



AQUACULTURE IN THE UNITED STATES OF AMERICA



Introduction and Context

Aquaculture - breeding, rearing, and harvesting of aquatic animals and plants—such as fish, shellfish, and algae—in controlled or selected environments.



Global Population

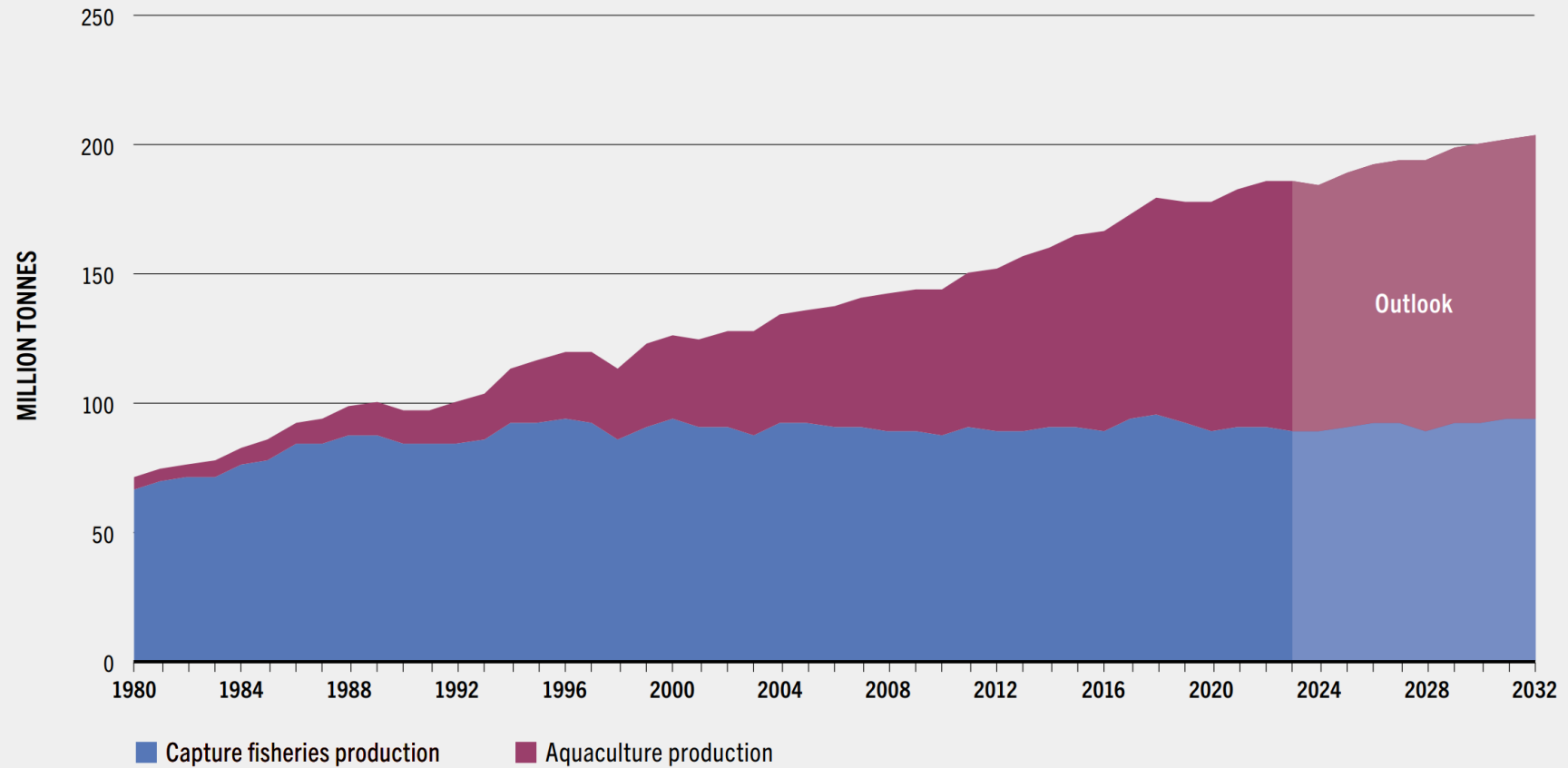
2026

8.3 Billion

2050

9.8 Billion

FIGURE 64 WORLD FISHERIES AND AQUACULTURE PRODUCTION OF AQUATIC ANIMALS, 1980–2032

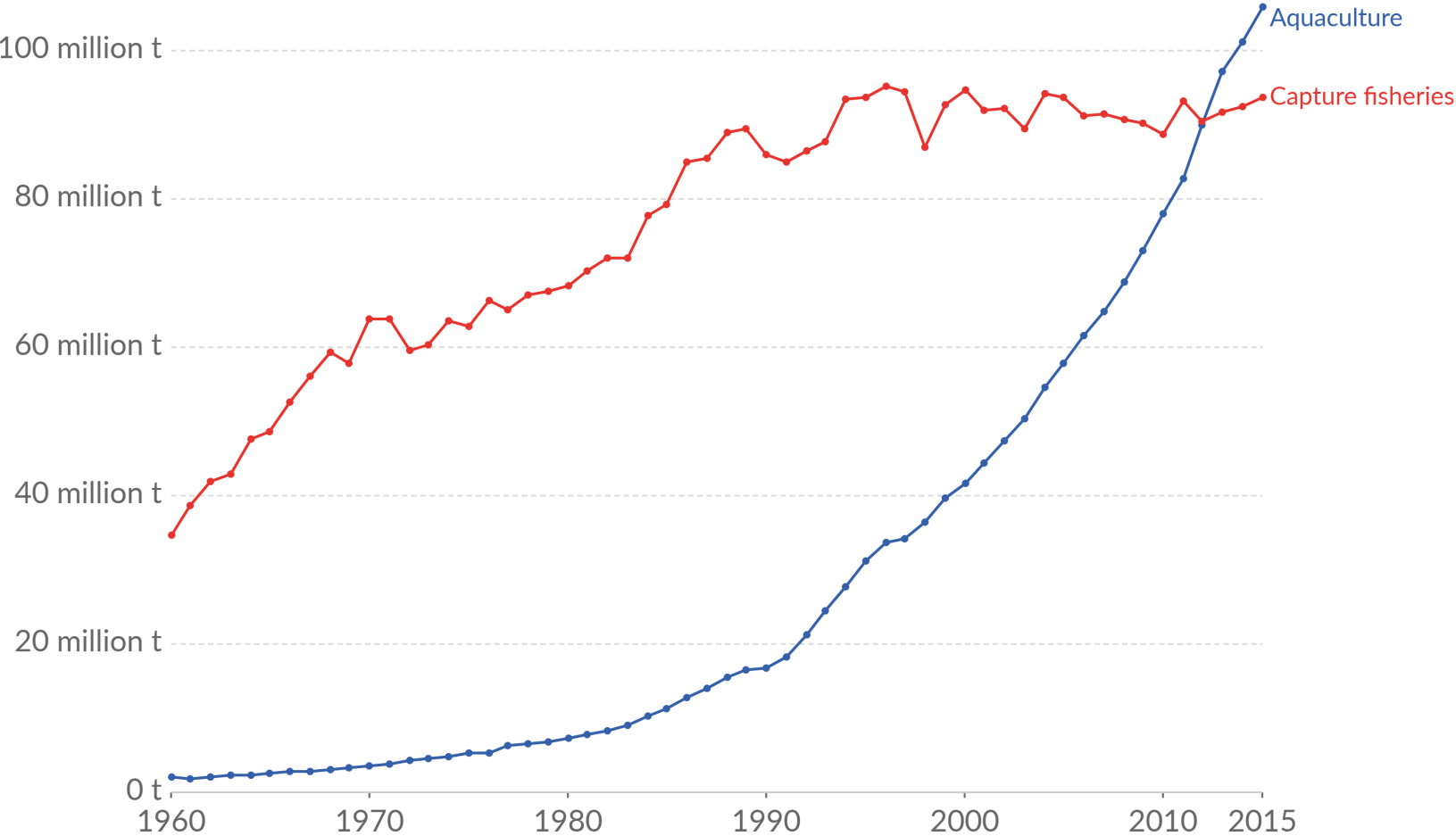


NOTES: Aquatic animals excluding aquatic mammals, crocodiles, alligators, caimans, aquatic products (corals, pearls, shells and sponges) and algae. Data expressed in live weight equivalent.

SOURCE: FAO estimates.

Seafood production: wild fish catch vs aquaculture, World

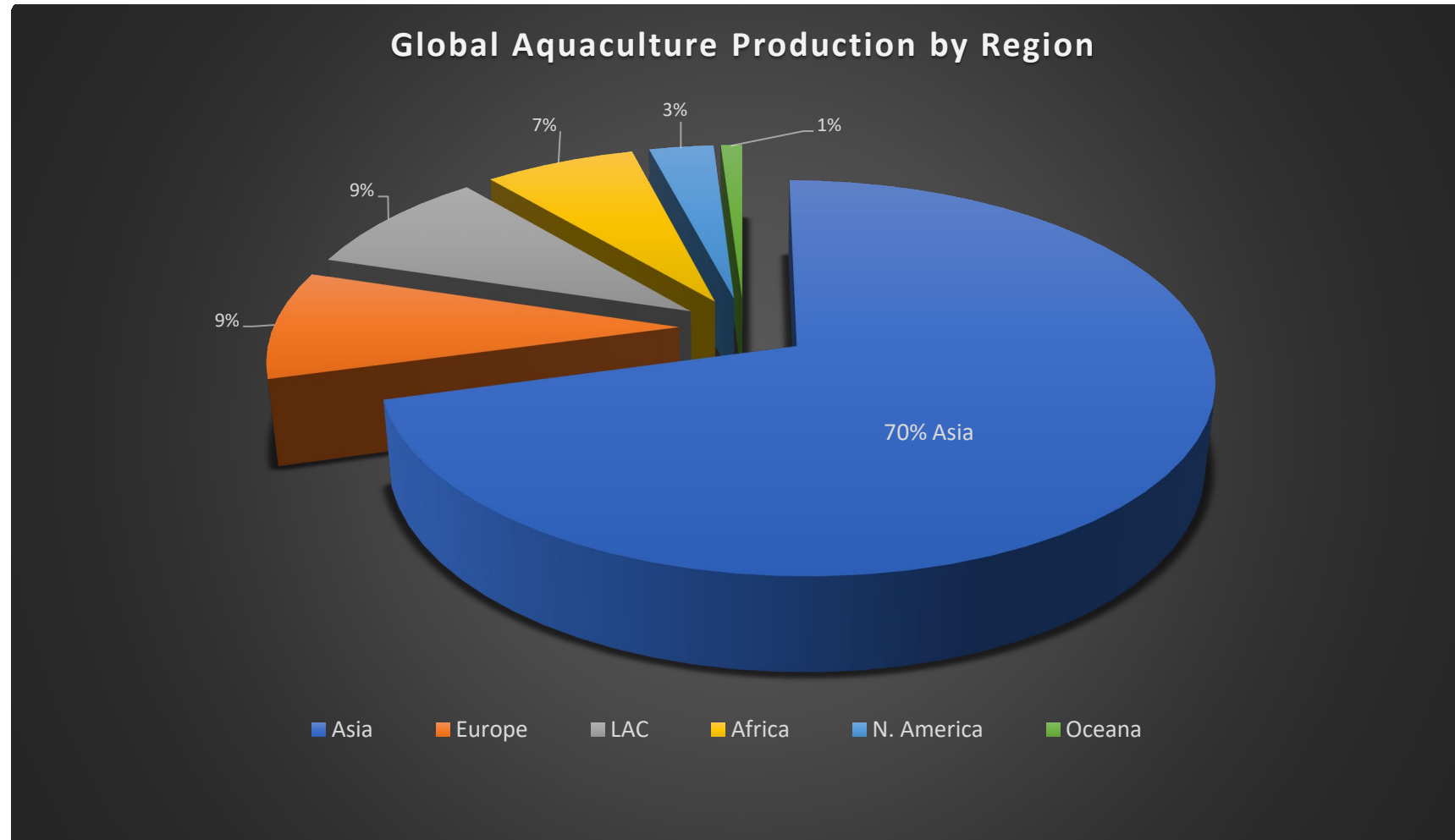
Aquaculture is the farming of aquatic organisms including fish, molluscs, crustaceans and aquatic plants. Capture fishery production is the volume of wild fish catches landed for all commercial, industrial, recreational and subsistence purposes.



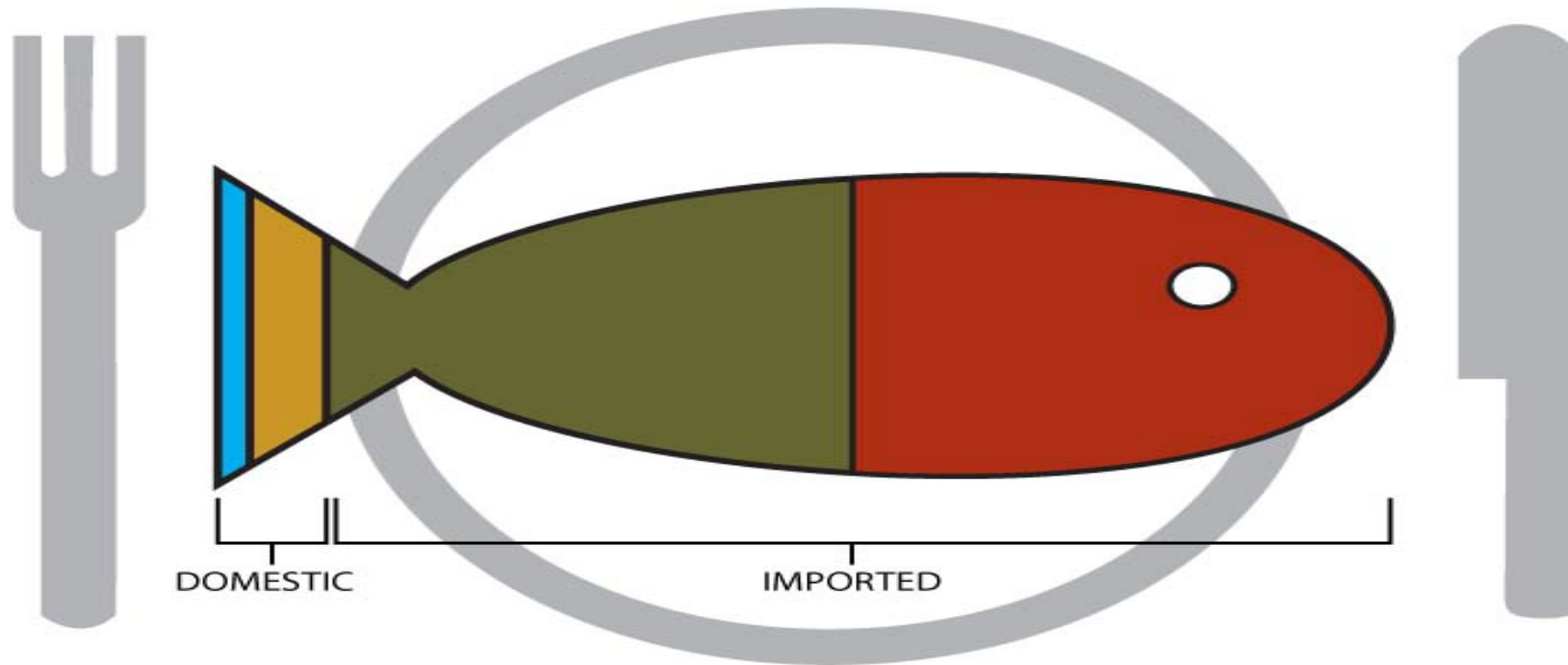
Source: UN Food and Agriculture Organization (FAO)

OurWorldInData.org/meat-and-seafood-production-consumption/ • CC BY

Where Does the U.S. Fit Into Global Aquaculture



Sources of all seafood consumed in U.S.



**U.S.
Farmed**
2.5%

**U.S.
Wild-caught**
6.5%

**Imported
Wild-caught**
45%

**Imported
Farmed**
46%

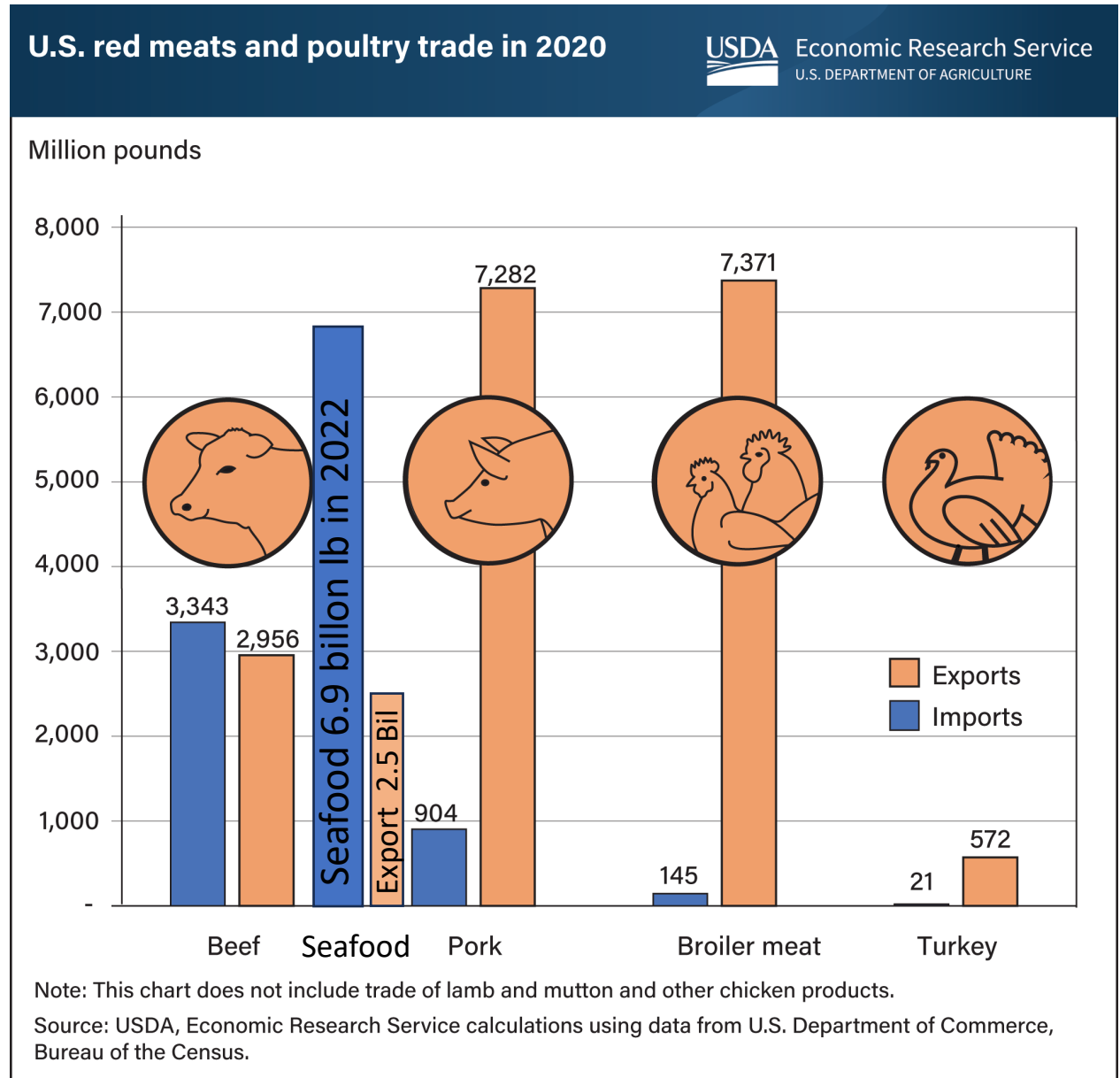
Data 2012, NOAA National Marine Fisheries Service.

David J. Landkamer, Ed.D., Aquaculture Extension Specialist, Oregon Sea Grant Extension Program.
Infographic by Patricia Andersson, Oregon Sea Grant

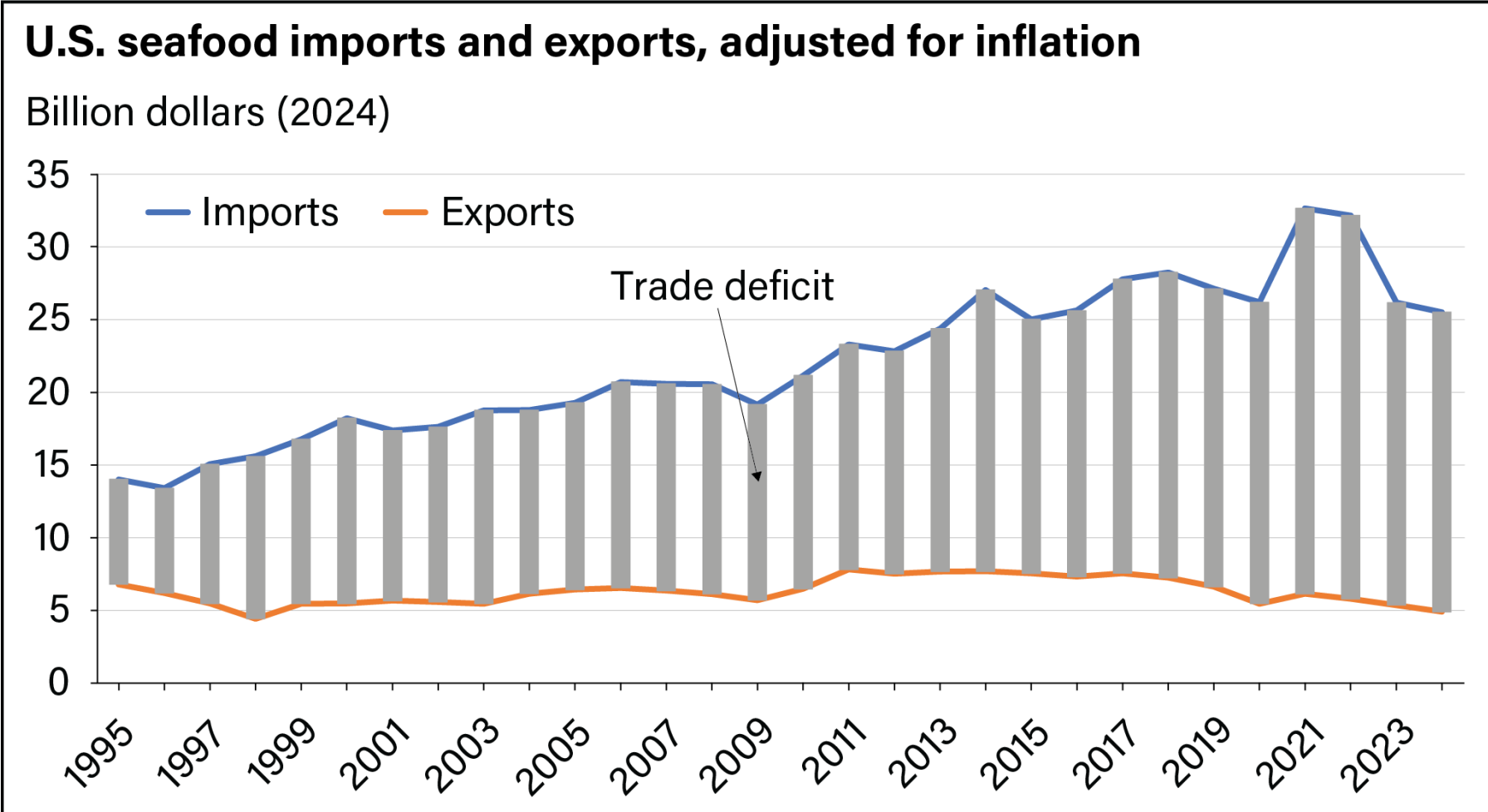
Import/Export

While most other livestock have exports greater than imports

The U.S. imports almost 3x more seafood than it exports



U.S. Seafood Trade Deficit

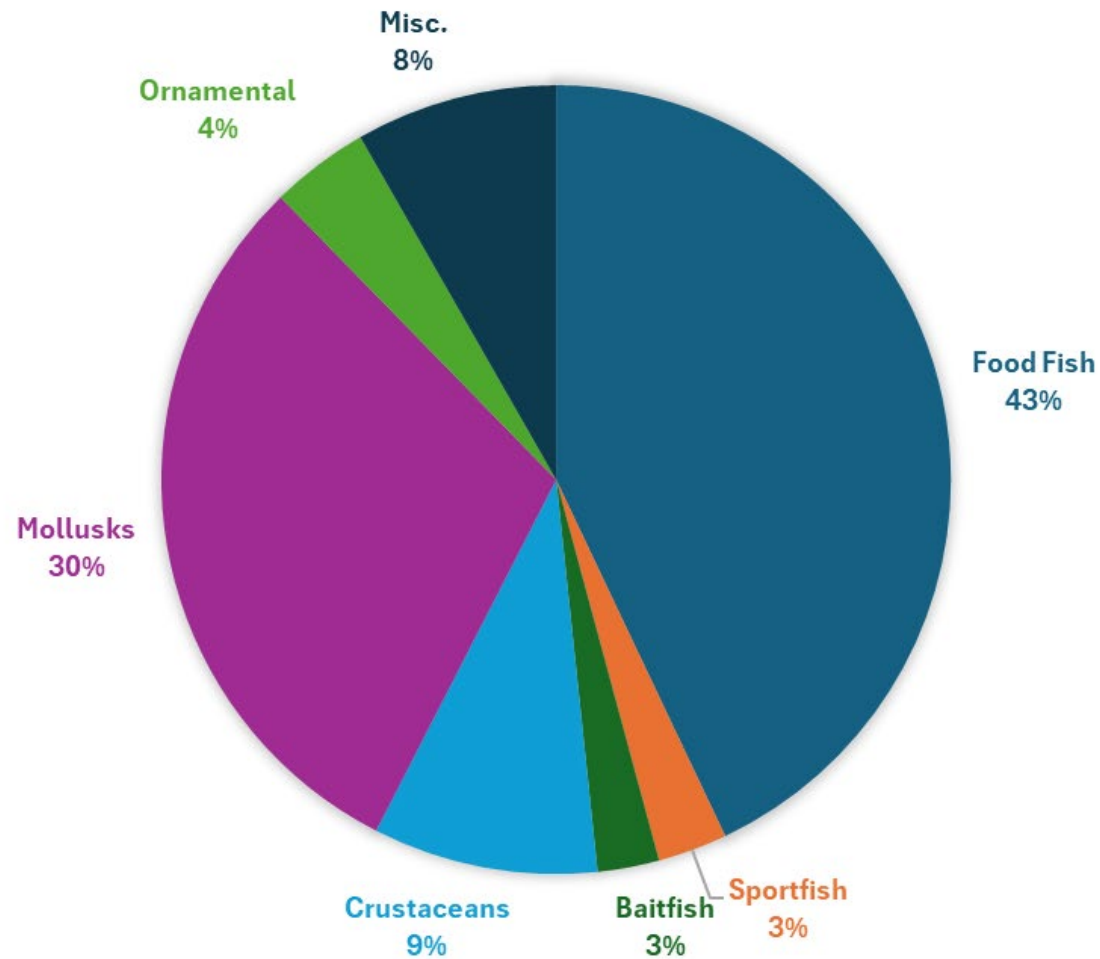


What does \$20 billion look like?



14 Tractor trailer loads of \$20 bills

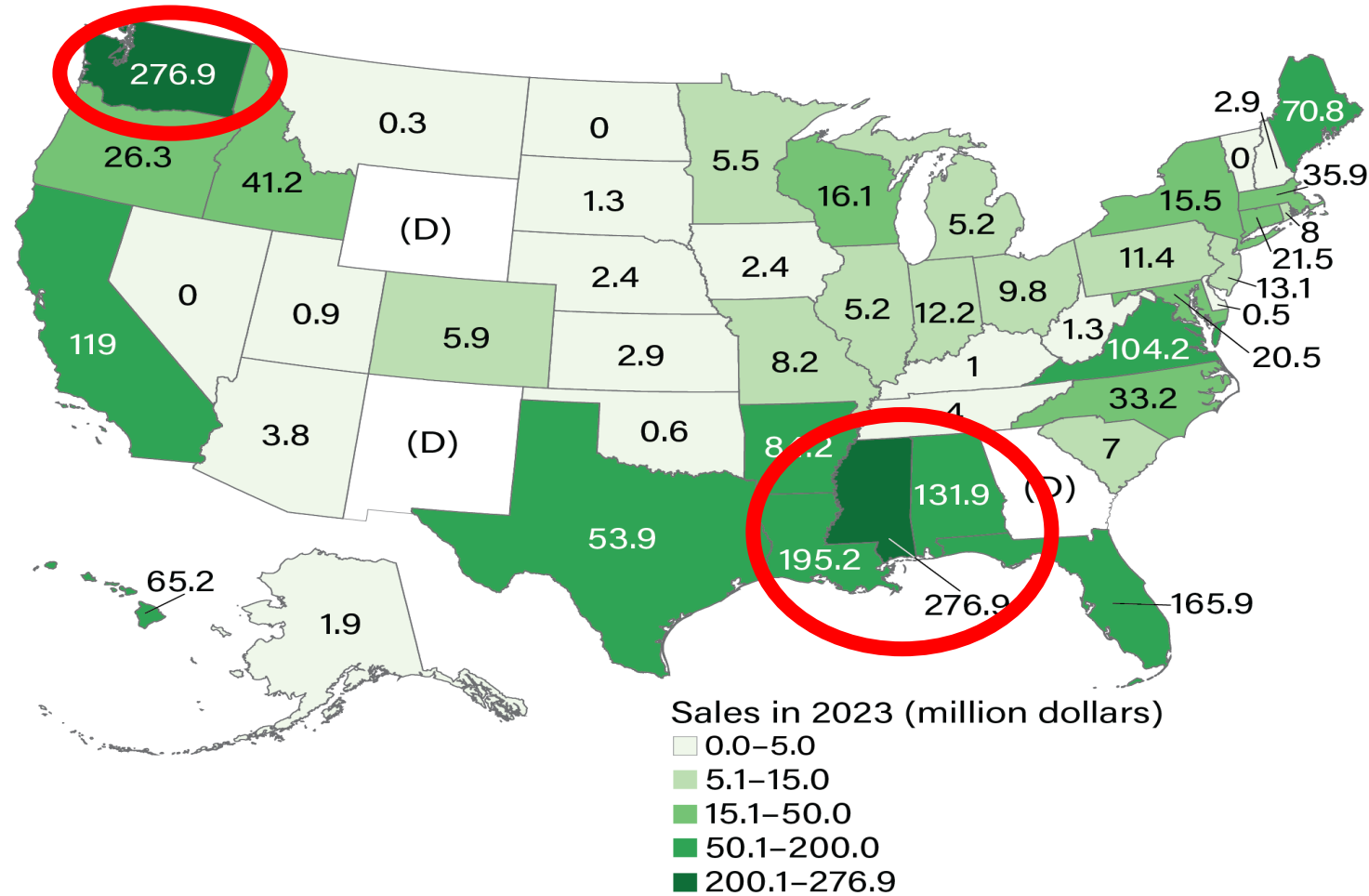
2026 U.S. Aquaculture Industry Valued at \$1.9 Billion



Product Type	Value (\$1,000's)
Food Fish	819,555
Sport Fish	54,390
Baitfish	48,125
Crustaceans	175,746
Mollusks	575,455
Ornamental	77,095
Misc.	157,655

Source: 2023 USDA Census of Aquaculture

Aquaculture sales in the United States, 2023



Note: All aquaculture sales are in nominal million dollars and all States with (D) indicate non-disclosure.

Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Aquaculture, 2023.

West Coast

Shellfish

- Oysters
- Mussels
- Clams
- Abalone

Emerging

- Kelp
- High value finfish

New England

- Oysters
- Mussels
- Clams
- Salmon
- Kelp

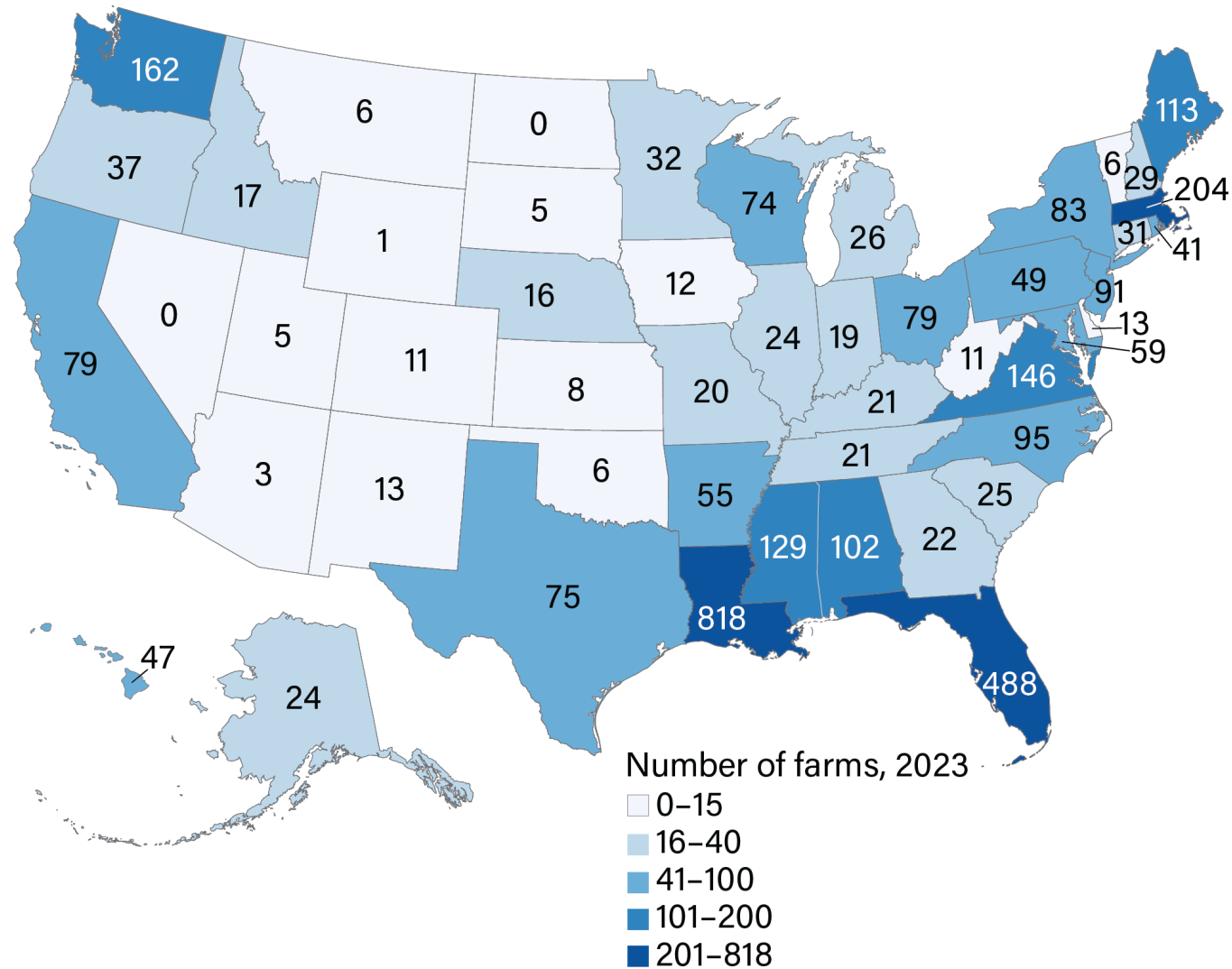
Mid Atlantic

- Oysters – Clams
- Tilapia, Trout, HSB

Southeast

- MS – Catfish
- FL - Tropical fish
- LA – Crawfish, Catfish, Oysters, Alligators, Tilapia, Turtles, Baitfish
- AL – Catfish, Oysters
- AR – Baitfish
- TX – Finfish
- HSB, Redfish, Catfish
- Shrimp, Crawfish, Bait

Aquaculture farms in the United States, 2023

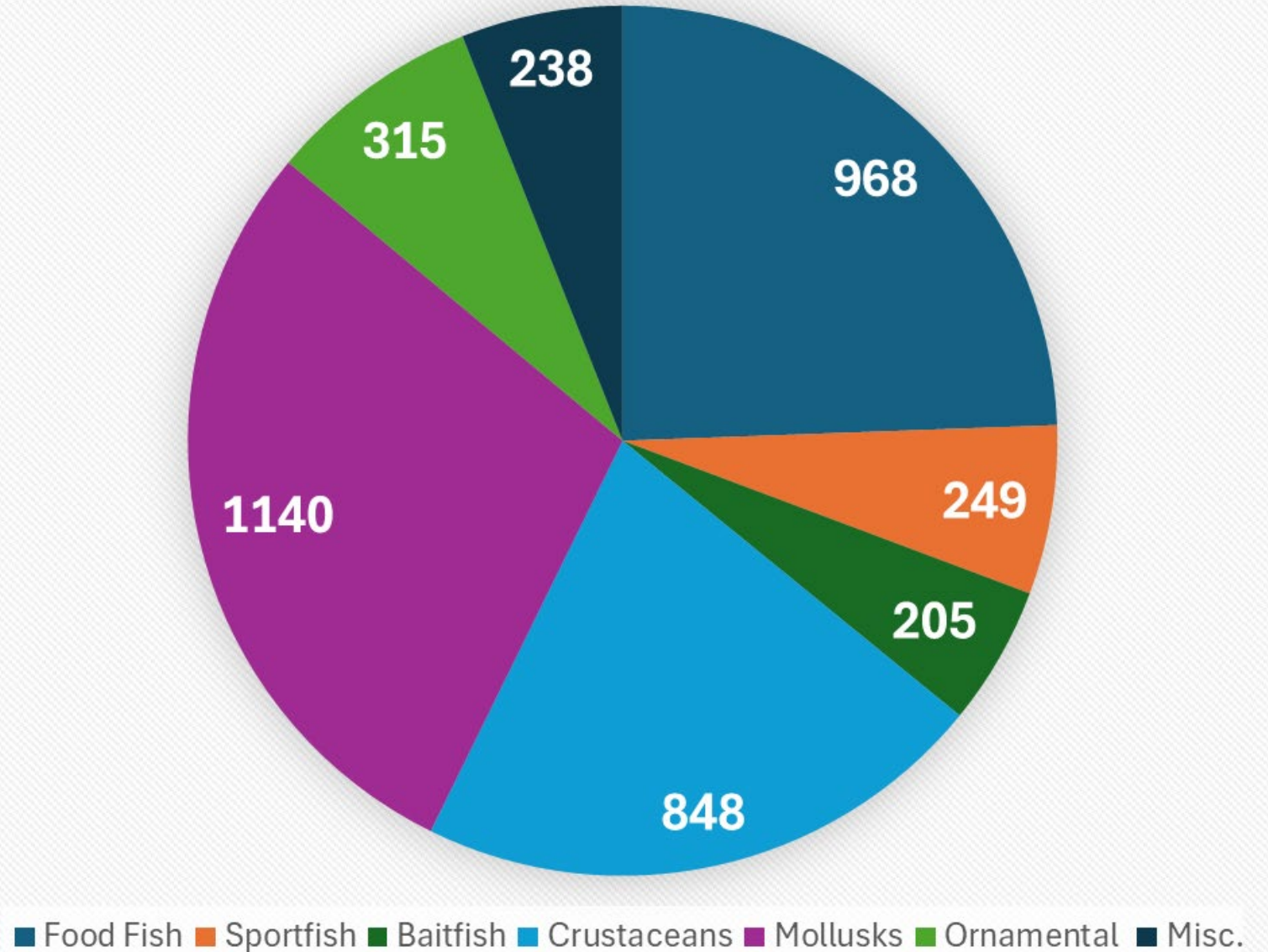


Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Census of Aquaculture, 2023.

Aquaculture Farms

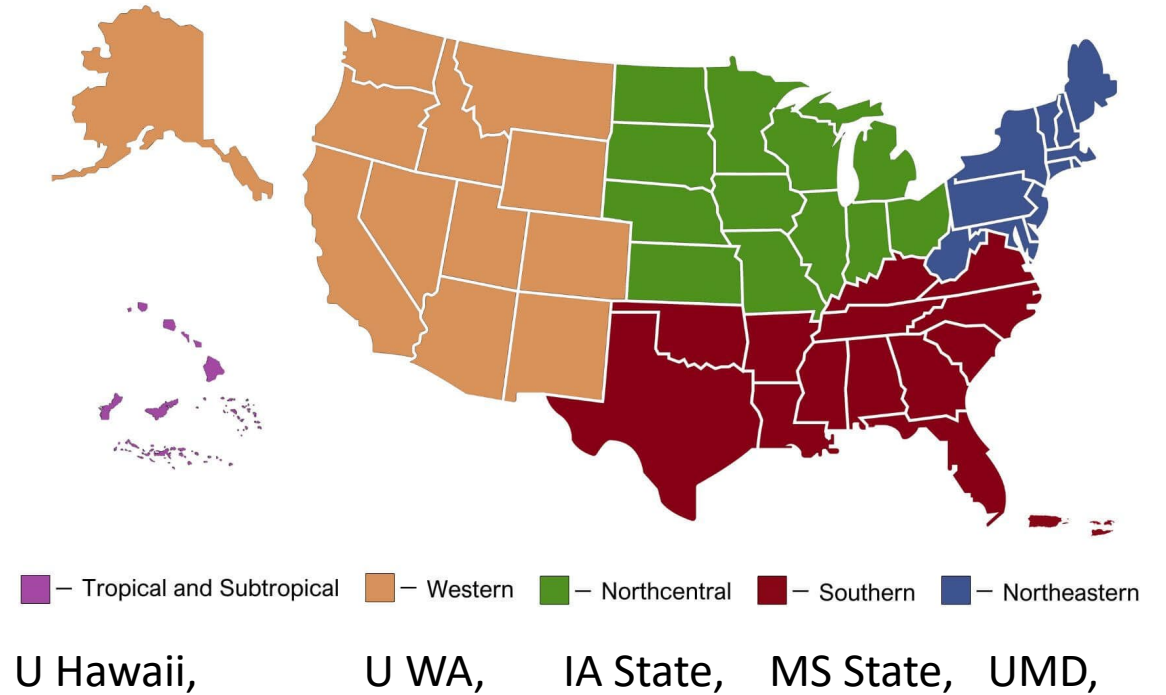
3,963

2023 Census of Aquaculture Number of Farms



Take Home Message

- Aquaculture in the U.S. is very diverse, and while it is concentrated in a few areas, all 50 states have at least one farm.
- USDA 2023 Census of Aquaculture has a treasure trove of information
- Information
 - Regional Aquaculture Centers
 - Extension, Sea Grant



Aquaculture Basics

- Water
- Food
- Oxygen
- Waste Removal



Water Sources

- Groundwater – wells and springs
- Rainwater
- Surface water – streams, rivers, lakes, and dams
- Municipal water
- Marine/Coastal water



Water Sources and Considerations

Source

- Groundwater – wells and springs
- Rainwater
- Surface water – streams, rivers, lakes and dams
- Municipal water
- Marine/Coastal water

Key Considerations

- Quality
- Quantity
- Temperature
- Water type

Water Quality Management

- Dissolved oxygen
- Temperature
- pH
- Alkalinity
- Hardness
- Ammonia
- Nitrite
- Nitrate
- Chloride



Aquaculture Feeds

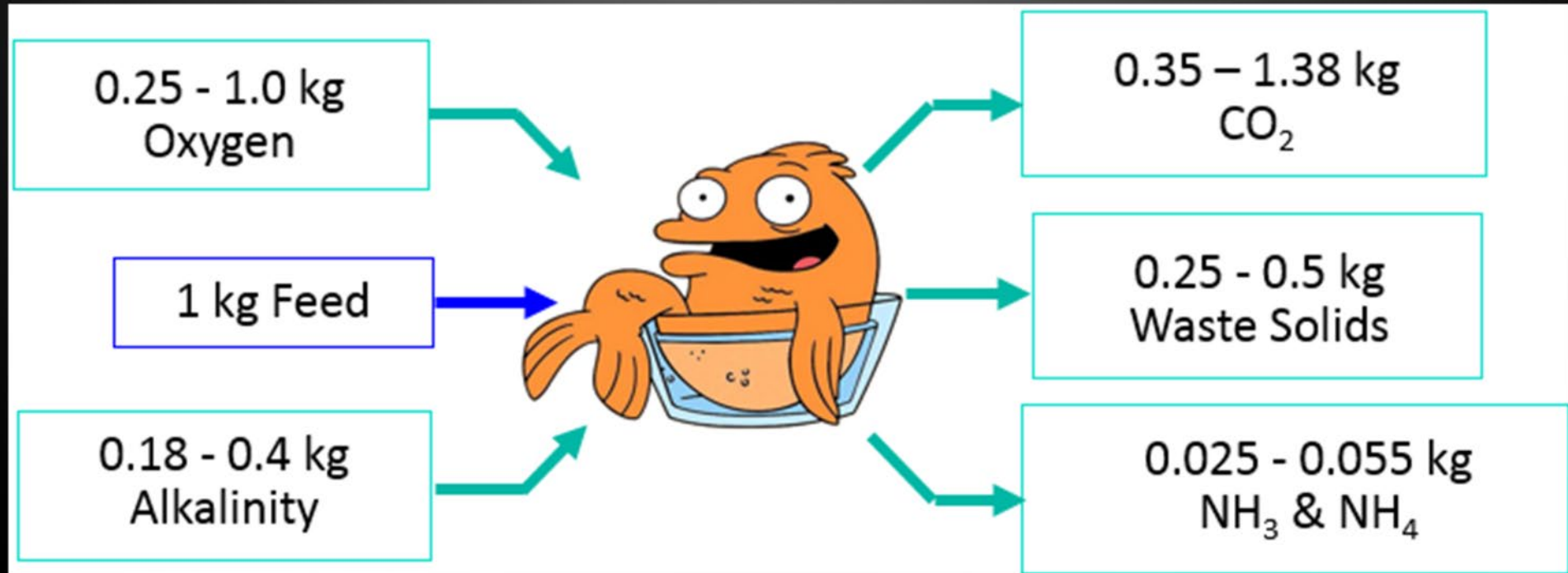
Feed is typically the highest production cost

Aquaculture diets vary by species. Common ingredients include:

- Corn
- Soybeans
- Wheat
- Fish Meal
- Fish Oil
- Vitamins and Minerals



FISH FOOD HAS AN IMPACT ON WATER QUALITY



“Feed formulation and feeding strategy directly influence waste loads. Better feed = cleaner water.”

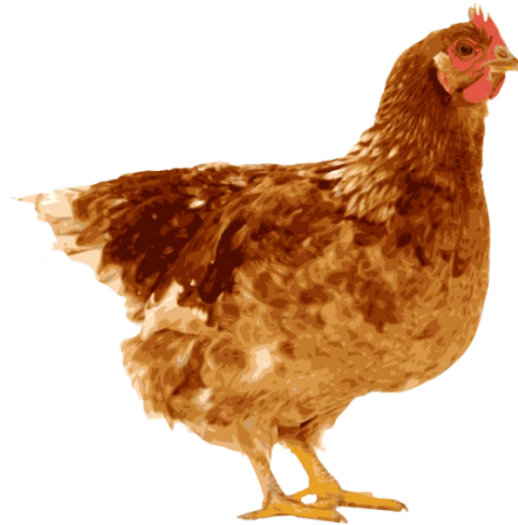
Feed Conversion



8 to 1



3 to 1



2 to 1



1.5 to 1

Dealing with Waste

- Ponds
 - Control overflow
 - 3,6 method
- Raceways
 - Settling ponds
- RAS
 - Filters – mechanical, biological
 - Sludge removal
- Aquaponics
 - Nitrification, plants, denitrification



Production Systems

- Ponds
- Raceways
- Recirculating Systems (RAS)
- Net Pens (Marine Cages)
- Shellfish Culture Systems
- Integrated Multi-Trophic Aquaculture

Ponds: Rectangular and Watershed



Water supplied by wells



Captured rainwater

Ponds

Pro's

- Forgiving
- Primary production system
- Production boosted with intensive aeration
- New pond systems evolving

Cons

- Water may be limited in some years
- Susceptible to off flavor
- Can be challenging to harvest
- Fish only grow in warm weather

Split Ponds



Raceways

Raceways are long, single pass culture units, typically constructed of concrete. They need a continuous, high-volume flow of water.

Production of 15,000 pounds of trout per cubic foot per second of water.



Raceways

Pro's

- High density possible
- Improved water quality
- Ease of feeding and harvesting
- Faster growth and better FCR
- Inventory control
- Simple disease treatment

Cons

- Limited suitable locations
- High capital costs
- Waste management issues
- Limited species suitability

Raceways



Recirculating Aquaculture Systems

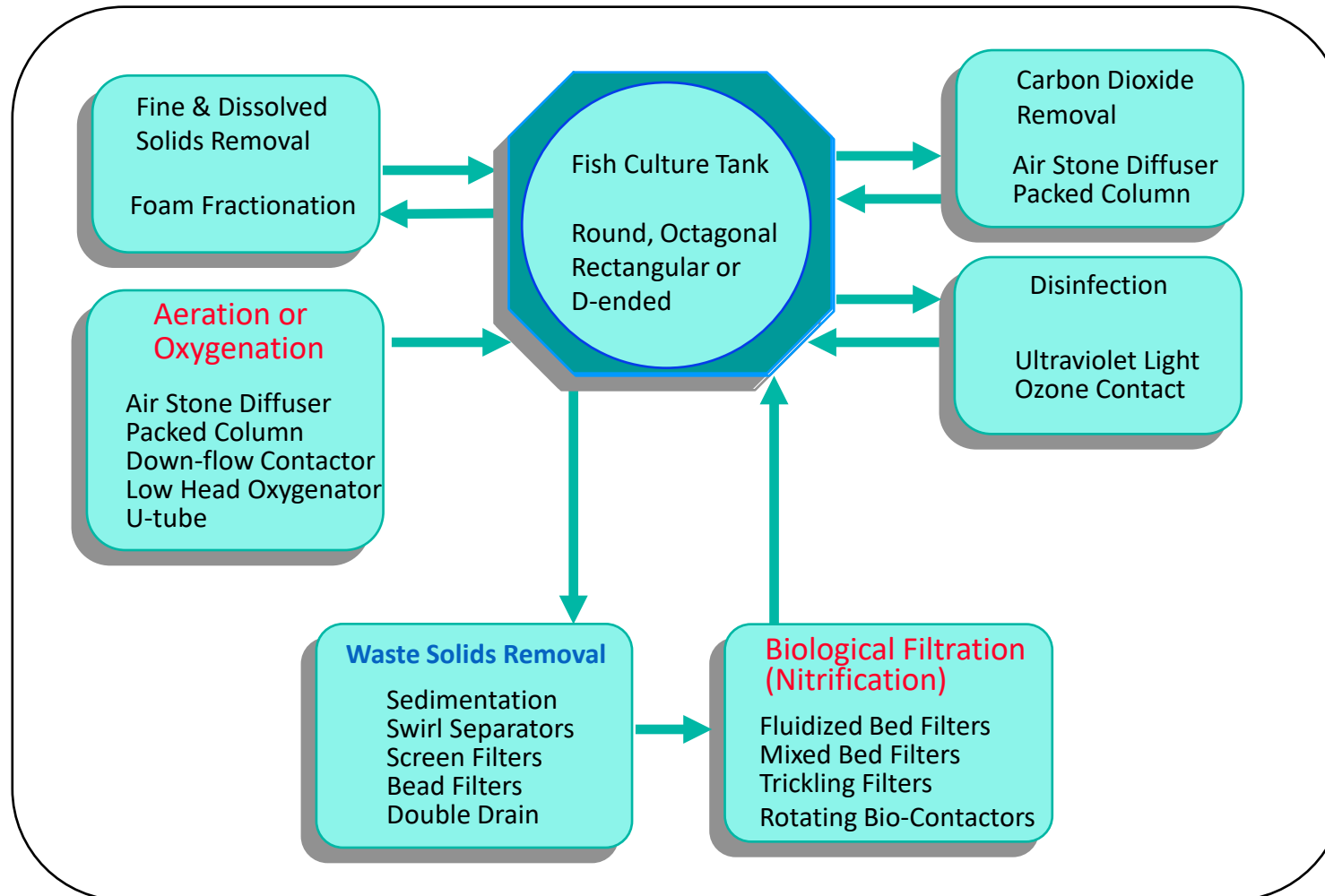
RAS are high intensity, controlled environment, closed-loop systems that continuously filter, treat and reuses water.

More than 90% water reuse

Production of 1.25 pounds of fish per gallon of water possible



Required Unit Processes



RAS

Pro's

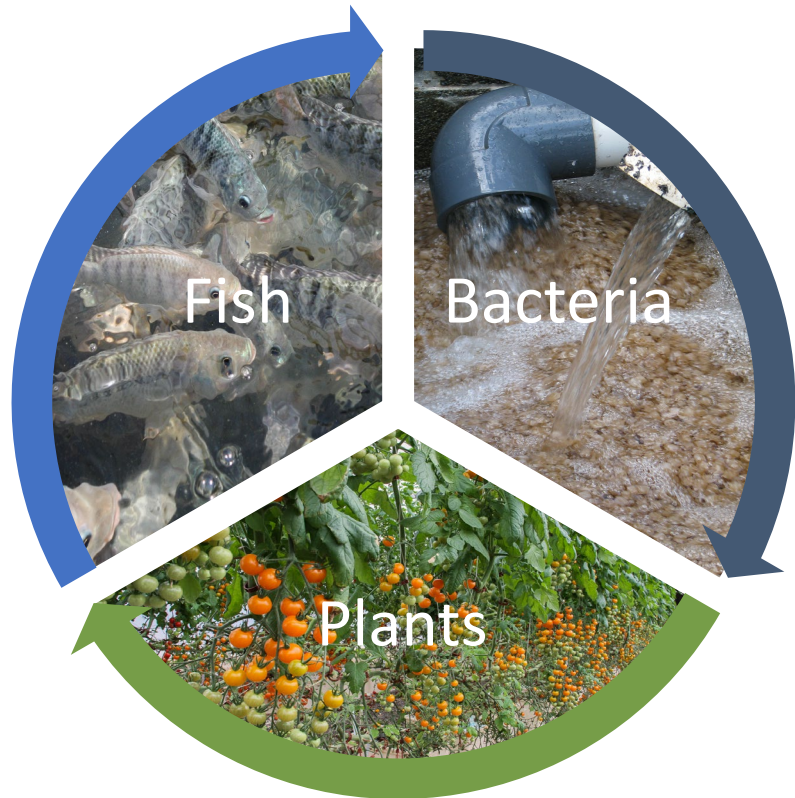
- Reduced Water Requirements
- Reduce Area Requirements
- Control of Temperature
- Potential for Water Quality Control
- Potential for Waste Capture
- Potential for Better Feed Conversion
- Isolation of Product (from disease & pollution)
- Better Inventory Control

Con's

- High Initial Investment
- High level management required
- Very Short Response Time (20-30 min)
- Very Poor "Track Record"
 - failures have been common (some very large)
 - hard to finance (because of these failures)
 - economy of scale (cannot be ignored)

Aquaponics

Aquaponics is a sustainable farming practice that combines aquaculture and hydroponics into a single, symbiotic, recirculating system.



Aquaponics

Pro's

- Uses 90% less H₂O than traditional farming
- Vegetable production up to 25X
- Grow almost anywhere
- Reduces cost of hydroponic nutrients
- Provides organic nutrients
- Eliminates soil born pathogens

Con's

- Can be complex to balance
- Need dual expertise
- Requires premium market
- Typically requires a greenhouse
 - More energy

Oyster Culture Methods

On Bottom



Off Bottom



On Bottom Oyster Gear

Place hard objects on bottom

Wild natural oyster larvae settle and grow



A clump of several healthy oysters from a restored reef in Harris Creek, Maryland. Credit: NOAA.



Off Bottom Oyster Gear

Australian long line system

Can be lifted out of the water



Off Bottom Oyster Gear – Floating Bags



Off-Bottom Oyster Gear

Floater keep oysters off the bottom

They can be flipped to dry off the oysters to prevent fouling

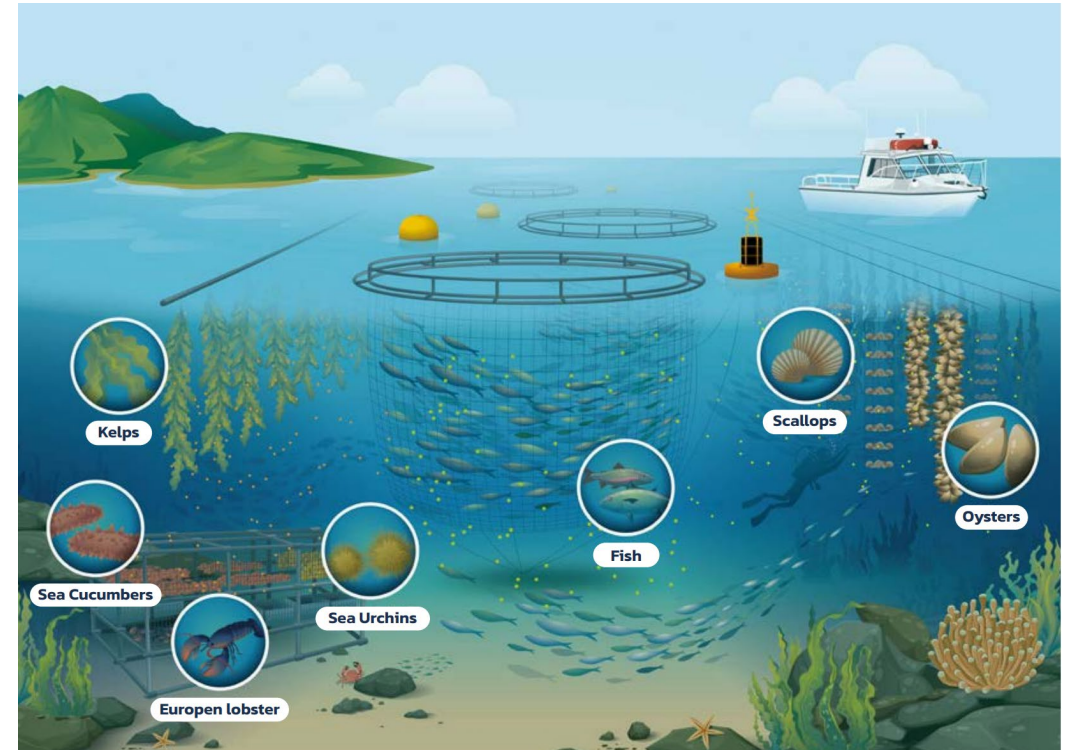


Other Culture Systems

Net Pens



Integrated Multi-Trophic



NRCS Aquaculture Related CPS

- [Aquaculture Pond \(CPS 397\)](#)
- [Fish Raceway or Tank \(CPS 398\)](#)
- [Bivalve Aquaculture Gear and Biofouling Control \(CPS 400\)](#)
- [Restoration of Rare or Declining Natural Communities \(specifically, oyster restoration scenarios\) \(CPS 643\)](#)

Species

Aquaculture Products

- Food
- Recreation
- Restoration
- Ornamental
- Medicinal
- Industrial
- Research



Potential Species = 1000+

Abalone to Zebrafish

- Catfish
- Tilapia
- Trout
- Koi
- Crawfish
- Bass
- Bluegill
- Bait minnows
- Freshwater shrimp
- Aquatic plants
- Goldfish
- Turtles
- Eels
- Carp
- Ornamentals (800+)
- Oysters
- Clams
 - Geoduck, Hard, Manilla
- Mussels
- Salmon
- Seaweed
- Crappie
- Cobia
- Shrimp
- Crawfish
- Freshwater Shrimp

Food Fish

Catfish

Trout

Salmon

Tilapia

Hybrid Striped Bass

Red Drum

Carp

Sturgeon

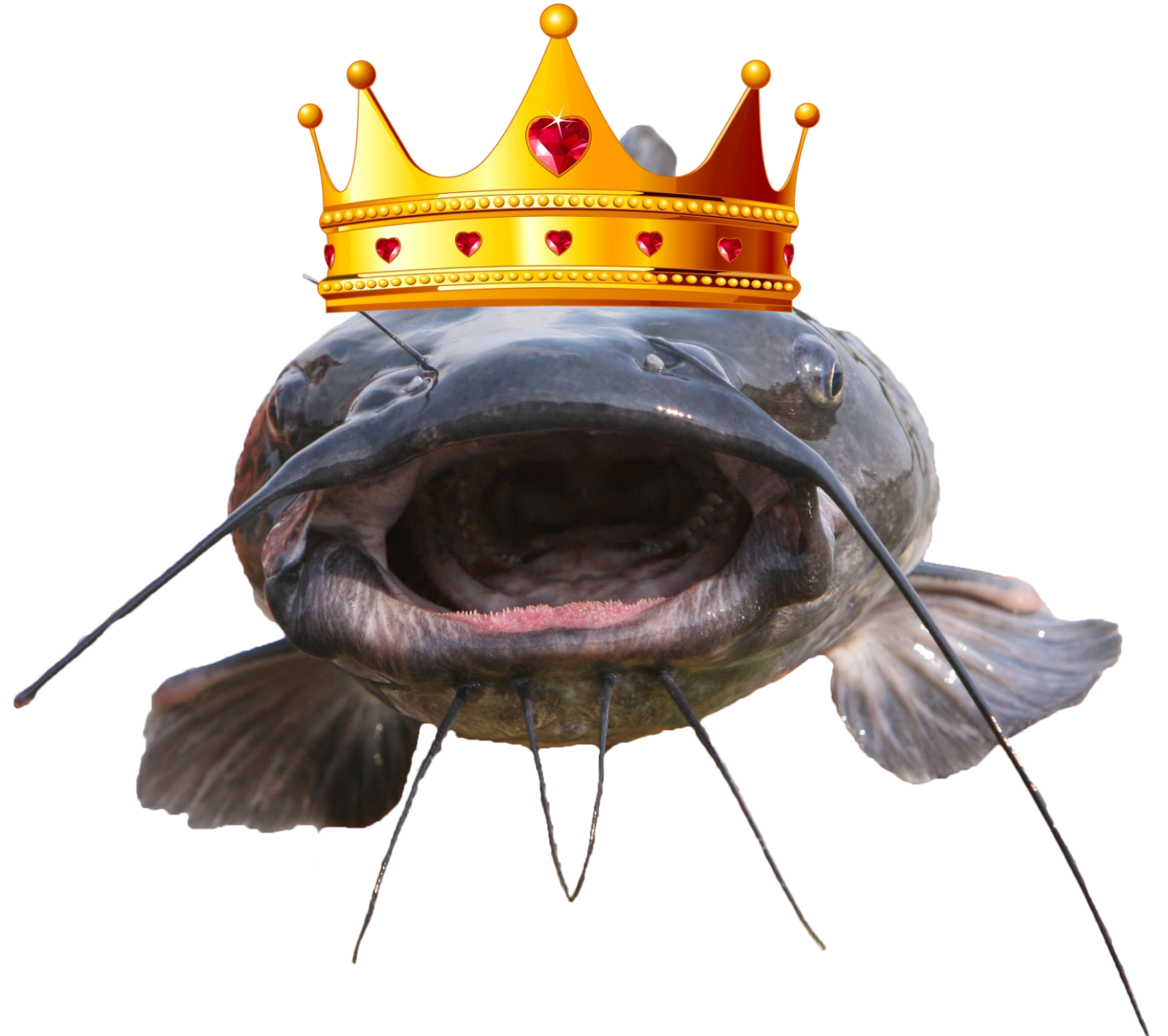
Grass Carp

Yellow Perch

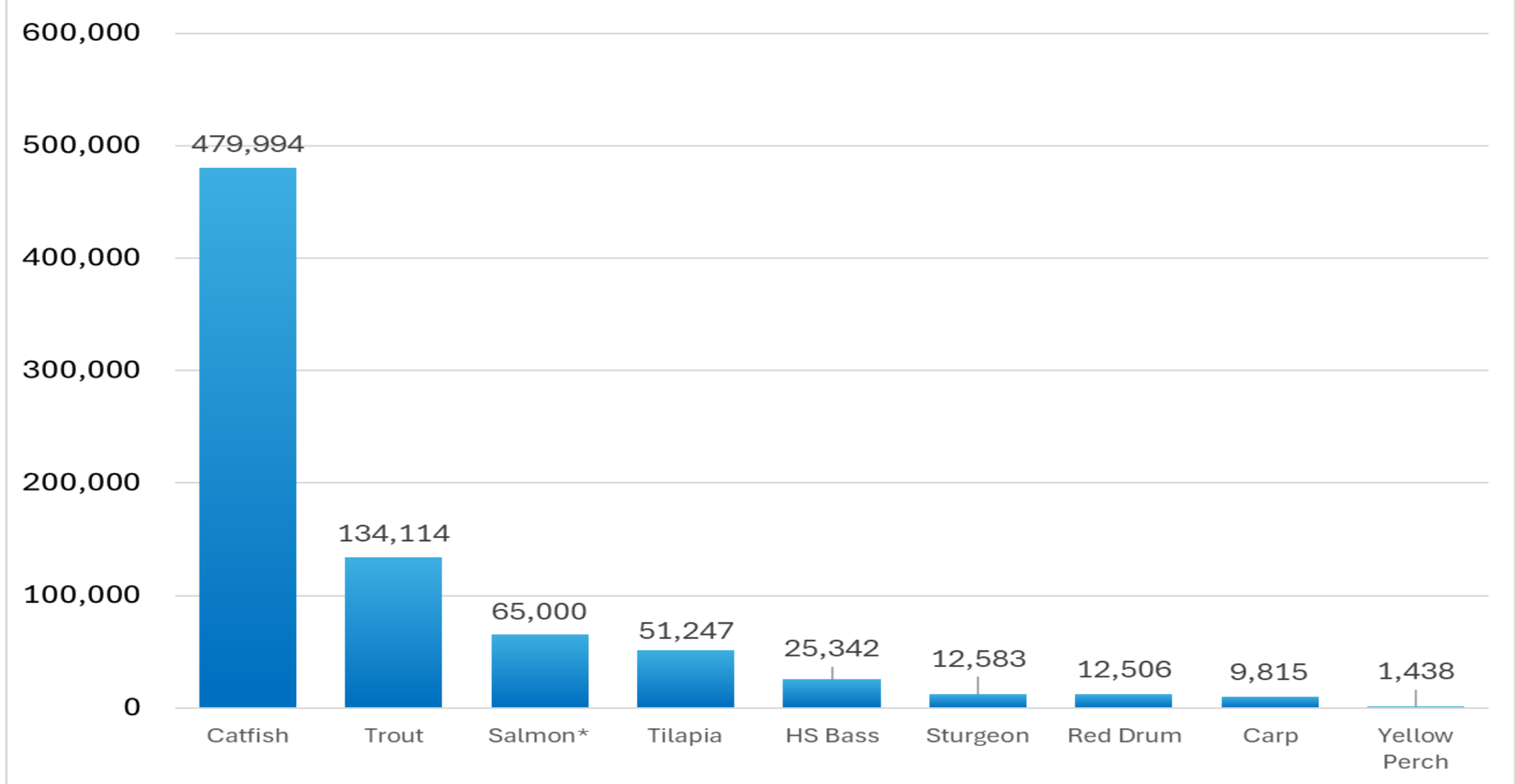
Flounder

Artic Char

Eel

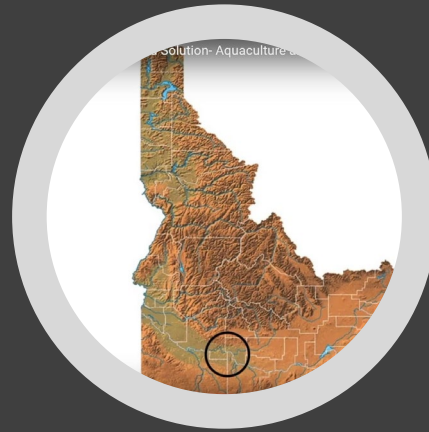


2023 US Food Fish Sales \$1000s



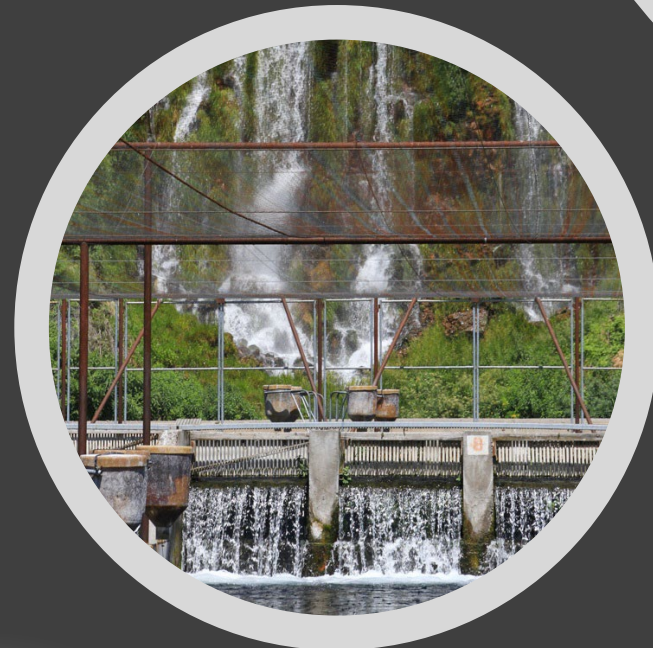
Trout Sales (2023)

\$116,704,000



Top Producing States (\$1000s)

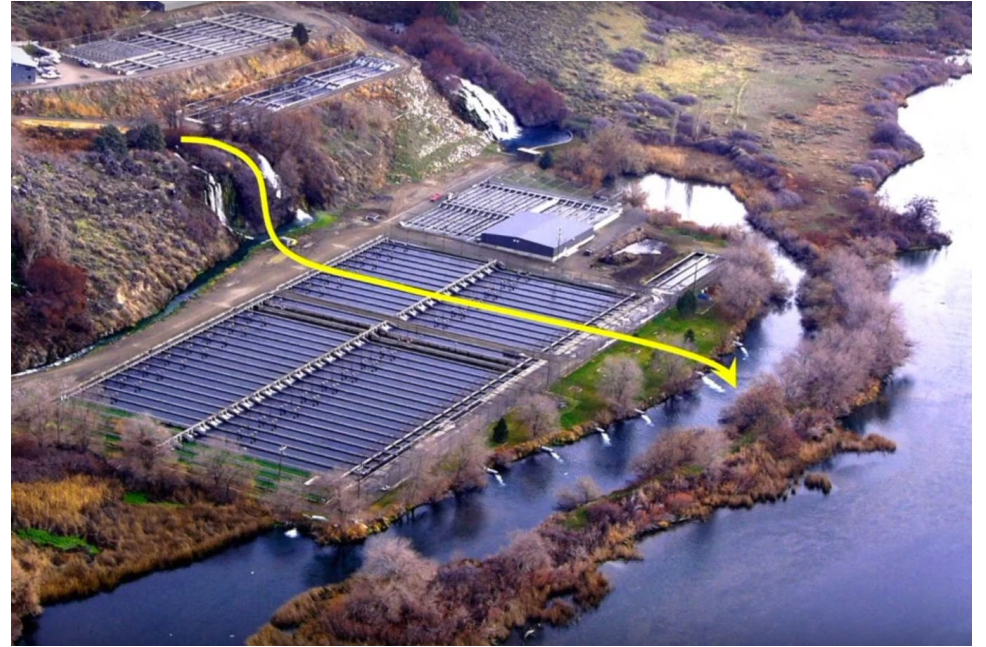
Idaho	\$37,953
Washington	*
North Carolina	\$15,649
Pennsylvania	\$8,496
California	\$7,439



*Undisclosed but \$26,153 in 2018

Trout Facilities

- Raceways
- Gravity fed
- Single pass system
- Oxygen increased by falling water
- Strict discharge standards





Salmon Sales \$61,000,000 (2019)

- Washington
- Maine
- Florida





Indoor Salmon Farms

Tilapia

\$51,247,000

- Tropical Fish
- Mostly Indoors
- Live Sales

Source: 2023 USDA Census of Aquaculture



Sportfish 2023 Value = \$54,400,000



Source: 2023 USDA Census of Aquaculture

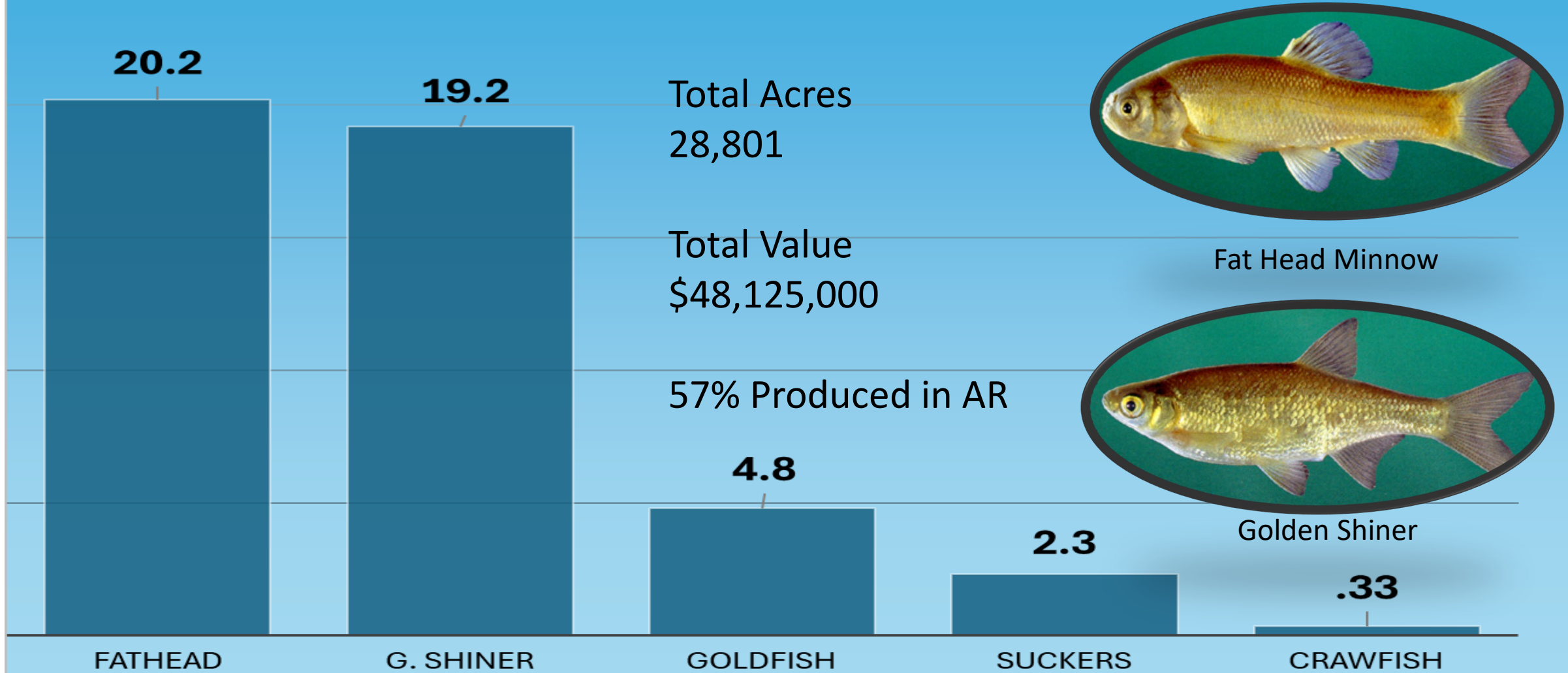
Sportfish Sales (\$1,000,000)



Top Producing States

Arkansas	\$15 million
California	\$14 million
Illinois	\$4 million

Baitfish Sales in \$ Millions



Source: 2023 USDA Census of Aquaculture



Mollusks

2023 Oysters – Top States – Millions in Sales

- Washington \$118.3
- Virginia \$35.2
- Massachusetts \$32.3
- California \$31.7

- TOTAL \$326,980,000



Source: 2023 USDA Census of Aquaculture

2023 Clams – Top States – \$Millions in Sales

- Washington \$111.5
- Virginia \$51.8
- Florida \$32.0
- Connecticut \$9.0

- **TOTAL = \$222,159,000**



Source: 2023 USDA Census of Aquaculture

2023 Crawfish Total Production = \$127,797,000

States Reporting Sales

AL	NE
AR	NC
LA	OH
MI	SC
MO	TX



Source: 2023 USDA Census of Aquaculture



2023 Shrimp Sales \$51,131,000

- States Reporting
- AL, FL, HI, ID, KY, MN, NE, SC, TX



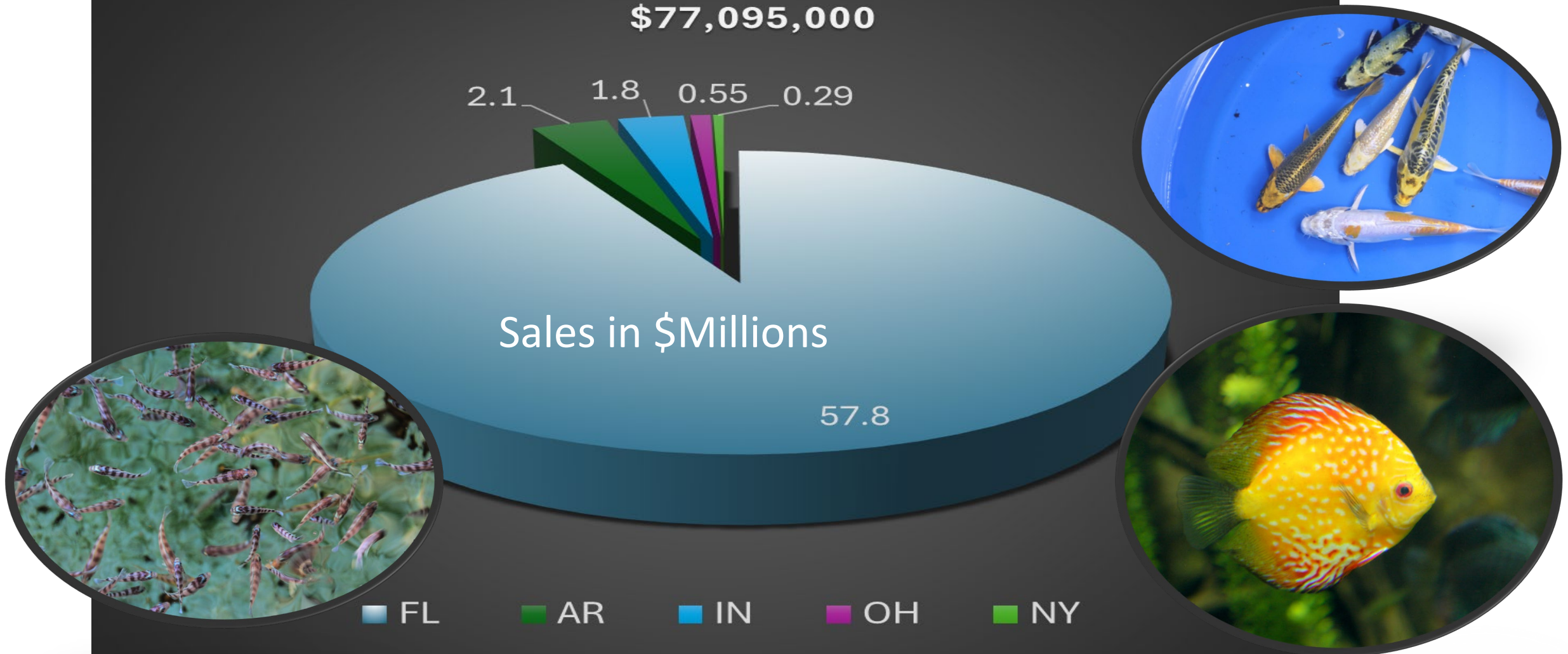
Freshwater Prawn 2023 = \$345,000

- Hawaii
- Ohio
- Texas



Source: 2023 USDA Census of Aquaculture

2023 Value of U.S. Ornamental Fish Production \$77,095,000



Source: 2023 USDA Census of Aquaculture



Other Species



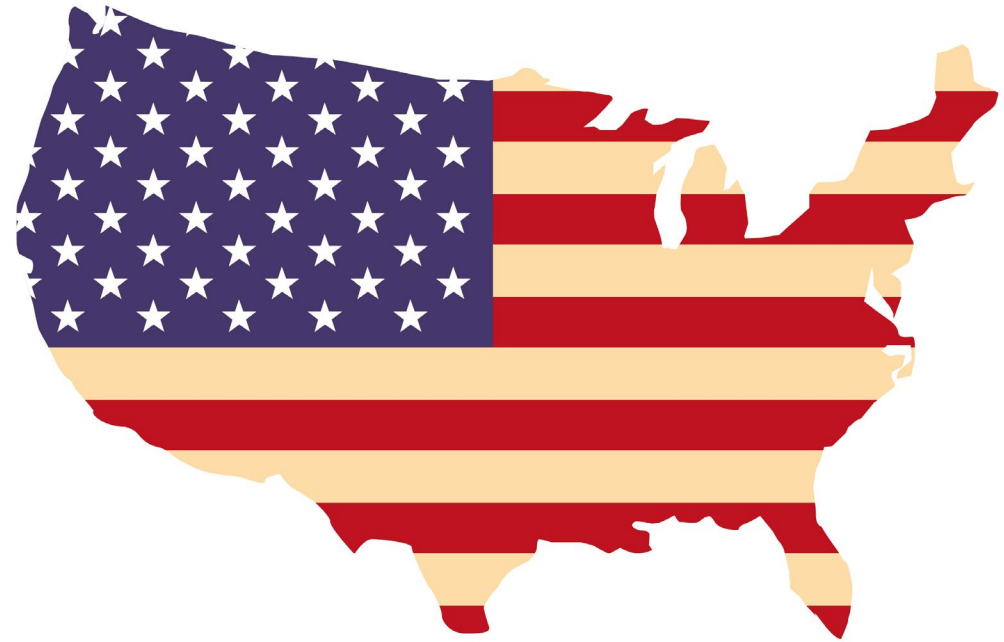
Limitations

- Permitting and Regulation
- Proposed Legislative Bans
- Environmental and Ecosystem Concerns
- Spatial Conflicts
- Socioeconomic and Political Factors
- Resource Limitations

20 Year Annual Growth Rate



8%



1%

U.S. Aquaculture is HEAVILY Regulated

National Authorities

- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- Army Corps of Engineers
- Environmental Protection Agency
- Department of Agriculture
- U.S. Department of Commerce
- U.S. Coast Guard
- U.S. Department of Labor
- FDA
- ISSC (International Ship Security Cert)

Regional Authorities

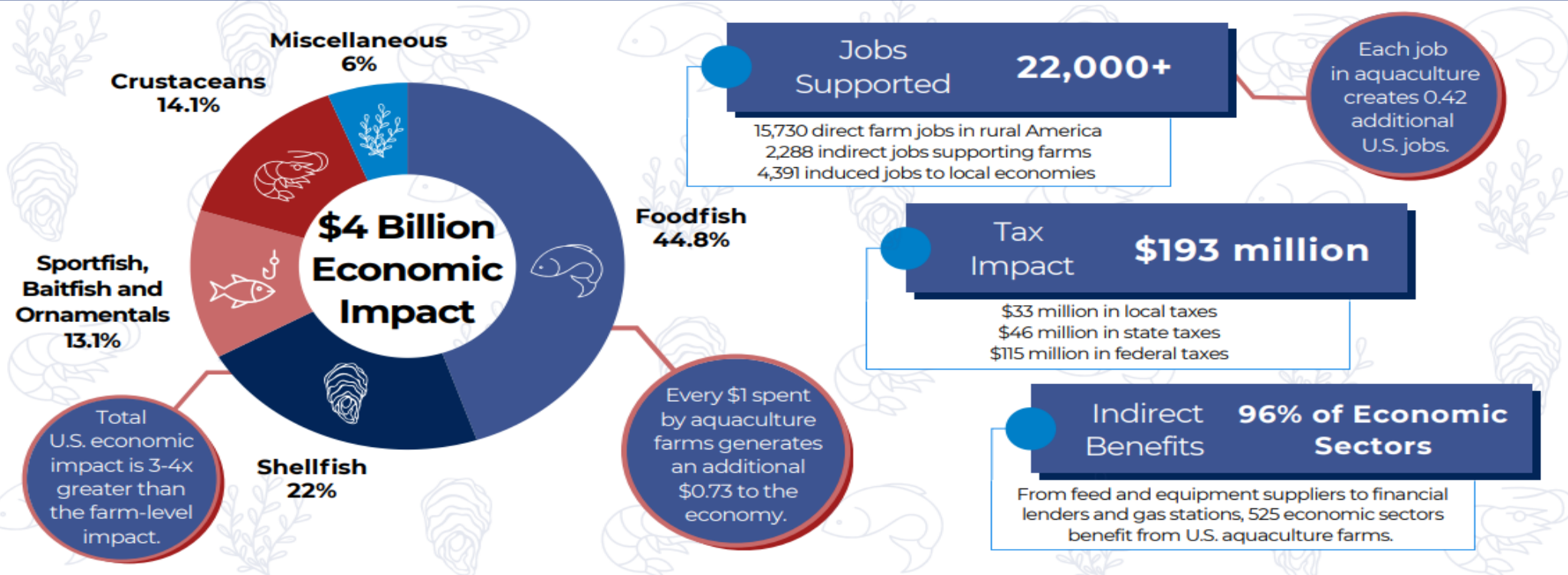
- New England Fisheries Mgt. Council
- Atlantic States Marine Fisheries Commission
- **State Authorities**
 - Dept. of Environmental Protection
 - Dept. of Marine Resources
 - Inland Fish and Wildlife
 - Dept. of Agriculture
 - Dept. of Health and Human Services

Wait.....There's MORE (Federal Oversight)

34

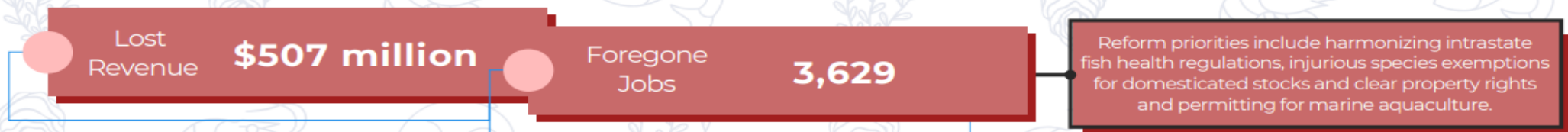
- Clean Water Act
- National Environmental Policy Act
- Coastal Zone Management Act
- Rivers and Harbors Act
- Endangered Species Act
- Lacey Act
- Migratory Bird Treaty Act
- Marine Mammals Protection Act
- Magnuson-Stevens Fisheries and Conservation Act
- Sustainable Fisheries Act
- Food, Drug & Cosmetic Act
- Nonindigenous Aquatic Nuisance Prevention and Control Act
- Federal Insecticide, Fungicide and Rodenticide Act
- Virus-Serum-Toxin Act
- Federal Sanitation Standards (HACCP) Regulations
- National Food Safety Act
- National Marine Sanctuary Act

Economic Contribution of U.S. Aquaculture Farms



Regulations are Impeding U.S. Aquaculture Development

In the U.S., regulatory complexity and compliance costs have resulted in loss of access to markets, lost business opportunities and thwarted attempts to expand current farms or establish new farms.



Opportunities

- Land and water resources in some locations
- Increased exports
- Value-added markets
- Research advances

Harmony of Aquaculture and Fisheries



THE U.S. ROLE IN GLOBAL AQUACULTURE

PRODUCTION

Moderate global producer
Regional leader, small global share

INNOVATION

Leader in RAS, feeds, technology
Strong research network

TRADE

Largest seafood importer (~17%)
Drives global demand

POLICY

Sets global standards
Food safety, sustainability

KEY TAKEAWAY: U.S. GLOBAL INFLUENCE COMES FROM MARKETS, INNOVATION, AND POLICY

ALABAMA A&M and AUBURN UNIVERSITIES

Questions?



In accordance with Federal law and U.S. Department of Agriculture (USDA) civil rights regulations and policies, this institution is prohibited from discriminating because of race, color, national origin, sex (including gender identity and sexual orientation), age, disability, and reprisal or retaliation for prior civil rights activity. Program information may be made available in languages other than English. Persons with disabilities who require alternative means of communication for program information (e.g., Braille, large print, audiotape, and American Sign Language) should contact the Alabama Cooperative Extension System Human Resources Department at (334) 844-5531 or the State of Alabama Governor's Office on Disability (GOOD) at (888) 879-3582 or USDA's TARGET Center at (202) 720-2600 (voice and TTY) or contact USDA through the Federal Relay Service at (800) 877-8339. To file a program discrimination complaint, a complainant should complete a Form AD3027, USDA Program Discrimination Complaint Form, which can be obtained online at www.usda.gov/oascr/how-to-file-a-program-discrimination-complaint from any USDA office, by calling (866) 632-9992, or by writing a letter addressed to USDA. The letter must contain the complainant's name, address, telephone number, and a written description of the alleged discriminatory action in sufficient detail to inform the Assistant Secretary for Civil Rights (ASCR) about the nature and date of an alleged civil rights violation. The completed AD-3027 form or letter must be submitted to USDA by mail: U.S. Department of Agriculture Office of the Assistant Secretary for Civil Rights, 1400 Independence Avenue, SW, Washington, D.C. 20250-9410; Fax: (833) 256-1665 or (202) 690-7442; or Email: program.intake@usda.gov. This institution is an equal opportunity provider.

CONTACT INFORMATION

David Cline

Clinedj@aubun.edu

334-844-2874

