Growing Missouri's Aquaculture Industry: Needs Assessment

Extension
University of Missouri

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Missouri Soybeans

MASBDA
Missouri Agricultural and Small Business Development Authority

MissouriCorn Merchandising Council

MX 461

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Summary

Missouri's aquaculture industry contains many small but diverse businesses, based on responses from 20 active businesses that participated in a 2023 aquaculture needs assessment survey. Those businesses represented 17 counties, and the survey had an estimated 70% response rate. The average respondent was a small business with seven employees that had been in business for 39 years. Respondents said they primarily use ponds or flow-through raceways and produce nearly eight different aquaculture species on average. In total, respondents produced 46 different species in 2022. Bluegill and largemouth bass were the two most common. They each contributed between 21% and 25% of total business sales.

Producers expressed concern about earning sustainable profit. Many strongly agreed that input costs were rising faster than prices they charge buyers. Most felt business diversification would not improve profit. Producers shared unified perspectives on the outlook of Missouri aquaculture industry. Most agreed that the industry needs to be innovative at cutting costs to operate competitively. They also thought the industry's future depends on creating direct-to-consumer distribution channels. Despite the concern about profitability and rising costs within their own businesses, 78% of respondents felt aquaculture producers have growing market opportunities.

Missouri aquaculture producers sell a variety of species into different markets. Four in five said they sell fish for pond stocking, and 43% noted selling fish to food markets. On average, operations focused on pond stocking were less diverse. They produced six species, but operations that stock ponds and sell to food markets said they produce up to 11 species. Approximately half of respondents sold products (e.g., fish for pond stocking, fish for food markets) through a single channel. The most common market channel was direct-to-consumer sales followed by sales to other aquaculture producers. Half of respondents had no desire to change market channels. Producers were interested in expanding sales of processed fish, selling to restaurants and pursuing direct-to-consumer markets. The largest perceived barriers to exploring new market channels were capital and advertising and transportation costs.

Comparing their businesses in 2022 and 2021, most producers sold similar aquaculture products and quantities. Half increased their total sales, but most indicated their net income stayed the same. Labor, feed and energy costs accounted for an estimated two-thirds of total business expenses. Most businesses had the same number of employees, but 30% had increased hours of hired labor. Feed costs averaged 22% of total business expenses in 2022. Missouri producers purchased feed from a range of companies, and half used more than one feed supplier — likely to meet the dietary needs of diverse aquaculture species.

1. Methodology

In 2023, University of Missouri Extension conducted an online survey to collect information about aquaculture businesses, their production practices, their future goals and perceived barriers to aquaculture expansion. When developing the survey, the project team consulted other survey efforts including the 2018 USDA Census of Aquaculture, a 2021 Aquaculture Producers in the Midwest interview project[1], and similar survey-based projects conducted in Oregon (seagrant.oregonstate.edu/sgpubs/oregon-marine-aquaculture-barriers-opportunities-and-policy-recommendations), New York (seagrant.sunysb.edu/Images/Uploads/PDFs/Aquaculture-NYNeedsAssessment-0321.pdf) and Virginia (vims.edu/research/units/centerpartners/map/frg/reports/docs_frg_reports/FRG-2006-04-Shawn-Stickler.pdf). The survey is included at the end of the report for reference in the Appendix.
The 23-question survey was optional and confidential. It gathered information about aquaculture businesses, production practices, species, marketing channels, feed sources and expenses for the 2022 operational year. In addition, respondents were asked to share their business goals for the next five years and provide their perceptions on barriers and opportunities within the broader industry in Missouri.

To create a contact list of Missouri aquaculture businesses, the project team used the 2022 Missouri Aquaculture Association (MOAA) directory, which listed 18 member-businesses, and a list of aquaculture businesses from Reference Solutions (Reference USA). Reference Solutions is a private business data firm that sells subscriptions to business listings. Combining these two lists generated 73 business entities. Those included nine establishments operated by the Missouri Department of Conversation (MDC); a facility operated by Lincoln University in Jefferson City, Missouri; and a national fish hatchery in Neosho, Missouri. These 11 listings were removed from the sample as they are government-operated and separate from the project's focus on active private sector businesses. The 18 current MOAA members were assumed to be in business, and the team focused on verifying whether the remaining 42 businesses were still in operation and encouraging operational businesses to complete the survey.

The team directly called and emailed the 42 businesses from Feb. 22, 2023, through April 4, 2023. The team determined that 31 of those businesses were no longer operational. Several former aquaculture business owners indicated the following reasons as to why they left the industry:

[1] Carlton, J.S., A. Shambach, and H.A. Hartenstine. 2021. "Voices from the Industry: Aquaculture Producers in the Midwestern United States" Choices. Quarter 4. Available online: https://www.choicesmagazine.org/choices-magazine/theme-articles/the-economics-of-us-aquaculture/voices-from-the-industry-aquaculture-producers-in-the-midwestern-united-states

- The cost of maintaining the business surpassed earnings. A couple of former owners said they had to take other full-time jobs to cover their costs.
- One owner said no family members wanted to take over the business, so it had to close.
- Another owner admitted to underestimating the time and cost it would take to operate the business and needing a business plan before starting the business.
- Multiple people felt that the government was overreaching, given the number of regulations and policies they had to follow. The cost and time associated with adhering to these regulations led to them closing their businesses.
- One business owner moved the business to Illinois to avoid Missouri regulations.

Active aquaculture businesses were informed about this project and the survey in multiple ways. In addition to directly contacting producers by phone and email, Ryan Milhollin presented the survey at the annual MOAA meeting in Jefferson City on Feb. 4, 2023. To encourage survey completion, he distributed paper copies of the survey and prepaid envelopes to attending producers. The paper-based version had a QR code to access the online survey. MOAA sent two survey reminder emails with links to the survey to its members. The survey was officially open from Feb. 4, 2023, to April 13, 2023.

These in-person, email and telephone outreach efforts to promote the survey resulted in 20 responses from active Missouri aquaculture businesses out of the known list of 29 businesses. Therefore, the survey achieved a 70% response rate. One respondent offered a partial response and indicated plans to discontinue the business. Given this one individual's responses, including listing no employees and no production system, it was unclear whether the business had already been discontinued. This respondent's answers were still included in the summary results reported below.

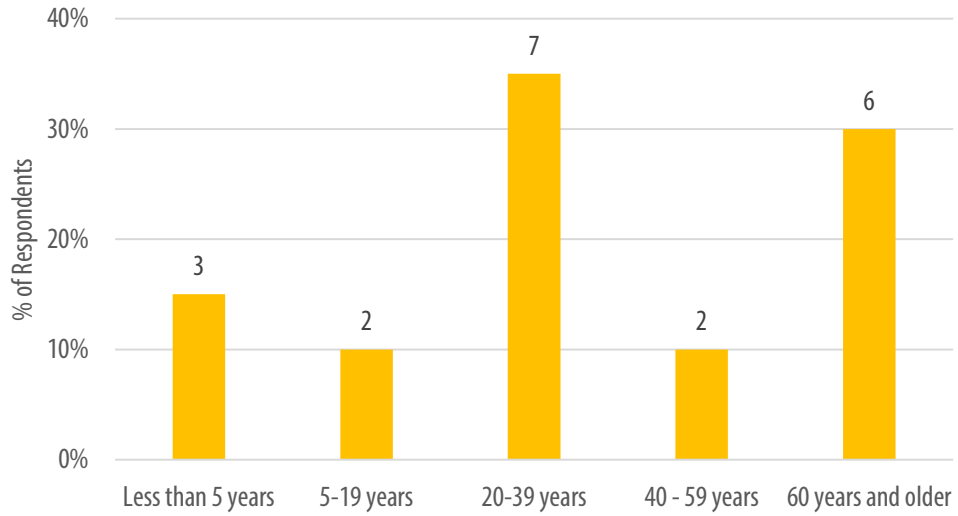
2. Business Context and Industry Background

Three questions collected background information on business age, total employees, production systems, species produced, expense categories and feed sources. The average respondent was well-established and had been in business for 39 years. Most producers ran small businesses with seven employees on average. The majority of respondents used ponds or flow-through raceways. Respondents produced a total of 46 species in 2022. On average, producers raised nearly eight different aquaculture species. Bluegill and largemouth bass were the two most common. Each contributed between 21% and 25% of total business sales. On average, feed costs were 22% of total business expenses in 2022. Missouri producers said they purchase feed from a range of suppliers, and half purchased from more than one feed supplier — likely to meet diverse species' dietary needs. The survey captured responses from businesses located in 17 counties.

2.1. Business Age and Size

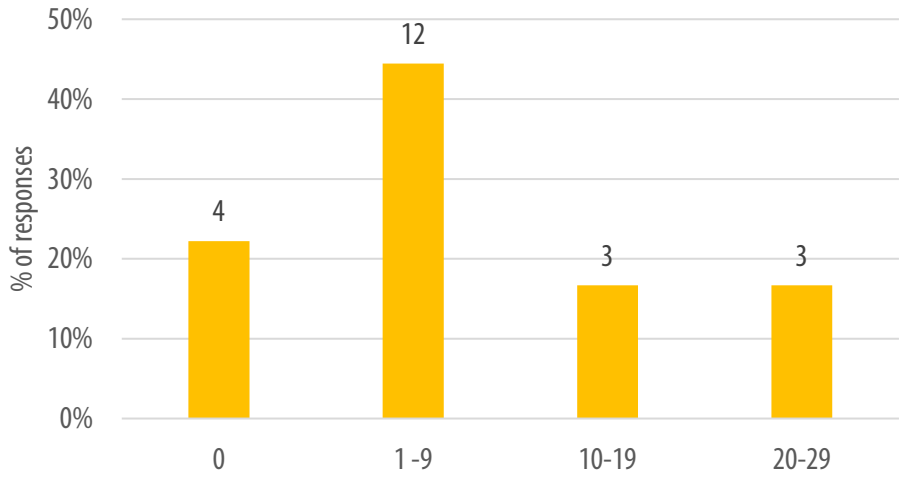
Many multigenerational aquaculture businesses operate in Missouri. Six have been in operation for 60 years or more, as shown in Exhibit 2.1.1. Seven have been in business between 20 years and 39 years. The average respondent had been in business for 39 years. The oldest established aquaculture business began in 1926; three businesses started in 2022.

Exhibit 2.1.1. Age of Missouri's Aquaculture Businesses



Most businesses reported employing between one and nine people in 2022. On average, the state's aquaculture businesses employed seven people. Six companies had more employees, shown in Exhibit 2.2.2.

Exhibit 2.2.2. Number of Current Employees in Missouri's Aquaculture Businesses, Spring 2023



2.2. Production Systems and Products

Production systems vary widely at Missouri aquaculture operations. Producers were given six choices, drawn from a national classification of system types, to indicate what type(s) of system they used. Nineteen respondents reported 34 different production systems (Exhibit 2.2.1).

Exhibit 2.2.1. Production Systems Used by Missouri Aquaculture Producers, 2023

System type	#	%
Ponds	12	63%
Flow through raceways	12	63%
Cages or pens	4	21%
Recirculating systems	3	16%
Nonrecirculating systems	2	11%
Aquaponics	1	5%
Total responses	34	100%

The two most common types of systems were ponds and flow-through raceways with 12 responses each, or 63% of the sample. Seven producers reported using both ponds and flow-through raceways. Current Missouri Department of Natural Resources regulations require permits for new aquaculture operations discharging wastewater from flow-through raceways if the facility produces at least 20,000 pounds per year in a cold water system of 100,000 pounds per year of aquatic animals in a warm water system. The full regulations can be accessed online at: dnr.mo.gov/water/business-industry-other-entities/permits-certification-engineering-fees/wastewater/fish-farms-hatcheries-mo-g130000

Existing flow-through raceway systems have been grandfathered in and can remain operational. Cages or pens were used by four producers. Recirculating systems, nonrecirculating systems and aquaponics were all used by three or fewer respondents.

Fish farms varied in total size. Four systems were more than 100 acres. These systems all featured ponds and flow-through raceways — sometimes in combination with other methods of production. Three systems were between six acres and 99 acres; these businesses also used a range of production systems. The other five responding operations were five acres or smaller. No respondents used a saltwater system.

The Missouri Department of Conservation has developed a list of 60 approved aquatic species eligible for production. Surveyed producers reported raising 46 species[2], or 76% of all approved species. The average Missouri producer raised 7.6 species in 2022. Six producers specialized in one species. Four reported particularly diverse operations that each raised 14 or more species. Respondents were also asked to disaggregate their shares of total 2022 sales by species. Missouri's 12 most raised species are listed in Exhibit 2.2.2; at least 20% of all respondents raised one of these species.

Bluegill and largemouth bass were the most commonly produced species. Half of all respondents indicated they raised these species; notably, nine producers raised both species. Bluegill producers derived an average of 25% of their total 2022 sales from bluegill. Largemouth bass represented a slightly smaller average, of 21%, of responding producers' total sales in 2022. Three other fish species of

Exhibit 2.2.2. Common Aquatic Species Produced in Missouri, 2022

Species	# of Producers	% of All Species	% of All Producers Surveyed	Avg % of 2022 Sales
Bluegill	10	7%	50%	25%
Largemouth bass	10	7%	50%	21%
Black crappie	9	6%	45%	5%
Channel catfish	9	6%	45%	20%
Fathead minnow	9	6%	45%	16%
Grass carp	7	5%	35%	6%
Rainbow trout	7	5%	35%	81%
Redear sunfish	7	5%	35%	12%
Smallmouth bass	5	3%	25%	18%
Blue catfish	4	3%	20%	2%
Common carp	4	3%	20%	9%
Goldfish	4	3%	20%	25%

[2] The 12 fish species not raised by responding Missouri producers were Atlantic salmon, blue sucker, bluntnose minnow, brook trout, brown trout, Coho salmon, cutthroat trout, river carpsucker, sauger, threadfin shad and crustaceans (i.e., calico, red swamp crayfish and white river crayfish). A full list of approved species can be found at mdc.mo.gov/fishing/regulations/approved-aquatic-species-list.

secondary importance to Missouri producers — channel catfish, fathead minnow and smallmouth bass — are commonly raised species. They contributed 16% to 20% of total sales among responding producers.

Rainbow trout producers heavily relied on that species. Among the seven responding businesses with rainbow trout sales, this species contributed an average of 81% of total business sales the. In contrast, two species are commonly raised but contribute relatively minor portions of total sales. Black crappie was raised by nine producers and represented on average 5% of their estimated 2022 sales, and grass carp was raised by seven respondents and contributed an average of 7% of total sales.

2.3. 2022 Operating Expenses

Respondents estimated their total 2022 expenses across five categories: labor, feed, energy, marketing and other. Seventeen respondents provided their best estimates, but the averages among each category varied widely. Exhibit 2.3.1 shows a few summary statistics representing this variation. For example, though on average 26% of all business expenses were labor costs, multiple businesses entered no cost in this category. Respondents presumably did not count their labor as business owners. The maximum percentage in this category was 60% of all expenses.

Exhibit 2.3.1. Missouri Aquaculture Expenses by Category, 2022

	Average	Min	Max	Trimmed Mean - 80%
Labor	26%	0	60%	25%
Feed	22%	0	92%	19%
Energy	19%	0	80%	13%
Marketing	6%	0	25%	4%
Other	25%	0	95%	17%
Total	98%			78%

Feed costs were the next highest expense. On average, feed represented 22% of all costs, and at most, it was 92% of all costs. Energy ranked as the third highest expense at 19% of total costs on average. Most producers reported minor marketing costs. Seven producers indicated they spent nothing on marketing in 2022, and the highest reported marketing cost was 25% of total costs. Several expenses were omitted from this shortened list, and producers on average thought 25% of their total costs tied to unlisted categories.

Given that at least one producer indicated no expenses within each category, we calculated a trimmed mean from the middle 80% of the dataset. This calculation discards both the lowest and highest 10% of all responses before calculating an average. See trimmed averages in the rightmost column of Table 3. The trimmed means show the percentages of costs associated with energy and other expenses changed the

most — both decreases of six percentage points or more. This finding indicates that the highest 10% of respondents skewed the averages.

2.4. Aquaculture Feed Sources and Needs

This needs assessment was partially motivated by a desire to understand opportunities for increasing fish food production in Missouri. This survey included four questions to understand current feed sources, estimate feed volumes purchased, assess the benefits of current feed suppliers and assess willingness to purchase feed locally.

According to visits to aquaculture producers and conversations with fish nutrition experts, diets differ substantially by fish species. Different species at different lifecycle stages also have varying nutritional and feed delivery needs. At times, feed needs to float or sink and change in size to be the most palatable. Producing different types of feed can require specialized equipment such as extruders. The relatively small size of Missouri's aquaculture industry and the relative diversity of species raised by producers present significant challenges to expanding fish feed production in the state.

Half of all responding producers listed more than one feed supplier (Exhibit 2.4.1). Producers most often purchased from both Cargill and Ziegler — the two dominant suppliers within our sample. Five respondents did not purchase from either of these companies in 2022 but relied instead on MFA or an unspecified agriculture feed supplier or sourced feed from Optimal Fish Food or AllTech Coppens. Producers also purchased from Fishbelt Feeds and Skretting USA in combination with Cargill.

Exhibit 2.4.1. Aquaculture Feed Sources Used by Missouri Producers, 2022

Company	Location	#	%
Cargill	Multiple	7	50%
Ziegler	Pennsylvania	6	43%
MFA or an ag feed supplier	Multiple	3	21%
Fishbelt Feeds	Mississippi	2	14%
Alltech Coppens	Germany	1	7%
Optimal Fish Food	Nebraska	1	7%
Skretting USA	Utah	1	7%

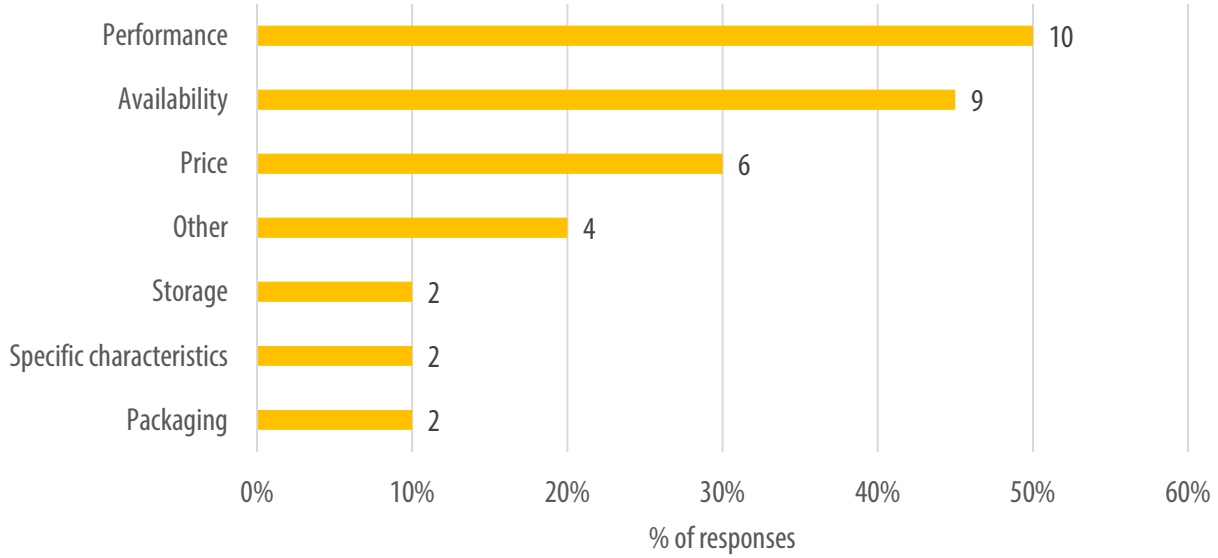
Producers also estimated their total feed volume purchased in 2022 by three packaging types: bulk in tons, totes in pounds and bagged in pounds. One barrier to specialty feed production is securing a viable quantity demanded. Because nutritional requirements vary by species, feed manufacturers must

understand current feed volumes demanded by species to decide whether they can economically justify adding a new formulation. However, this survey was unable to answer this question given the number of producers who raise multiple species. Eight respondents left this question blank, which limits the ability to accurately estimate total fish feed consumption within the state. Three producers purchased feed in different packaging sizes, presumably because they feed a range of diets in different quantities.

Responding producers estimated aggregate purchases of 2,636,442 pounds of feed in 2022. Bagged feed sold by the pound accounted for 63% of this total. Eleven respondents indicated they purchase bagged feed from Cargill, Zeigler, agricultural feed stores, Fishbelt Feeds and Optimal Fish Food. Seven producers placed bulk feed purchases; these represented 37% of total feed usage (973,220 pounds or 486 tons). Only one respondent indicated purchasing feed in tote bags, which supplied a minor amount.

From a list of seven options including a write-in box, aquaculture producers were also asked to identify benefits of their current feed suppliers. The most cited response was performance, noted by 10 respondents. Availability was the next most cited, and price ranked third (Exhibit 2.4.2). Four producers chose the "other" category. Three offered write-in responses: consistent quality; ease of business/made nearby & delivered; service, reliability and response; and protein source. Few producers noted packaging, storage and specific characteristics (e.g., organic, sustainable) as perceived benefits.

Exhibit 2.4.2. Benefits of Current Aquaculture Feed



As a follow-up question, aquaculture producers were asked if they would purchase from a local feed producer if that producer offered feed similar to their current supplier's, such as under license from the current supplier. Two-thirds of respondents said they would be willing to purchase from a local feed producer, but the other 33% stated they would not. Respondents who selected "no" had the option to write in a reason for their choice. One respondent didn't feel that local feed producers had an interest in producing feed for aquaculture. Another stated that using a local supplier in the past had not worked well because the feed was low-quality, and the supplier was unresponsive and provided a lack of service.

3. Market Practices of Missouri Aquaculture Producers

In terms of market practices, producers identified the types of products and specific market channels they used to make aquaculture sales in 2022. They also assessed their interest in entering new channels and barriers to market expansion. With respect to products, 80% of producers sold fish for pond stocking, and 43% sold to food markets. Fewer businesses sold to scientific and educational, bait or ornamental product markets. Operations focused on pond stocking were, on average, less diverse than operations that both stocked ponds and sold to food markets. Missouri producers raise the same species for multiple markets, and there were not clear differences in species by an operation's market focus.

3.1. Customer Types and Business Diversification

Of the producers surveyed, 90% sold fish, and 10% sold crustaceans. Producers sold two products, on average, though responses ranged from one product in one market channel to two products in eight market channels. One respondent's business was too new to have entered aquaculture product markets. The box to the right lists the five products and the eight market channels aquaculture producers could select from the survey.

The most common product category in 2022 was pond and sport fish stocking with 80% of respondents selling fish in this category. Fish for food markets were the next most common, 43% of all producers. Between 15% and 25% of all producers sold fish through ornamental, scientific and educational or bait markets in 2022 (Exhibit 3.1.1.). Aquaculture producers marketed crustaceans through all five of the identified market channels; the most common was food markets.

Missouri Aquaculture Products and Market Channels

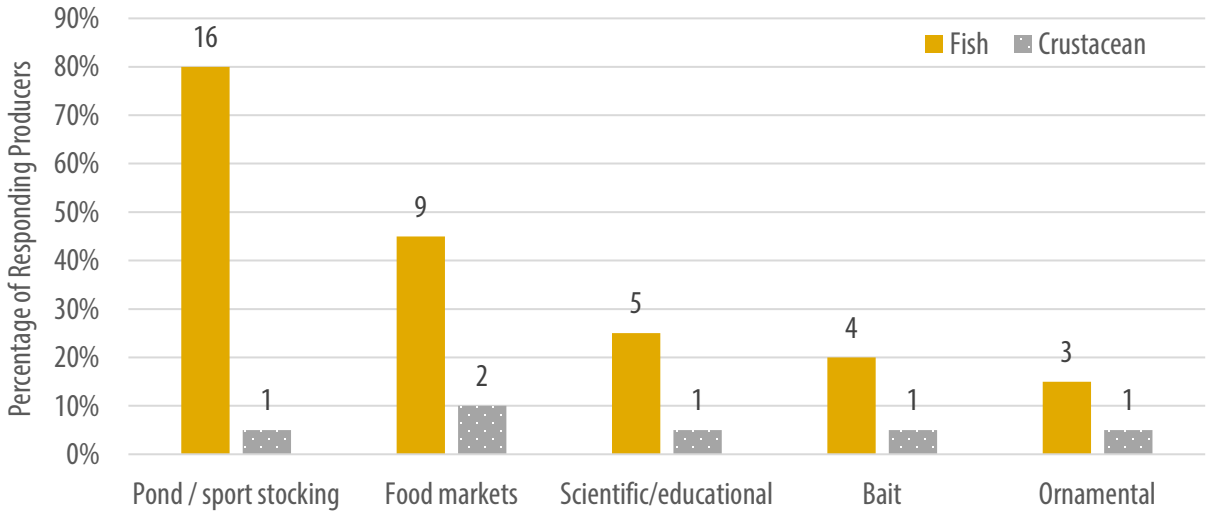
Producers were asked to identify which of the following **fish and crustacean products** they sold:

- Pond/sport stocking
- Food
- Scientific/educational
- Bait
- Ornamental

Then they were asked to identify which **market channels** they used to make sales:

- Direct to consumers
- Other aquaculture producers
- Brokers, distributors or wholesale markets
- Government agencies
- Restaurants
- Retailers
- Processors

Exhibit 3.1.1. Product Markets for Aquaculture Products Sold by Missouri Businesses in 2022

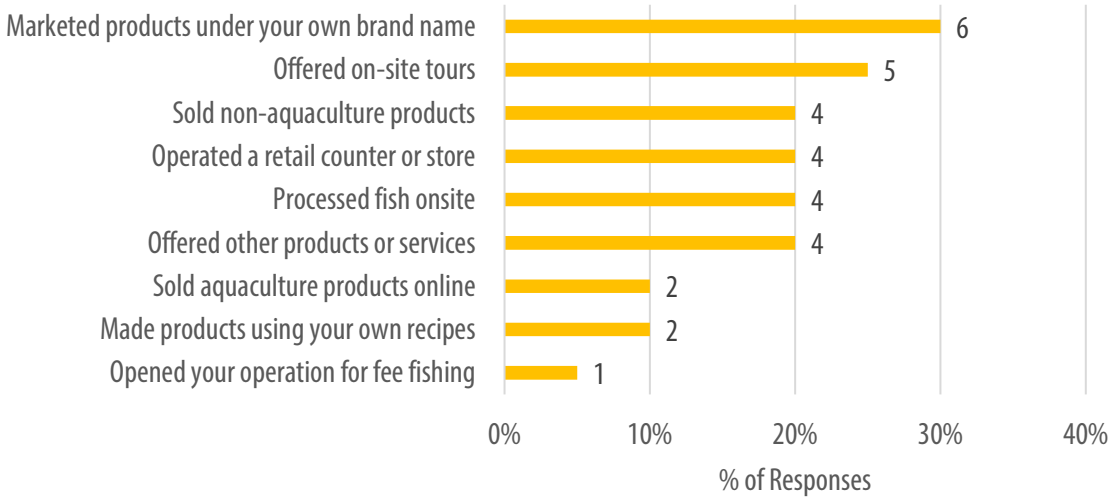


Seven of the 16 respondents that sold fish for pond and sport fish stocking also sold fish through food markets. The two other respondents selling to food markets only sold to food markets. The nine pond stocking producers not in food markets raised an average of 5.9 species. The five most commonly raised species were bluegill (5), fathead minnow (4), channel catfish (4), black crappie (4) and largemouth bass (4). Six of the nine pond stocking producers only sold fish to stock ponds.

The seven businesses that sold fish to pond stocking and food markets had more diverse species — 11.3 species on average. Three of these businesses also sold to other product markets. Missouri producers also raised the same species for multiple markets. For example, some producers only sold largemouth bass and rainbow trout to food markets, and others only sold those two species to pond stocking markets.

More than half of Missouri aquaculture businesses pursued at least one value-added activity in 2022. Respondents identified an average of four separate value-added activities their business pursued in 2022. Most commonly, 30% of respondents marketed products under their own brand name. On-site tours followed. Four respondents indicated they did one or more of the following: operated a retail counter or store, processed fish on-site or sold non-aquaculture products. Exhibit 3.1.2. shows that relatively few respondents sold online, made products from their own recipes or operated fee-fishing sites. Four respondents offered other products or services. One of these write-in responses noted merchandise sales. Another responding business owner wrote in, "We tried almost all the above [survey choices]. Operating costs, liability and time usage greatly consume profit."

Exhibit 3.1.2. Aquaculture Business Practices that Added Value or Diversified the Business in 2022



3.2. Market Channels and Barriers

To gauge sales by market channel, respondents estimated their total 2022 sales across seven categories: direct-to-consumer (in person or online), other aquaculture producers, restaurants, retailers, processors, brokers or distributors or wholesale markets and government agencies. Fifteen individuals responded. Approximately half, or seven respondents, sold fish through a single channel: five directly to consumers in person or online; one to other aquaculture producers; and one to brokers, distributors or wholesale markets. The remaining eight sold through two or more channels.

The most common sales channel was direct to consumers (in-person or online). The 13 producers selling directly to consumers captured 62% of total sales from this channel on average. Respondents using this channel identified selling a range of products: fish for pond stocking, fish for food markets, bait fish and ornamentals. The next most common channel was sales to other aquaculture producers; seven responding producers used this channel to sell on average 12% of their aquaculture products.

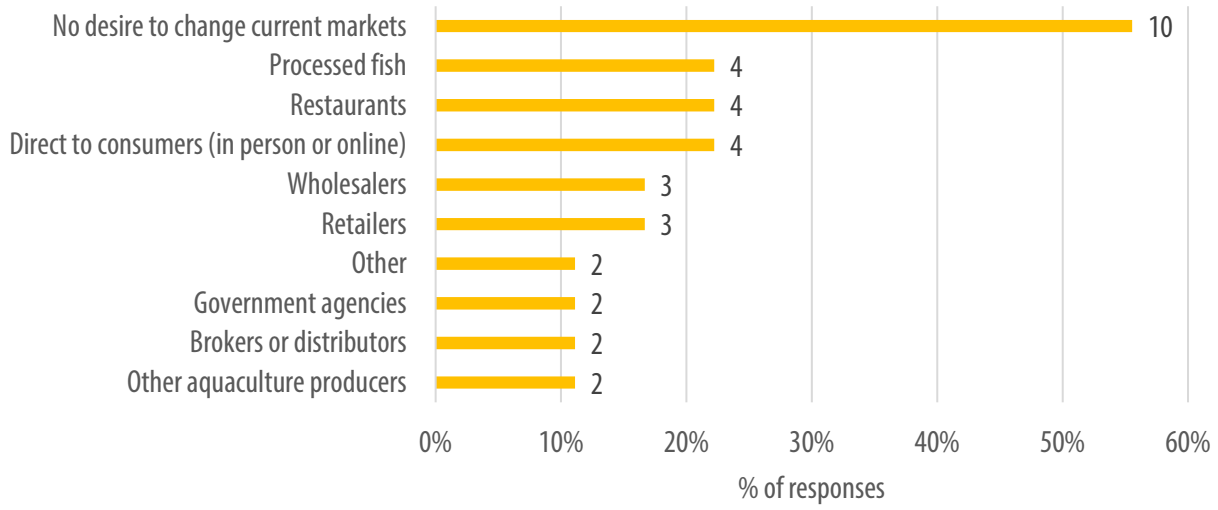
Responses indicated wide variation in the usage and importance of market channels to sales (Exhibit 3.2.1). For example, aquaculture product sales made to government agencies represented 8% of sales on average across survey respondents. However, multiple businesses made no sales in this category, and the maximum sales to this channel for a producer was 60% of all sales. Sales to restaurants and retailers were substantially smaller; three or fewer producers use these channels for a maximum of 24% to 30% of all sales. Only one respondent made a very small percentage of total sales directly to a processor.

Exhibit 3.2.1. Markets for Missouri Aquaculture Products, 2022

Market Channel	Average % of sales	Min %	Max %	Trimmed Mean - 80%	Producers Using this Channel
Direct to consumers	62%	0	100%	71%	13
Other aquaculture producers	12%	0	100%	0%	7
Brokers, distributors or wholesale markets	11%	0	100%	0%	5
Government agencies	8%	0	60%	0%	5
Restaurants	3%	0	30%	0%	2
Retailers	3%	0	24%	0%	3
Processors	0.1%	0	1%	0%	1
Total	100%				36

In terms of markets that aquaculture producers are interested in entering, slightly more than half of 18 respondents indicated they had no desire to change markets (Exhibit 3.2.2). The other half provided multiple responses and had the most interest in selling to consumers directly or restaurants or marketing processed fish products, and 17% said they would like to enter the retail or wholesale market. Fewer businesses were interested in selling to other aquaculture producers, brokers or distributors and government agencies. Two respondents wrote in responses: research or universities and stocking ponds and lakes.

Exhibit 3.2.2. Missouri Aquaculture Producers' interest in Entering New Markets



In a follow-up question, producers identified barriers they faced as they considered entering new markets. Respondents could "select all that apply" from seven listed choices and add one open-ended response. Fourteen of those surveyed responded to the question. Four businesses did not respond. In the previous

question, all four had indicated they had no desire to change their current markets. Exhibit 3.2.3 summarizes all responses. No clear patterns emerged between businesses that indicated a desire to enter new markets in the previous question and those that did not. Note this one exception, however. All five businesses that said they lacked a processor or co-packer also indicated they wanted to enter new markets.

Among those that offered examples of barriers, capital for business expansion was most often listed — by nine respondents. Costs for advertising and transporting aquaculture products were each selected by six respondents. HACCP certification and names of buyers were each chosen by five respondents. Four selected time to evaluate new market opportunities. Two businesses felt that meeting product quality specifications demanded by different channels would be a barrier. Two businesses chose "other" and added "Complying to regulations is expensive" and "Competition from state aquaculture operations."

Exhibit 3.2.3. Perceived Barriers to Entering New Markets

Market Barrier	All Producers	Desire to Enter New Markets	
		Yes	No
HACCP certification	5	2	3
Capital for business expansion	9	5	4
Names of buyers	5	3	2
Meeting new product quality specifications	2	1	1
Costs associated with advertising, transportation, etc.	6	3	3
Time to evaluate new market opportunities	4	3	1
Lack of processing or co-packer capacity	5	5	0
Other	2	0	2

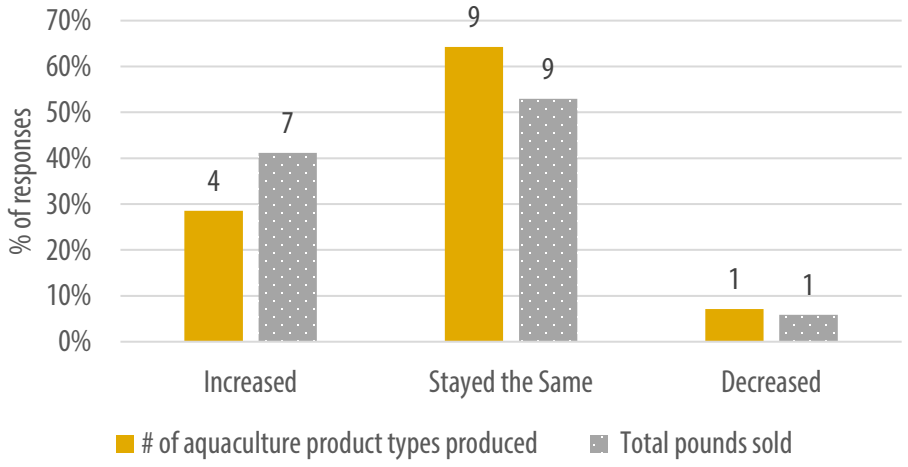
4. Changes among Missouri Aquaculture Businesses

To understand recent industry changes, producers reported whether the following six metrics increased, stayed the same or decreased between 2021 and 2022: number of products, total pounds sold, total sales, net income, number of employees and paid hours of hired labor.

A majority of producers reported these business metrics didn't change. When they did change, more producers reported increases than decreases. Between 14 and 17 responses were collected for each metric as not everyone offered a response for each metric.

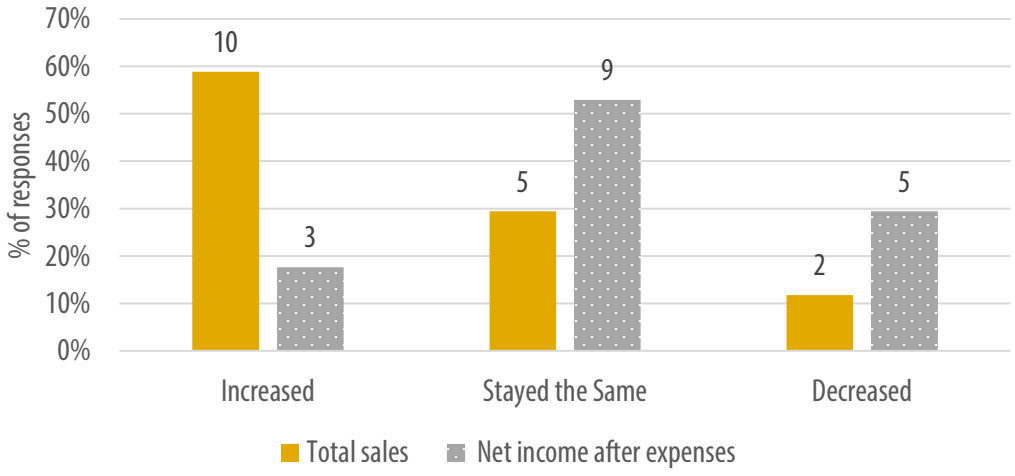
In 2022, the number of aquaculture product types sold stayed the same for 64% of the respondents and increased for 29%. Exhibit 4.1 shows nine producers reported their total pounds sold stayed the same in 2022, but seven respondents indicated their total pounds sold increased. One business recorded a decrease in the amount sold and the overall number of aquaculture product types sold during 2022.

Exhibit 4.1. Several Missouri Producers Sold More Product Types and Pounds in 2022 Compared with 2021



Nearly 60% of responding producers said their total sales increased in 2022 compared with 2021; however, only 18% indicated their net income after expenses had also increased over the same time. Missouri producers were more likely to indicate their net incomes had decreased than any other key business metric; 29% reported a year-on-year decline in 2022. The sales and net income perceptions in Exhibit 4.1, paired with Exhibit 4.2, indicate expanding producers face higher costs or are expanding into lower value markets for their aquaculture products.

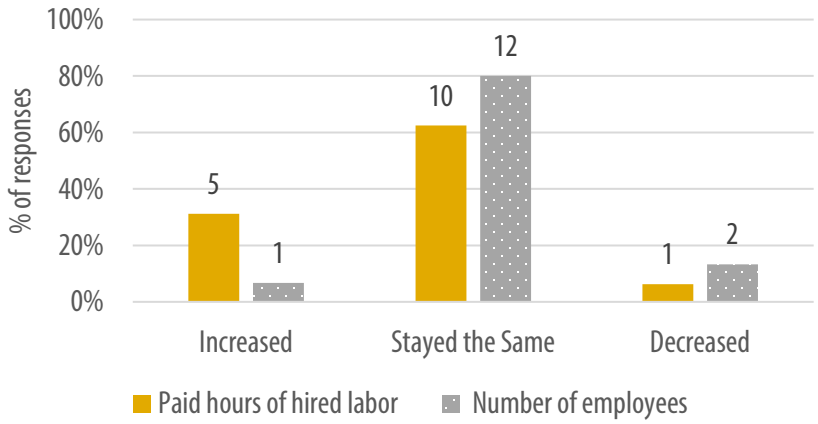
Exhibit 4.2. Producers were More Likely to Report Higher Sales but Unchanged Net Income in 2022 Compared with 2021



Given that labor was the largest expense category for producers, rising wages or higher employee turnover, recruitment and training costs could have all contributed to steady to lower net incomes — despite expansion of total sales, types of products and total pounds of fish sold.

Hired labor paid hours increased in 2022 compared with 2021, but the number of paid employees was relatively constant (Exhibit 4.3). Only one aquaculture businesses increased the number of employees; however, 31% of businesses increased the number of paid hired labor hours. Two businesses decreased the number of paid employees, and one business decreased its number of paid hours of hired labor.

Exhibit 4.3. Labor Requirements in Missouri Aquaculture Businesses, 2021 to 2022



5. Future of Aquaculture Businesses and the Industry

The final part of the survey posed five questions to understand aquaculture producers' future business goals for total sales, barriers to expansion, priorities for change in the next 12 months and perceptions. A 60% majority of respondents would like to expand their total sales, two respondents wanted to close their businesses, and four were uncertain of their future sales goals. Producers identified a range of barriers to expanding their businesses; the most common were workforce constraints and other costs. Lowering total business costs was the most important goal producers wanted to accomplish in the next 12 months.

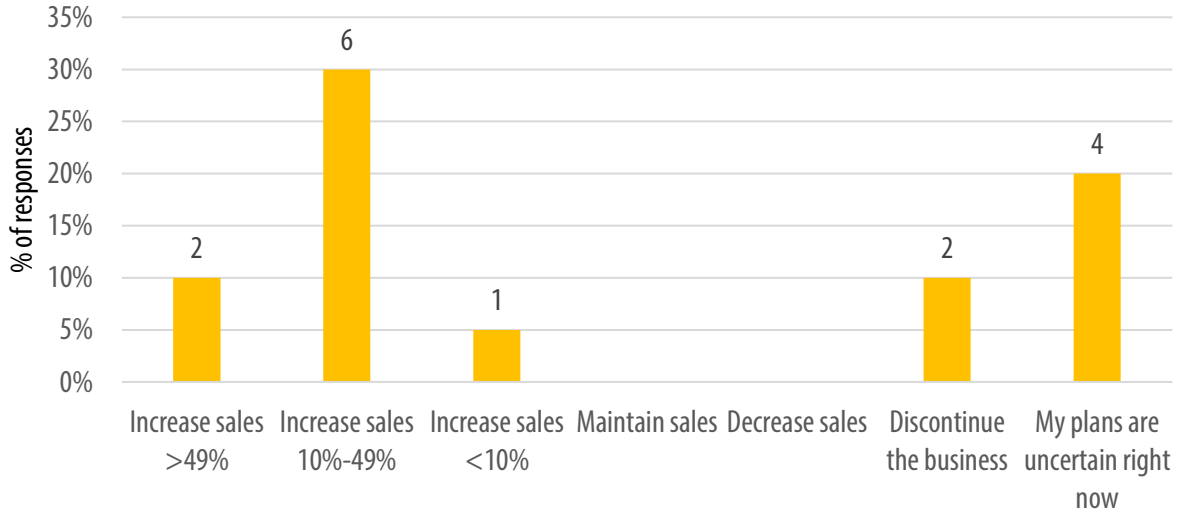
Two multipart questions intended to gauge respondents' sentiments about their own aquaculture businesses and the overall aquaculture industry in Missouri. Producers expressed some concern overall about their ability to earn a sustainable profit. Many strongly agreed that "input costs were rising faster than the prices I can charge my current customers." Most felt diversifying their businesses would not improve profits and focusing on specializations would not improve product quality. Producers agreed overall that they had built strong brand awareness for their businesses.

Responding producers were unified in their outlook on the Missouri aquaculture industry's future. Producers agreed that the industry needs to be innovative at cutting costs to be competitive and that the industry's future depends on creating direct-to-consumer distribution channels. Despite concerns about profitability and rising costs within their own businesses, 78% of respondents felt aquaculture producers have growing market opportunities. Respondents felt regulatory requirements were too burdensome, and they did not feel that the industry needs additional technological advancements to be competitive.

5.1. Desired Changes to your Business

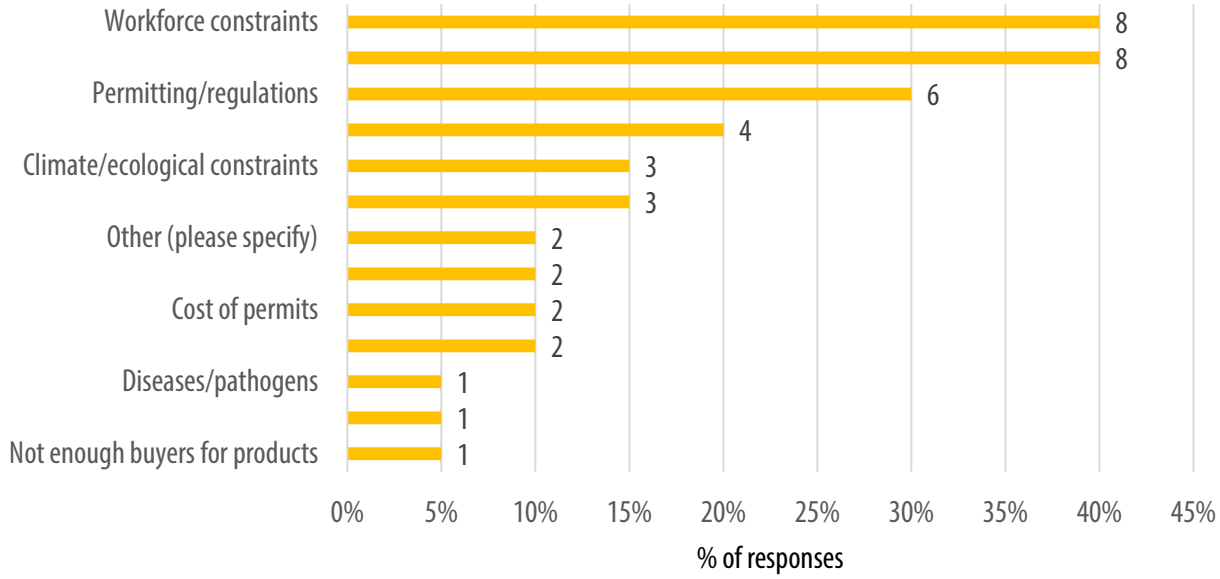
Exhibit 5.1.1 describes producer plans for total business sales over the next five years. Of those surveyed, 60% planned to increase their total business sales; most felt a 10% to 49% increase was achievable. The remaining 40% indicated uncertain future sales plans or planned to discontinue their businesses.

Exhibit 5.1.1. Missouri Aquaculture Businesses' Plans for Sales during the Next Five Years



A follow-up question asked aquaculture producers to identify the top three barriers — from a list of 14 options — to expanding their businesses in the next five years. Exhibit 5.1.2 summarizes the barriers selected by 15 responding producers; one-quarter of respondents chose not to respond to this question. The two barriers most often noted (by eight respondents each) were workforce constraints and other business costs, not permits. Six respondents, nearly one-third of the sample, cited permitting and regulations as a barrier.

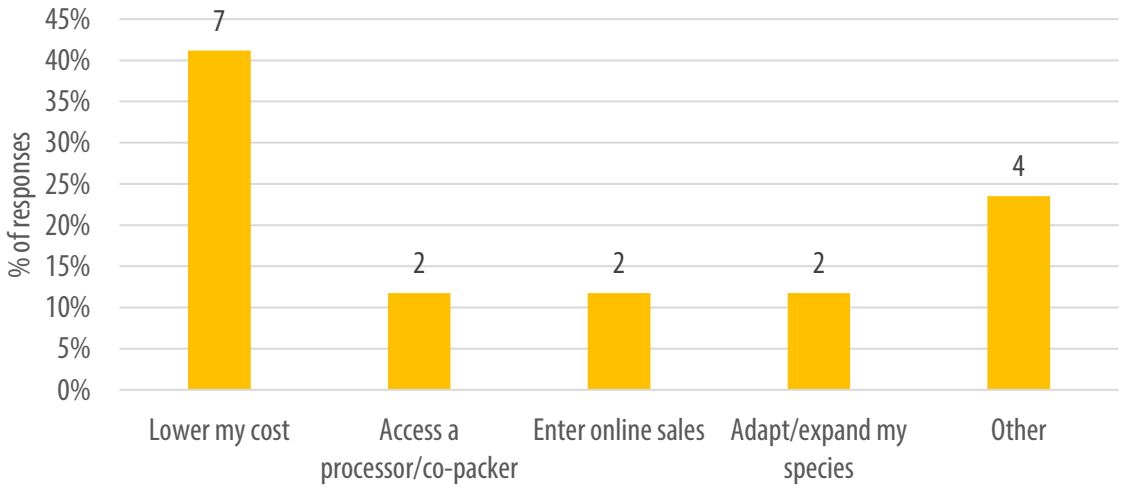
Exhibit 5.1.2. Missouri Producer Perceptions of Business Expansion Barriers during the Next Five Years



Given that the average time these businesses have been in operation was 39 years, it was not surprising that four businesses indicated succession planning as one of their top three barriers to expansion. Consistent with responses to earlier questions, three respondents indicated they had no interest in expanding their businesses. Three businesses were concerned about climate and ecological constraints. Half of the barriers offered were rarely selected. Two businesses offered a write-in response: One was unsure how to expand, and the other cited external driving factors such as government regulations, public awareness and the economy's overall stability.

Aquaculture businesses also identified the most important priority they would like to do or change in their businesses in the next 12 months. As indicated in Exhibit 5.1.3, 41% — seven businesses — wanted to lower their costs. Four businesses offered these written-in responses: Get income established so we can move forward; reduce impact of unfair trade practices, and unnecessary regulations; stay in business; and improve efficiency. The remaining three priorities — gaining access to a process or co-packer, enter online sales and adapt/expand my species — were each selected by two responding businesses.

Exhibit 5.1.3. Desired Changes by Aquaculture Producers during Next 12 Months



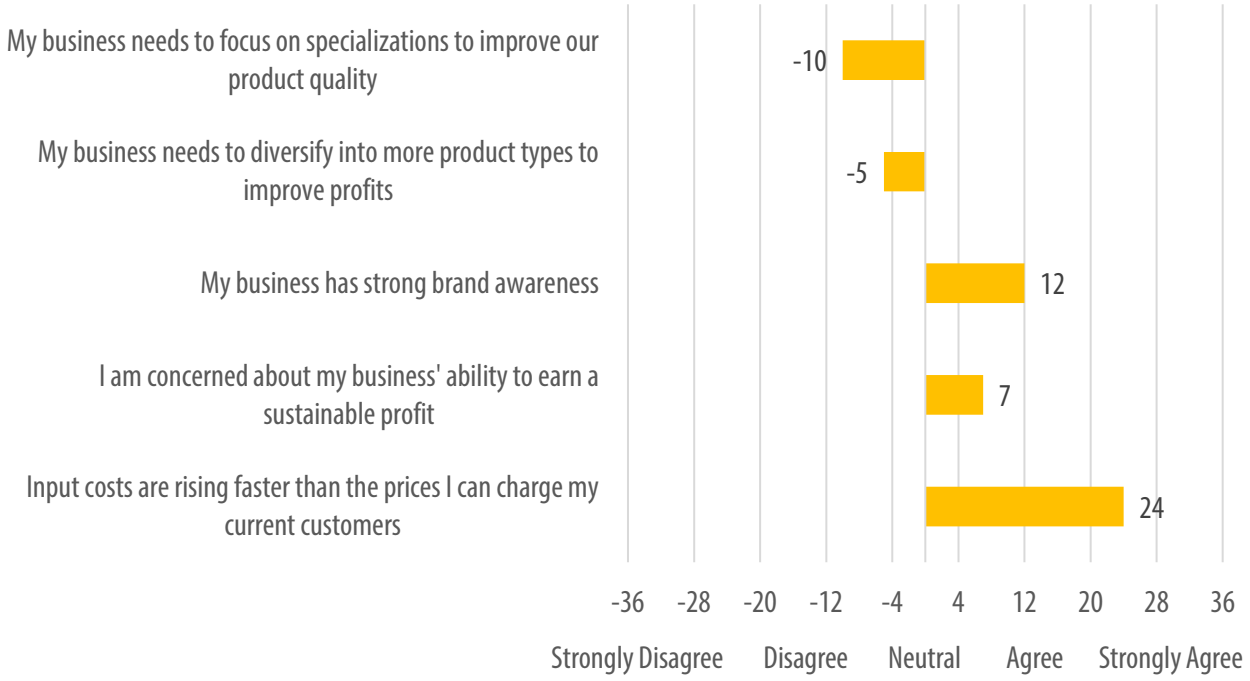
5.2 Perceptions of the Overall State of your Aquaculture Business

To indicate perceptions and sentiments about their current businesses, Missouri aquaculture producers selected whether they strongly agreed, agreed, disagreed or strongly disagreed with a series of five statements. A total of 18 respondents answered this question. We derived a single sentiment score by assigning values on a scale from +2 for strong agreement to -2 for strong disagreement and then summing

these values across all respondents. This sentiment score could have ranged from +36, or unanimous strong agreement across all responses, to -36, unanimous strong disagreement.

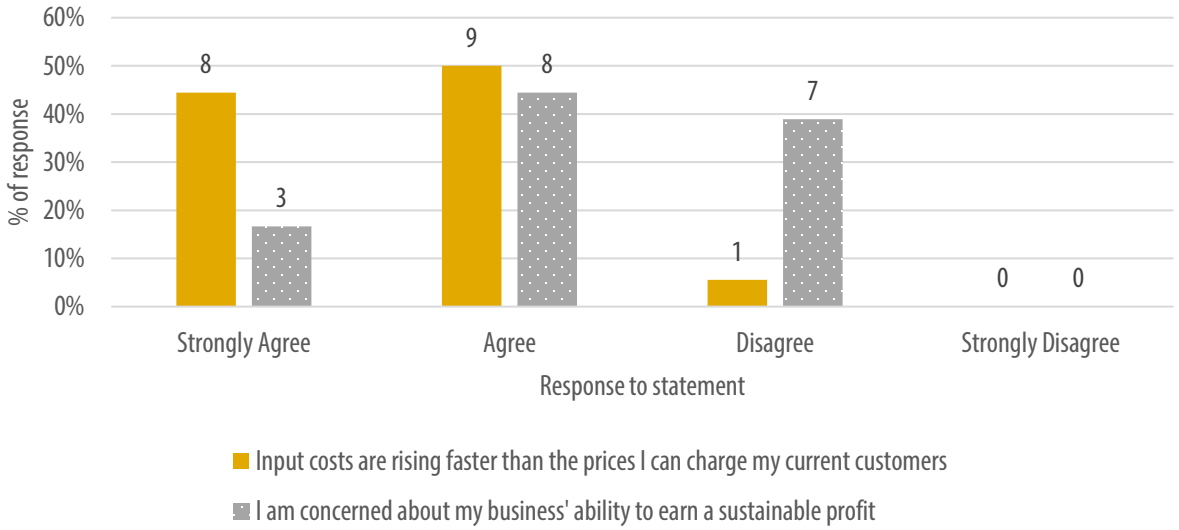
Respondents were more likely to agree than disagree with the provided statements (Exhibit 5.2.1). Producers agreed most strongly that "input costs were rising faster than the prices I can charge my current customers." This statement's sentiment score totaled +24. Producers also agreed — but less strongly with a total sentiment score of +12 — that they "had built strong brand awareness" for their businesses. Sentiment scores indicated producers felt split in their concern about earning a sustainable profit. Overall, producers were more likely to disagree than agree to statements that their businesses needed to specialize to improve product quality or diversify into more product types to improve profits. Exhibit 5.2.2 disaggregates these responses.

Exhibit 5.2.1. Missouri Aquaculture Producers' Perceptions about their Businesses



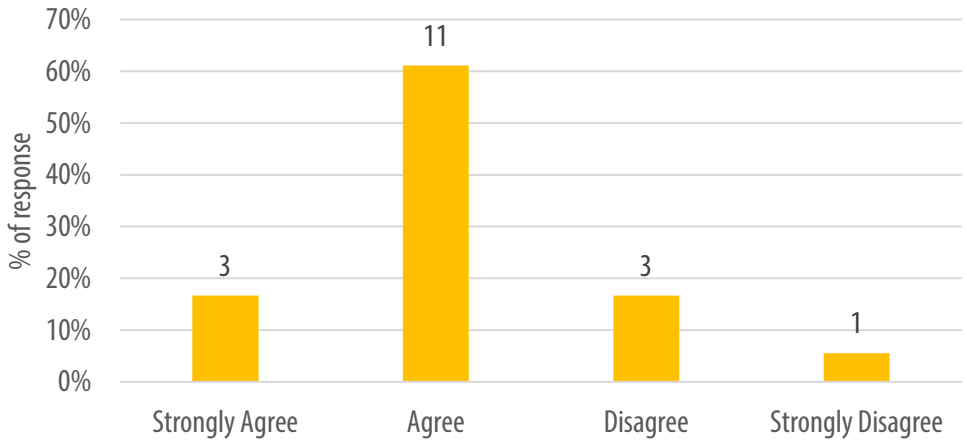
All but one business, or 94% of respondents, agreed or strongly agreed that input costs were rising faster than their ability to raise prices they charge customers. In a companion statement, fewer businesses, 61%, expressed concern about their businesses' ability to earn a sustainable profit. This optimism may reflect broader sentiments during spring 2023 that inflationary pressures could subside.

Exhibit 5.2.2. More Producers are Concerned with Rising Input Costs than Sustaining Business Profits



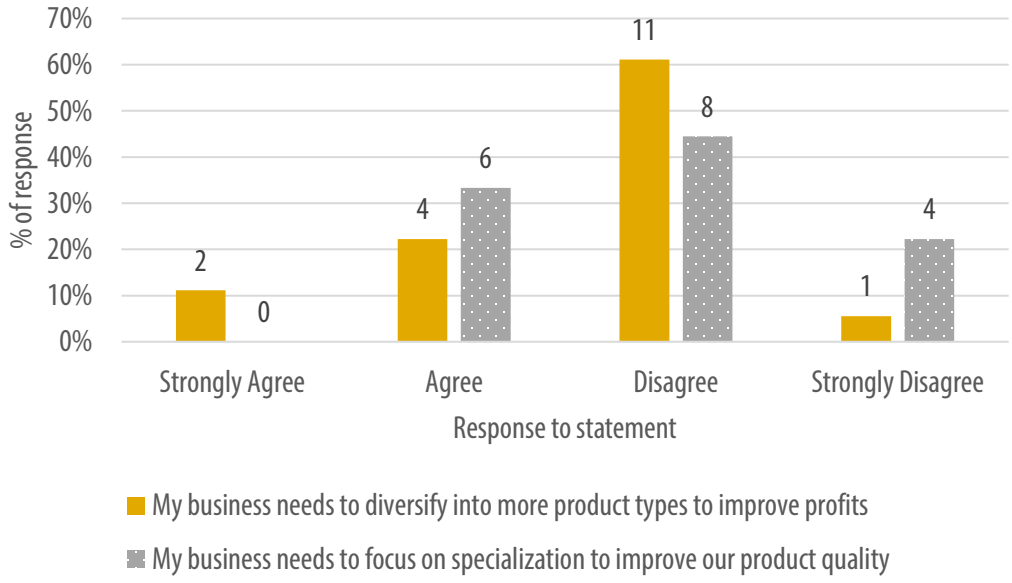
Overall, 78% of responding producers agreed that their businesses had strong brand awareness. Most chose the "agree" response, and four businesses disagreed — one of those noted strong disagreement (Exhibit 5.2.3). Many producers indicated they sell direct to consumers across multiple product types: pond stocking, food markets, bait fish, ornamentals and scientific products. These responses indicate that most producers are aware of their target audience and have established a relationship with that market. Still, the majority also agreed they could continue to improve brand awareness among their targeted customers.

Exhibit 5.2.3. Missouri Producer Sentiment toward "My Business has Strong Brand Awareness."



The survey posed two statements to gauge producer sentiment toward specialization as a pathway to improve quality and diversification to improve profits (Exhibit 5.2.4). Two-thirds of responding producers disagreed or strongly disagreed with these two ideas. Regarding diversification, many of these businesses are already diversified because they raise multiple species and market more than one product type through more than one market channel. This is useful context for understanding general disagreement about the need to diversify into more product types to improve profits. The slightly stronger disagreement about specialization improving product quality may indicate that many producers already feel their current production is high quality, despite their relative degree of diversification. One-third of respondents agreed that specialization might improve product quality.

Exhibit 5.2.4. Perceptions about How to Improve Business Profits and Product Quality

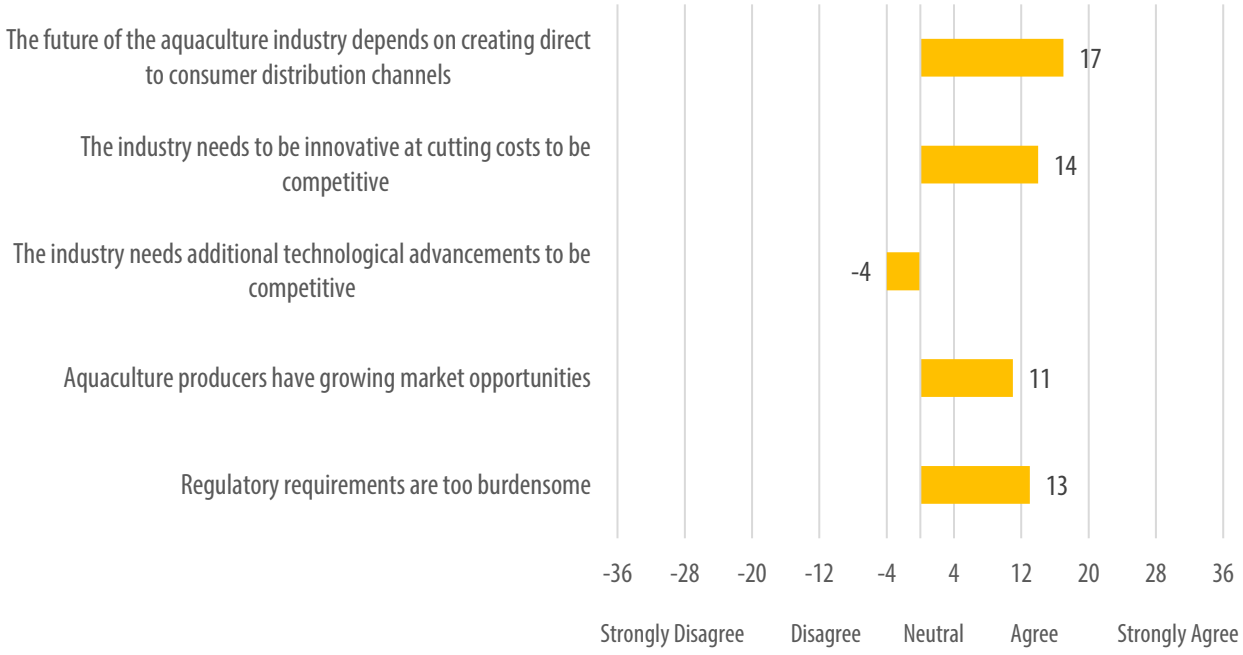


5.3. Perceptions of Missouri's Aquaculture Industry

Respondents also had an opportunity to strongly agree, agree, disagree or strongly disagree with five statements about the Missouri aquaculture industry. The same 18 respondents who provided perceptions about their current businesses also answered these questions. We derived a single sentiment score by assigning values ranging from +2 for strong agreement to -2 for strong disagreement and then summing these values across all respondents. Scores could have ranged from +36, or unanimous strong agreement to -36, unanimous strong disagreement.

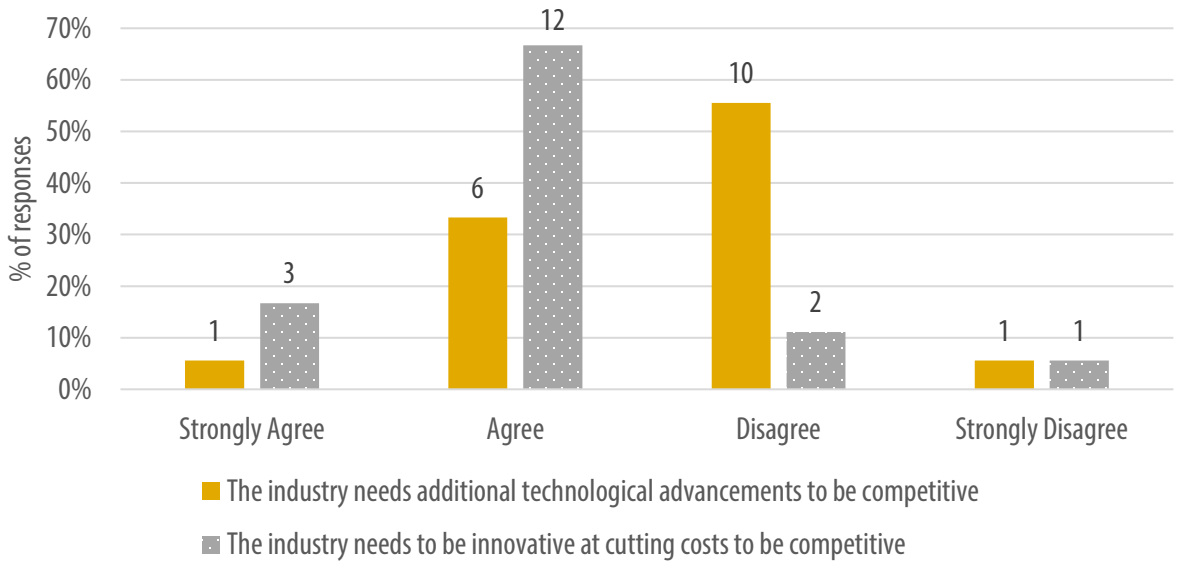
Producers showed similar positive agreement for four of the five statements (Exhibit 5.3.1). This indicates producers perceived similar challenges (i.e., burdensome regulations, the need to cut costs to be competitive) as well as similar opportunities (i.e., growing market opportunities, need to create more direct-to-consumer distribution channels). Producers had mixed feelings about the role of technological advancements to be competitive. These differences are disaggregated below.

Exhibit 5.3.1. Missouri Aquaculture Business Owners' Perceptions of the Industry in Missouri



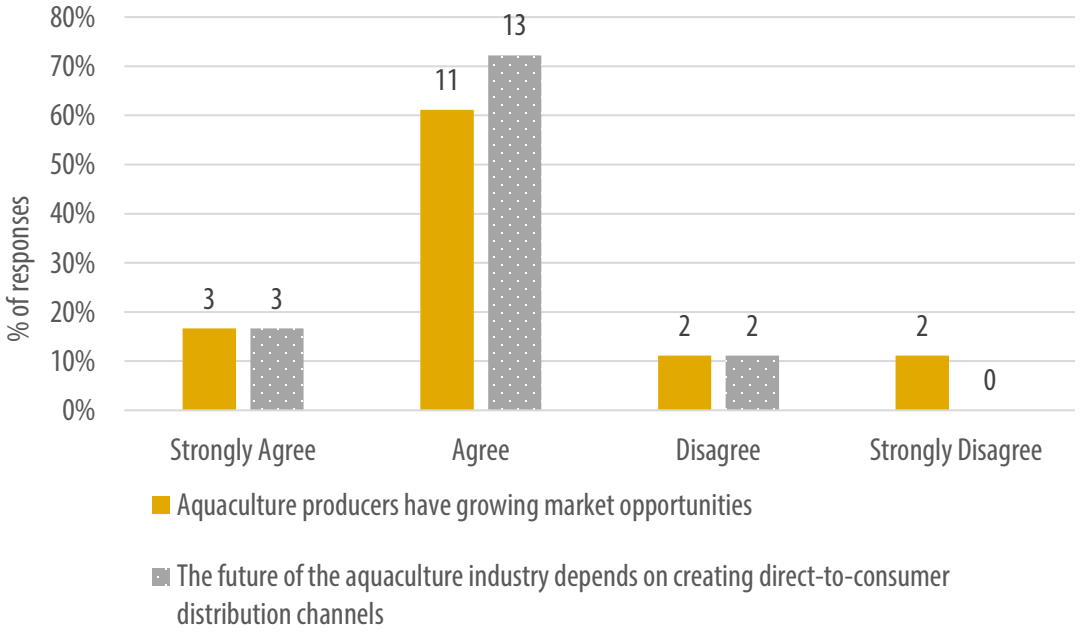
Two questions were designed to understand producer sentiments about increasing competitiveness in the industry (Exhibit 5.3.2). Most (84%) of the respondents felt that Missouri businesses need to cut costs to be competitive; three respondents disagreed. Producers were more evenly split in their opinions on the role of technological advancements as 39% felt additional technology advancements could help the industry be competitive, but 62% disagreed.

Exhibit 5.3.2. Perceptions on How to Improve the Competitiveness of Missouri's Aquaculture Industry



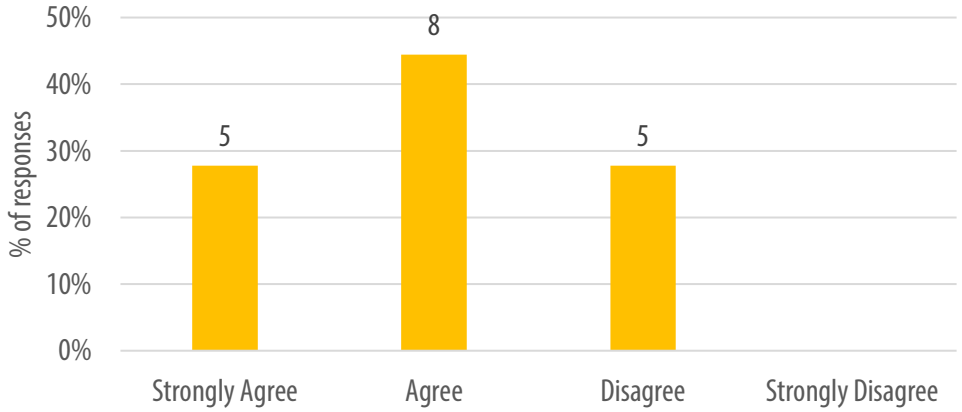
Producers were then asked to rate perceptions of future marketing opportunities. More than 78% of respondents agreed that "aquaculture producers have growing market opportunities." With respect to sentiment toward "the future of the aquaculture industry depends on creating direct-to-consumer distribution channels," the majority of those polled (89%) agreed that direct-to-consumer distribution channels would be better for business as eliminating the "middleman" would increase their profit margins (Exhibit 5.3.3). However, 11% disagreed, stating they didn't feel they needed to sell direct to the consumer due to potential increased cost, increased risk and the added work and stress of building a distribution channel.

Exhibit 5.3.3. Perceptions on Future Market Opportunities



Stakeholders in the U.S. aquaculture industry often cite regulations as a barrier to growth, and 72% of the Missouri survey's respondents indicated they strongly agreed or agreed that regulatory requirements are too burdensome. The other 28%, however, didn't feel that regulatory issues posed a burden (Exhibit 5.3.4).

Exhibit 5.3.4. Missouri Aquaculture Producers Perceive Regulatory Requirements are Too Burdensome



5.4. Final Comments by Responding Aquaculture Businesses

Survey respondents could also provide an open-ended response to the needs assessment survey. Seven respondents offered a comment. The list below shares their verbatim responses to provide more context.

Is there anything else you would like to share about your experiences in Missouri aquaculture, especially regarding barriers and needs? Or are there other relevant topics that we did not ask about?

- Small producer and the next generation does not want to work this hard to make a small amount.
- Don't over-regulate the business.
- 1. Agriculture is a dying occupation in Missouri; 2. No interest from Government of Missouri except to regulate; 3. MO Dept. of Conservation dominates and excessively regulates private sector as well as directly competes with private sector.
- Hard work, good work, complicated for new entry (youth).
- Technology advances for aquaculture and assistance for fish farmers in helping improve technology on the farm is needed.
- The aquaculture producers in Missouri are of high quality, but there needs to be more. Less burdened government would be helpful. Missouri is primarily made of aquaculturists producing fish for the recreational fishing market, and ornamental markets. I think there would be room for food fish production in the state if producers could keep input costs low enough to have a competitive bottom line. Labor is currently a barrier within MO. Regulatory costs are also a barrier. CDL Drivers are a barrier. The department of Ag should have a program for helping ag businesses send employees to certify CDL driving courses for free or reduced costs.
- We need to crack down on how the money is spent from the government.

Appendix: Missouri Aquaculture Survey Instrument

The University of Missouri Extension is conducting a short survey to collect information about barriers to aquaculture expansion in Missouri.

We are asking for input from Missouri's aquaculture businesses. We plan to share a summary of the survey (no raw data) in a publicly available report. We are not asking for your business name, and we will never release any data for an individual business.

Your participation is voluntary and confidential, and your participation decision will not affect your relationship with the University of Missouri. You can skip any questions and end the survey at any time. You have the option to provide contact information at the end, but it is not required.

If you have any questions about this study, you can contact Mallory Rahe at Mallory.rahe@missouri.edu, (573) 884-7606 or Ryan Milhollin at milhollinr@missouri.edu, (573) 882-0668.

You can also complete this survey online by following the link in this QR code:

1. In what year did your aquaculture business first begin operations? _____

2. In what county(ies) does your aquaculture business operate?

   _____

3. How many people do you currently employ?

   _____

4. What production systems do you use? ***Select all that apply***

   - ☐ Ponds
   - ☐ Flow through raceways
   - ☐ Recirculating systems
   - ☐ Nonrecirculating systems
   - ☐ Aquaponics
   - ☐ Cages or pens
   - ☐ Other: _____

5. Please describe the size of area you used to produce fish, mollusks, crustaceans, or other aquaculture products in 2022.

	Freshwater	Saltwater
Acres **OR**		
Surface area in sq feet		

6. Which of the following aquaculture products did your business sell in 2022? ***Select all that apply***

	Food markets	Pond / Sport stocking	Scientific / educational	Bait	Ornamental
Fish					
Crustaceans					
Other, *please specify:*					

7. Please indicate if your aquaculture business did any of the following in 2022:

   Select all that apply

   - ☐ Processed fish onsite
   - ☐ Made products using your own recipes
   - ☐ Marketed products under your own brand name
   - ☐ Operated a retail counter or store
   - ☐ Sold aquaculture products online
   - ☐ Diversified your business with non-aquaculture products
   - ☐ Opened your operation for fee fishing
   - ☐ Offered on-site tours
   - ☐ Offered other products or services: _____

8. Which of the following species do you currently raise? Please estimate, by percentage, how much of that species was part of your total sales in 2022. ***Select all that apply***

Alligator gar %	American eel %	Atlantic salmon %	Bighead carp %
Bigmouth buffalo %	Black crappie %	Blue catfish %	Bluegill %
Blue sucker %	Bluntnose minnow %	Bowfin %	Brook trout %
Brown bullhead %	Brown trout %	Channel catfish %	Coho salmon %
Common carp %	Cutthroat trout %	Fathead minnow %	Flathead catfish %
Freshwater drum %	Gizzard shad %	Golden trout %	Goldfish %
Grass carp %	Green sunfish %	Largemouth bass %	Longear sunfish %
Longnose gar %	Mosquitofish %	Muskellunge %	Northern pike %
Orangespotted sunfish %	Paddlefish %	Pumpkinseed %	Quillback %
Rainbow trout %	Redear sunfish %	River carpsucker %	Sauger %
Shortnose gar %	Shovelnose	Smallmouth bass %	Spotted bass %
Threadfin shad %	Walleye %	Warmouth %	White bass %
White crappie %	White sucker %	Yellow bullhead %	Yellow perch %
Calico %	Freshwater prawn %	Pacific white shrimp %	Red swamp catfish %
Virile crayfish %	White river crawfish %	Other: %	

9. To the best of your knowledge, how would you allocate your 2022 expenses among the following categories?

Labor	%
Feed	%
Energy	%
Marketing	%
Other	%
Total	**100 %**

10. In 2022, please indicate whether the following items increased, stayed the same, or decreased from the previous year for your aquaculture business?

	Increased	Stayed the Same	Decreased
# of aquaculture product types produced			
Total pounds sold			
Total sales			
Net income after expenses			
Number of employees			
Paid hours of hired labor			

11. Where do you primarily source your aquaculture feed?

Brand names:	
Feed Mills/Companies:	

12. How much aquaculture feed did you purchase in 2022?

Total volume in Bulk (Tons)	
Total volume in Totes (Pounds)	
Total volume in Bags (Pounds)	

13. What are the benefits of your current feed? ***Select all that apply***
    - ☐ Price
    - ☐ Packaging
    - ☐ Performance
    - ☐ Availability
    - ☐ Specific characteristics buyers demand (organic, sustainable, etc.)
    - ☐ Storage
    - ☐ Other: _____

14. Would you buy feed from a more local feed producer, if they were able to produce similar feed to your current supplier, such as under license from your current supplier?
    - ☐ Yes
    - ☐ No, because: _____

15. Of your 2022 total sales in dollars, what percentage originated from the following customers? *Total should equal 100%*

	% of 2022 Sales in $
Direct to consumers (in person or online)	**%**
Other aquaculture producers	**%**
Restaurants	**%**
Retailers	**%**
Processors	**%**
Brokers or distributors or wholesale markets	**%**
Government agencies	**%**
Other:	**%**
Total	**100 %**

16. What markets are you most interested in entering? ***Select all that apply***

- ☐ No desire to change current markets
- ☐ Direct to consumers (in person or online)
- ☐ Other aquaculture producers
- ☐ Restaurants
- ☐ Retailers
- ☐ Processed fish
- ☐ Brokers or distributors
- ☐ Wholesalers
- ☐ Government agencies
- ☐ Other: _____

17. What barriers are you facing as you consider entering these markets? ***Select all that apply***

- ☐ HACCP Certification
- ☐ Capital for business expansion
- ☐ Names of buyers
- ☐ Meeting new product quality specifications
- ☐ Costs associated with advertising, transportation, etc.
- ☐ Time to evaluate new market opportunities
- ☐ Lack of processing or co-packer capacity
- ☐ Other: _____

18. In the next five years, which of the following best describes your plans regarding total business sales?

- ☐ Discontinue the business
- ☐ Decrease sales
- ☐ Maintain sales
- ☐ Increase sales <10%
- ☐ Increase sales 10%-49%
- ☐ Increase sales >49%
- ☐ My plans are uncertain right now

19. What are the major barriers to expanding your aquaculture business in the next 5 years? ***Please select your top 3 barriers.***
    - ☐ None, I have no interest in expansion
    - ☐ Permitting/regulations
    - ☐ Not enough buyers for products
    - ☐ Lack of processing or co-packer capacity
    - ☐ Lack of space to lease/buy
    - ☐ Cost of permits
    - ☐ Other costs
    - ☐ Climate/ecological constraints
    - ☐ Diseases/pathogens
    - ☐ Invasive species
    - ☐ Workforce constraints
    - ☐ Succession planning
    - ☐ Low cost of imported products
    - ☐ Other (please specify): _____

20. What is the one most important thing you would like to do or change in your business in the next 12 months?
    - ☐ Enter online sales
    - ☐ Gain HACCP certification
    - ☐ Access a processor/co-packer
    - ☐ Lower my costs
    - ☐ Adapt/expand my species
    - ☐ Other: _____

      _____

21. Please indicate the extent to which you agree or disagree with the following statements about your aquaculture business.

	Strongly Agree	Agree	Disagree	Strongly disagree
Input costs are rising faster than the prices I can charge my current customers				
I am concerned about my business' ability to earn a sustainable profit				
My business has strong brand awareness				
My business needs to diversify into more product types to improve profits				
My business needs to focus on specializations to improve our product quality				

22. Please indicate the extent to which you agree or disagree with the following statements about the overall aquaculture industry in Missouri.

	Strongly Agree	Agree	Disagree	Strongly disagree
Regulatory requirements are too burdensome				
Aquaculture producers have growing market opportunities				
The industry needs additional technological advancements to be competitive				
The industry needs to be innovative at cutting costs to be competitive				
The future of the aquaculture industry depends on creating direct-to-consumer distribution channels				

23. Is there anything else you would like to share about your experiences in Missouri aquaculture, especially regarding barriers and needs? Or are there other relevant topics that we did not ask about?

_____

_____

Thank you for completing the survey!

If you would like to be directly sent a copy of the survey results when they are compiled OR if you would be willing to provide additional information about needs and barriers surrounding aquaculture in Missouri, please provide your contact information below.

This is entirely optional. We will not share your personal information with anyone outside the study team and your identity will not be associated with your survey responses.

Optional contact information:

Name:

_____

Best phone number to reach you for additional questions:

_____

Email address to receive a copy of the final survey report:

_____