this scenario. The long tradition and history of aquaculture in Connecticut, which has survived many ups and downs, endures despite challenges and setbacks.

Resources

The location of Connecticut aquaculture farms can be found here: https://arcg.is/19ePHr2

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