
Know Your
Fish Farm
Paula Daniels

Know Your Fish Farm

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Why Fish?

What would it take to have a fish farm be part of a food hub? This was a question I was given the opportunity to examine when I was awarded the Stanton Fellowship of the Durfee Foundation. Why fish? It's a healthy form of animal protein. Why a fish farm? Our fisheries are stressed and our oceans are showing the impacts of carbon acidification. Aquaculture, or fish farming, can take place on land and through environmentally sound methods that produce a healthy form of animal protein using less water, feed, and energy than it takes to raise other forms of animal protein. Why me? As a Senior Advisor on Food Policy to Mayor Villaraigosa of Los Angeles, I've worked on creating and implementing strategies to develop "Good Food" systems, where food that is local, sustainably grown, fairly produced, healthy and affordable, can be available to all. In the course of this work I became convinced that we should make room in our food system for an emerging model of local food production and distribution, called a food hub. What is a food hub? A deliberately scaled and networked distribution system; a way to bring size to small scale. In other words, it is the farmer's market model writ larger. The greater increment is scale, and it has the potential to be created through a system called a food hub.

Why do we need this? As communities examine their participation in the food system, we grapple with the realization that our poorest communities suffer the worst health problems from having only the cheapest food available to them —junk food that is far from healthy. At the same time, smaller scale farms, most of which are growing healthy produce, struggle to bring their food to market. In reconciling the current largess of our food system with the imbalance at the struggling ends of it, the 21st Century model of a distributed network of smaller scale production, applies. Cities around the country are considering how to be better leaders in creating regional food systems that bring local, sustainably grown, fairly produced healthy food to the tables of those most in need.

This paper summarizes some of the key points I've gleaned from my two-year journey in the Stanton Fellowship, made possible by the Durfee Foundation, which believes in investing in possibilities. If one day, urban food consumers know the provenance of their fish through a local fish farm, as well as they now know the provenance of their fruit; if one day, a community struggling to afford access to healthy food can count on a regular dinner of locally grown fish and vegetables…then possibilities will have seen their promise.

Paula Daniels
January 2014

For more information, please go to www.KnowYourFishFarm.info

Aquaculture has been in practice for centuries, and definitions vary.

UN Food and Agriculture Organization

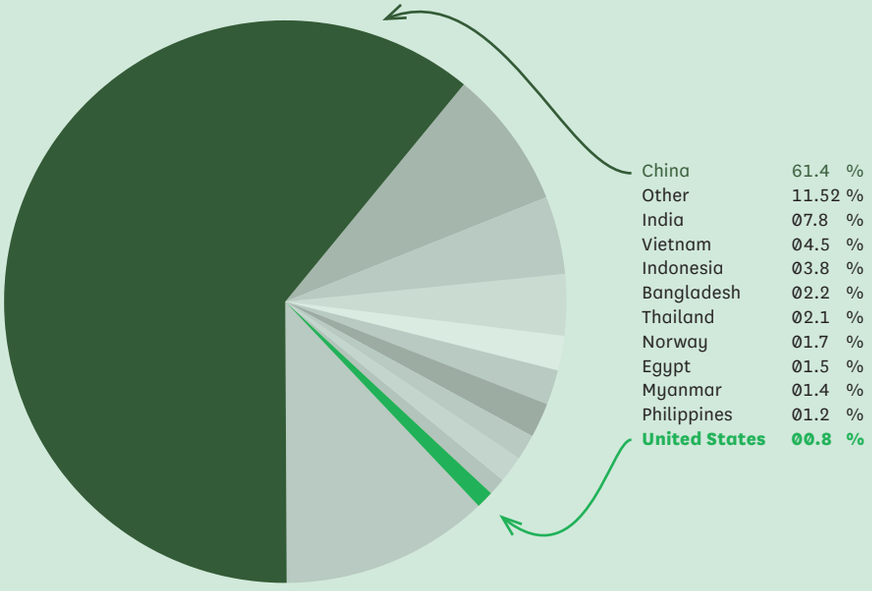
The farming of aquatic organisms in inland and coastal areas, involving intervention in the rearing process to enhance production and the individual or corporate ownership of the stock being cultivated.

US National Oceanic and Atmospheric Administration

The breeding, rearing and harvesting of plants and animals in all types of water environments, including ponds, rivers, lakes and the ocean.

USDA Economic Research Service

The production of aquatic animals and plants under controlled conditions for all or parts of their lifecycles.



US AND WORLD AQUACULTURE PRODUCTION, 2012

Source: UN FAO (2012). State of World Fisheries and Aquaculture.

A Bird's Eye View

THE POSSIBILITY The 21st century farm in a resilient modern city might be found in the middle of a mixed-use development with affordable housing —and it won't use soil. It might be very much like David Rosenstein's farm. David has his hands on a two acre parcel in a 500 acre redevelopment project near the San Francisco waterfront, and plans to develop a pilot greenhouse aquaponics farm that will supply the local market in this distressed community, with the very freshest catfish, lettuce, herbs and tomatoes. Aquaponics is the term for a farming practice that combines aquaculture and hydroponics into a combined system. David's farm will grow fish in tanks and use the waste from these tanks as a natural fertilizer for plants grown hydroponically (in water). The natural filtration of the plants' use of the water cleans it, and it is then returned back to the fish. It is a closed loop system that can provide a complete meal. In the city where Uber cab was launched, David hopes to bring local food to the uber level.

David learned about aquaponics when he was in documentary television production, researching environmental issues and solutions. He became convinced that it was "the most viable option" to meet the triple bottom line of sustainability: health of the individual, health of the community, and health of the planet. He left television and founded his Los Angeles based company called Evo Farm, through which he hopes to "cultivate resilient communities by producing high yields of produce that are distributed truly locally, using the latest technology." David is a 21st century farmer, at a quiet but leading edge of one aspect of our vastly complex food system.

As regions plan for climate change and struggle with food security, a path would be to create networks of ecologically sound food production. Fish farming is, and will be, an important part of the foodscape.

THE BIG PICTURE Fish is increasingly the farmed animal of choice in the world. With demand for seafood rising, and 85% of the world's fisheries under stress, farmed fish —aquaculture— has an important place in the food system, and can be produced in a manner that is sustainably sound. Projections for 2012 showed that aquaculture production surpassed that of wild caught fish,[1] and in 2013 the world produced more farmed fish than beef[2]. Fish farming is one of the fastest growing food producing sectors in the world[3] —but not in the United States.

While the U.S. is first in the world in beef production, and the world leader in agriculture with a record $140.9 billion in exports for 2013,[4] it is 13th in aquaculture, producing less than 1% of world output. China is the undisputed leader, producing over 60% of the world's farmed fish. The Food and Agriculture Organization of the United Nations estimates that in 2010, the total farmgate value of the aquaculture industry worldwide was $119.4 billion in food fish.[5] Food fish production in the US was $691,714,000 in 1998, and fell to $672,377,000 in 2005.[6]

The United States is the third largest consumer of seafood products (behind China and Japan),[7] yet we import over 90% of our seafood, and have been experiencing an estimated $10 billion trade deficit in seafood products —the second largest trade deficit in a natural resource product, second only to petroleum.[8] We are "fish dependent"[9] in the way that we are petroleum dependent.

This dependence is not only an economic concern, it is also an environmental one. It is widely recognized that the world's fisheries are stressed; the Food and Agriculture Organization of the United Nations has classified 85% of the world's fisheries as exploited (32% overexploited and 53% fully exploited).[10] Sardines have nearly disappeared from the west coast of North America, which affects fisheries up the fish chain, since sardine are not only baitfish but also common prey. In 2012 there was a sudden reduction in sea lion pups, possibly due to a declines in sardines and anchovies.[11] In addition to the depletion of our fisheries, our oceans are changing in temperature due to carbon pollution. The consequences to marine life are tragic. Ocean acidification threatens our shellfish industry and has been linked to massive loss of oysters.

As Mark Spalding, President of the Ocean Foundation, put it, we have "crashed the system on wild [fish]." The constraint on the ability of wild fish stocks to meet demand has given rise to the significant global production and trade in aquaculture products. Aquaculture now fills the global demand for seafood —but not without problems.

Over half of our seafood imports are farmed fish, mostly from countries where environmental and food safety regulations are not as stringent as ours. Farmed fish production in Asia, in particular, has been suffering a bad reputation among those who pay attention, due to widely reported issues with weak or no environmental regulations in those countries. Reports are of fish being grown in polluted water, destruction of mangroves for shrimp farming, and overuse of antibiotics and chemicals.[12]

We need to develop a local fish policy.

The struggle of the farmed fish industry in the U.S. seems counterintuitive when viewed in the context of how favorably fish compares to other animal proteins both in health benefits and the relative environmental impacts of farmed fish production. The American food system tilted out of nutritional balance in the last few decades, and the price of cheap food has become enormous from a public health standpoint. According to the Center for Disease Control and Prevention, more than one-third of adults in the United States are obese, one of the highest obesity rates in the world. Obesity has created a healthcare cost of $147 billion dollars, due to the correlation with heart disease, stroke and diabetes. Obesity has also become an epidemic of global proportions, largely due to the "low cost of energy dense foods" (also known as junk foods) which are increasingly available in the urban areas of developing countries.[13] Paradoxically, due to the lower cost of junk food, the highest rates of obesity are in areas of poverty.[14]

In addition to recent recognition of the expense of health impacts of junk food, we need to take into account the environmental cost of our food. The post-industrial revolution of 1960's in agriculture saw an increase in the efficiency of food production due to intensive

farming techniques, mechanization, chemical fertilizers and pesticides. But the resulting loss of species diversity to monoculture, and the impacts to public health and the environment as a result of the more industrial type of farming practices (which include use of chemical fertilizers, pesticides, and widespread antibiotic use) have received critical attention.[15]

In any form of food production, intensification of farming methods can bring complications, and aquaculture is no exception. There are several publicized environmental impacts of intensive aquaculture production: the flushing or runoff of improperly managed effluent from ponds into coastal or inland waters can result in eutrophication and algae blooms, which may threaten other species;[16] cage finfish culture and shrimp culture have been associated with significant coastal modification and heightened rates of erosion and runoff;[17] some methods of ocean aquaculture result in the mixing of wild stocks with farmed stocks, causing genetic modification as well as the spread of disease and parasites to wild stocks;[18] and many fish raised in aquaculture environments are carnivorous and require fish protein in their diets, often obtained by using fish meal or fish oil from wild fish, which contributes to the depletion of wild stocks.[19] However, a significantly developing body of university research is leading to improvements and the development of best management practices that are favorably noted by entities such as the Aquaculture Stewardship Council, the Global Aquaculture Alliance —Best Aquaculture Practices Program, and the Monterey Bay Aquarium Seafood Watch guide.

Overall demand for animal protein continues to rise in the US, and we are the second largest consumer of meat in the world (second only to Luxembourg).[20] Fish raised using sustainable aquaculture methods can provide a healthy animal protein source to U.S. consumers, with a lower impact on environmental resources than many other forms of animal protein production.

Often lost in the public discussion of aquaculture is the fact that aquaculture encompasses a wide variety of species and production methods. The most well known is the open ocean in net pens or cages, typical of salmon farming, which has received the most public attention and criticism. Shellfish (such as oysters and abalone) are raised in the coastal zones; many other species (such as catfish, trout and bass) are raised on land, in ponds or in tanks. Two methods of farm fish production are receiving notice as having the potential to lend themselves more readily to environmentally sound production practices. Both are land-based systems and are known as recirculating tank systems, and aquaponics.[21]

Recirculating tank aquaculture —in which fish are grown in tanks that recirculate the water— is considered environmentally sound for several reasons. It requires less water than other aquaculture systems; it offers the ability to control and monitor the inputs and outputs of the system and manage the quality of the water; the containment eliminates the concern about escapes of farmed fish from open ocean pens mingling with wild; and it requires less use of antibiotics to control disease because a farmer can shut down one of the multiple tanks typical in a recirculating farm system, if there is a disease outbreak.

Aquaponics builds on the recirculating tank method. It is a form of integrated production system that is growing in popularity around the country, and is the subject of study at a number of leading academic institutions. In aquaponics, water from the fish tank is used to grow plants in hydroponic, or water based, systems. The water from the plants is then returned to the fish tank. This type of production system, where fresh fish and vegetables can be grown in warehouses or greenhouses in cities and available locally, is sprouting up in cities throughout world and thousands of aquaponics systems of various sizes are in place in the United States, from Hawai'i to New York.

These systems can tie into a network of local food distribution that could serve as a food hub for communities. Regional food hubs are a business model supported by the USDA as a complement to the current food distribution system, and are an emerging model that offer supply chain infrastructure development, source verification for local foods, expanded markets for small and mid-sized growers, and increased access to fresh food in underserved communities.

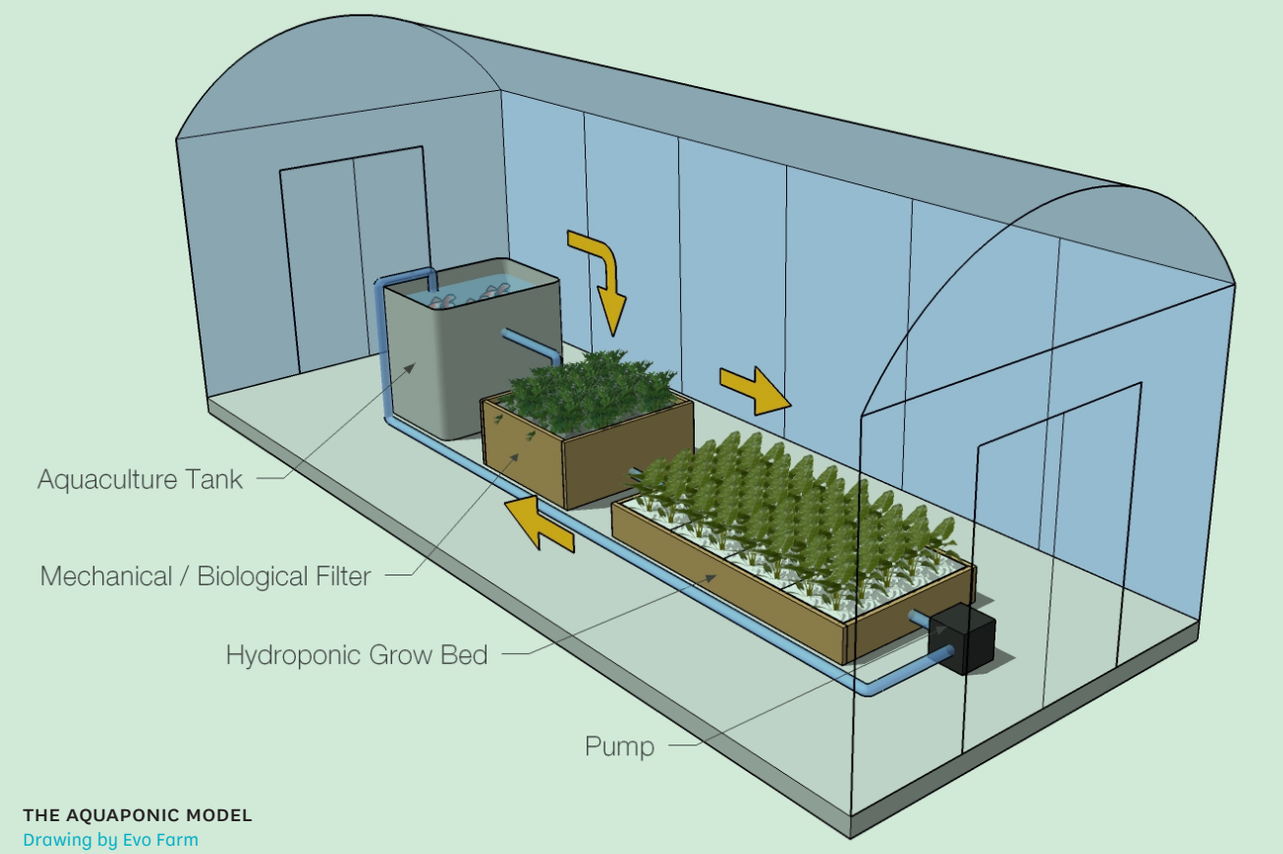
The potential exists to meet our needs where we find them, through local production tied in to a regional food system that could also address the more vexing problems in the food system: the lack of sufficient healthy food access in low income communities. Fish and vegetables are known to be healthy food staples, yet sustainably produced fish and produce are often less available and less affordable in disadvantaged communities, largely because the economies of scale that produce cheaper food often are the result of shortcuts around sustainability. A way to address this is to provide the aggregation service of a food hub. The resulting potential is a complete food system, grown locally, sustainably, and available to all.

Between here and there is a complicated range of issues in commercial fish production, a resulting complexity in governance and oversight of the field, and little funding for aquaculture development.

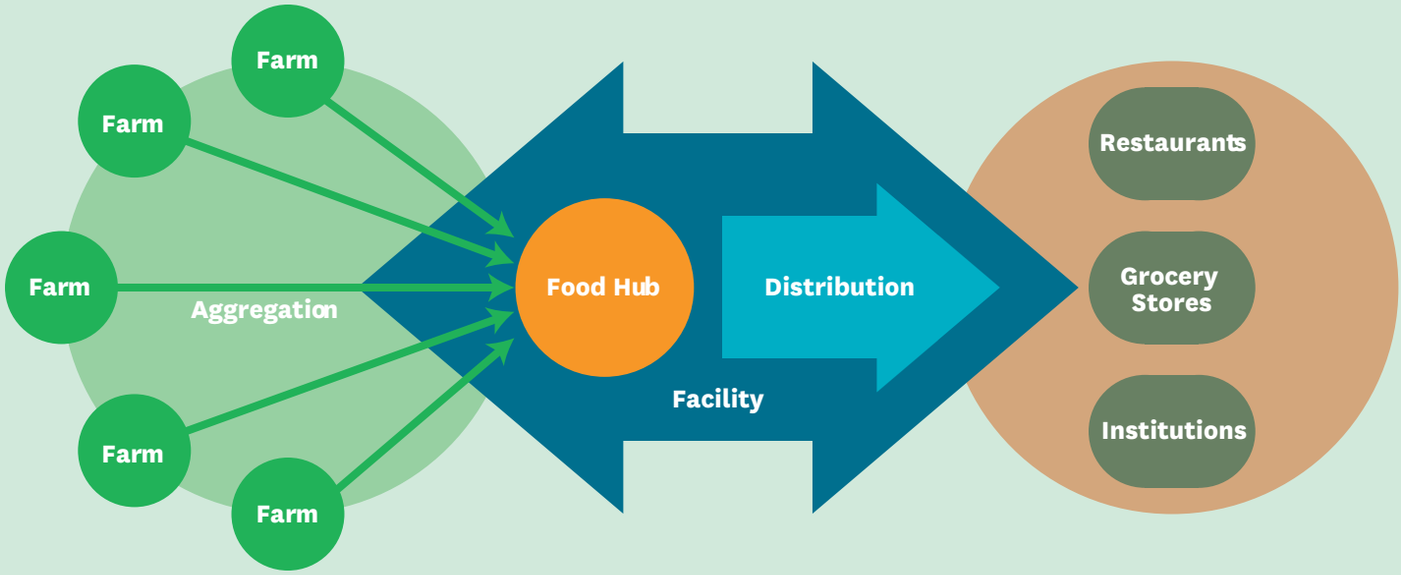
But there is a rising tide. In June of 2013 the US Conference of Mayors unanimously passed a resolution entitled "Support for Urban Aquaculture Development" which calls for federal funding for aquaculture development; federal, state, and local funding for research and development of sustainable feeds; development of national organic standards for aquaculture products; the streamlining of regulations and zoning ordinances by cities to encourage aquaculture production, and the development of markets for sustainably produced aquaculture by cities.[22]

How can we make this good idea a reality? We can start by knowing our fish farms.

Know Your Fish Farm



THE AQUAPONIC MODEL
Drawing by Evo Farm



THE FOOD HUB MODEL
Source: Adapted from Craig Page

What We Can Do Better to Make Aquaculture Great?

The Investment Advisor

Zack Porter's appetite for risk is as big as his appetite for the ocean. He embraces it fully, respectfully, and intelligently —and then enjoys the ride of a big reward. Zack grew up wanting to start a business, and wanting it to involve the ocean he loved in all the ways a person can. Spearfishing, sailing, surfing —if there is any way to sing a full volume song of the ocean, Zack will find it. He merged his passion for the ocean with a business degree at the University of Southern California, and as part of a self-initiated class project volunteered with the research laboratory of oceanographer Will Berelson.

As part of his work he had the opportunity to interview dozens of scientists at major oceanographic institutes around the world. Knowing that he wanted to start a business that related somehow to the oceans, he asked them for the top 10 industries to watch for with the greatest growth potential.

Aquaculture was on everybody's list.

Zack became an operating partner at Pegasus Capital Advisors, focusing on investments in aquaculture and agriculture worldwide. He is now a director at Proteus Environmental Technologies. Since Zack's survey, the forecast has proven true: 2012 was the first time in world history that aquaculture production surpassed wild catch of fish. But this is because of overseas production, as US production has flatlined.

Frustrated with those who consistently choose wild caught over farmed at fish counters and in restaurants, Zack states: "It's a false reality we live in if we think that eating wild caught is better for the planet, because there aren't many wild caught fish left. Aquaculture is already over 50% [of fish produced worldwide] and will only grow. We are beyond the moral debate, if you will; it's now a matter of how we do it and what we can do better to make it great —how we need to focus our efforts to get there."

Rising Tide

"So you say you want a blue revolution?" wrote fisheries expert and author Michael Weber in a 1996 article for Amicus Journal, about aquaculture and its potential.[23] Noting the stresses on ocean fisheries he asked whether aquaculture could satisfy the world's appetite for fish, and if so, what kind. Everything old can be new again; for example, we once thought of white bread as better than whole grain, but public health officials have caused us to reconsider and we now have a multitude of varieties of multigrain bread. In a way that could be the best thing since sliced bread, some ancient methods of fish cultivation are emerging in new ways, particularly in urban areas.

In 2003, Weber identified land based, recirculating tank aquaculture as a promising option. Weber also reported about closed loop aquaculture alternative practices that mimic the natural systems on a small scale. More typical of developing countries, the closed loop systems reported by Weber use human or animal waste as natural fertilizer for fish in ponds, and livestock waste to fertilize trees and vegetables. Such systems, he noted, can produce yields of 1,000 to 9,000 pounds per fish acre per year.[24]

The Food and Agriculture Organization of the United Nations (FAO) has also highlighted this production method in its many reports regarding aquaculture. In its 2009 report "Integrated Mariculture: A Global Review" it defined Integrated Multi-Trophic Aquaculture, or IMTA, as an emerging system mimicking the historically well-known Asian village practice of raising rice and fish in the same system.[25] The system has "an explicit incorporation of species from different trophic [feeding] positions or nutritional levels in the same system;" in other words, it is a diversified system in which animal waste can feed fish, fish waste can feed plants, and in the process nothing could really be called waste anymore, as everything would be put to a beneficial use.

At North Carolina State University, preliminary work is being done on studies to see if such a system could be applied in a commercial setting. Scientists propose to determine if post-harvest water drained from fish ponds can be used for poplar trees. In addition to the natural filtration provided by this tree system, the woody biomass produced by the trees will be used for cellulosic ethanol. This type of closed loop practice would also create resilience in the system and a buffer against risks such as a price change in one of the species or a devastation of one of the crops.

An example of the lack of resilience in a conventional monoculture system was the devastation wrought by the 2012 drought, which resulted in severe losses of corn crops. Corn is a prime source of animal feed, so this crop loss also caused a change in poultry and beef prices.[26] The economic impact did not stop there, as large payments of federally funded crop insurance were made to the Corn Belt farmers.[27]

Leaders around the world are calling for a more adaptive strategy that would make room for a new model. In a 2011 speech to the Future of Food Conference at Georgetown University, Prince Charles of Wales discussed the need to make our food production systems more resilient and responsive to their environmental context:

Essentially, we have to do more today to avert the catastrophes of tomorrow and we can only do that by reframing the way we approach the economic problems that confront us. We have to put Nature back at the heart of the equation. If we are to make our agricultural and marine systems (and therefore our economies) resilient in the long term, then we have to design policies in every sector that bring the true costs of environmental destruction and the depletion of natural capital to the fore and support an eco-system based approach. And we have to nurture and support the communities of small-holders and family farmers.[28]

The United Nations Conference on Trade and Development agrees. Its report "Trade and Environment Review 2013" called "Wake Up Before It Is Too Late; Making Agriculture Truly Sustainable Now for Food Security in a Changing Climate" called for, among other things:

A paradigm shift in agricultural development: from a 'green revolution' to an 'ecological intensification' approach. This implies a rapid and significant shift from conventional, regenerative production systems that also considerably improve the productivity of small-scale farmers. We need to see a move from linear to a holistic approach in agricultural management, which recognizes that a farmer is not only a producer of agricultural goods, but also a manager of an agro-ecological system that provides quite a number of public goods and services (e.g. water, soil, landscape, energy, bio-diversity and recreation.[29]

The report called for a two-track approach that reduces the environmental impact of conventional agriculture while broadening the scope of agro-ecological production methods.

These concepts are more than wishful thinking. A recent USDA study proved that high diversity crop rotations can provide higher yields than conventional farming systems while reducing the need for synthetic fertilizers and herbicides.[30] "All these characteristics are aspects of increased system resilience," said professor Matt Liebman, who led the project.[31] The Rodale Institute in Pennsylvania recently completed a similar study covering a thirty-year span, finding that organic yields match conventional yields in normal years and outperform conventional yields during drought years.[32]

Farms of various sizes, using these sustainable production methods, can tie in to a network, as also recognized by chef Erik Oberholtzer of the Los Angeles restaurant chain Tender Greens. In December of 2013 he wrote about urban aquaponics farms, describing them as a balanced system that does not need the same chemical inputs that large-scale production often requires. "We imagine a day," he wrote, "when Tender Greens develops a network of aquaponic farms in every city we do business so that

we always enjoy a consistent supply of locally grown, organic fish and vegetables without disrupting our taxed environment."[33]

Imagine further, if the network served the most disadvantaged communities of a city, the places hit hardest by low incomes, low investment and the lack of open space, where obesity and diabetes rates are worst, but where an aquaponics warehouse could bring a needed source of fresh food and healthy animal protein to communities that have historically had little access to both.

It would be the best thing since sliced multi-grain bread.

THE 21ST CENTURY FARM In the few years since he founded Evo Farm, David Rosenstein has become known in California as a leading expert in aquaponics, and is chair of the western region of the Aquaponics Association. His company designs, builds, and consults on aquaponics facilities. He guided a team of Los Angeles Unified School District students in the design of a greenhouse aquaponics facility on the grounds of Westchester High School. It became a highlight of the 2013 Aspen Ideas Institute.[34] On the project's Facebook page is a quote from Robert Louis Stevenson: "Don't judge each day by the harvest you reap but by the seeds you plant."[35]

David sees aquaponics as the best "of all the food production methods because it has the highest yields and uses the least amount of water with no waste. With live fish in the system, chemical use is simply not an option." Since 2013 was the driest year on record in Los Angeles, and with increasing uncertainty about the impacts of climate change, water efficiency in food production is paramount. He acknowledges that a number of aquaponics facilities are currently "recreational," or hobby farms, but he is among many whose goal is to bring greater commercial viability to the field. He is working closely with researchers from the University of Southern California and plans to open a research lab to answer the technical questions about aquaponics.

Evo Farm is one of the hundreds of aquaponics operations around the country being tracked by Marianne Cufone, founder of the Recirculating Farms Coalition. An environmental lawyer, Marianne became aware of recirculating aquaculture through her years in fisheries work, first at the Center for Marine Conservation, then at Food and Water Watch. Noticing that the U.S. was behind the rest of the world in recirculating farm production, she decided to found an organization to help bring the U.S. to pace with Norway, Israel, India and Dubai.

Marianne also believes that aquaponics is an important supplement to our traditional food system, which leaves socially disadvantaged communities in the dirt. "We have a soil culture in the US," she said. We are oriented to believe that soil is the basis for life "but actually, water is the stuff of life." Growing food in water is a good option when soil cultivation of food is not practical —as is the case in paved over cities.

She researched and analyzed a number of US cities that might be good testing grounds for the concept, looking at characteristics such as poverty, unemployment, obesity, and income disparities. She landed on, and then in, post-Katrina New Orleans. In addition to being a distressed area ready to rebuild, the soils in New Orleans were contaminated, rocky or paved over. In other words, it was a good place for proof of concept. It is now her home and since 2011 has been the headquarters for her organization.

The aquaponics vision has been embraced by the community. Concentrating her efforts in seven areas, (including the 9th Ward which was hard hit by the 2005 hurricane), Marianne has recirculating systems "popping up all over" and conducts training classes with growing attendance.

David and Marianne agree with the general view that aquaponics is not "mainstream" yet, and that a deliberately supportive distribution model is needed before it can be. As David observed, farmers know how to grow food but not necessarily how to distribute it.

Excerpt from Funge-Smith, S. Phillips, M.J. (2001). "Aquaculture systems and species." In R.P. Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery & J.R. Arthur, eds. Aquaculture in the Third Millennium. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. pp. 129-135. NACA, Bangkok and FAO, Rome.

Future Developments in Systems and Technology

Crucial positive trends are the integration of pond systems (with other agriculture and water-using processes), reuse of water, and recirculation. For example, a recirculation system can achieve 150L water per kg of fish, or 40L per kg with a de-nitrification unit...

Integration of Aquaculture into Other Systems
Many "outputs", often called "wastes" or "byproducts" of farming subsystems, can become basic inputs for other subsystems rather than just additive components of the overall farm economy.

There are examples of such integrated systems. Dual pond systems in Israel, for example, link irrigation water storage with aquaculture ponds, with seasonal transfers according to respective needs of irrigation and culture. Cages placed within reservoirs and ponds can also provide integrative processes on a small scale, making more effective economic use of the water resources as a whole.

Veta La Palma

A 27,000-acre aquaculture farm in Spain called Veta La Palma has received the praise of New York chef Dan Barber, who praised their results in a 2010 TED talk titled "How I Fell in Love with a Fish." The fish are raised in a symbiotic multi species (multi-trophic) system that includes a bird sanctuary, and feeds the fish with the type of animal by-products it would eat in the wild, but derived from other species in the farm, apparently mimicking the cycle of feeding from nature.

Swimming with the Fish

Among the obstacles that operators of recirculating tank fish farms face when they try to start a facility in an urban area, is the current lack of recognition in building codes and city ordinances about the new method of fish production, or the fact that fish is not fowl.

In Chicago, at an artisanal production facility called The Plant, the operators of aquaponics farm Greens & Gills had to seek a change in the laws that prohibited raising livestock, including fish, for sale within the city limits.

Rob Ellis of Astor Farms in Charleston, North Carolina was told by city staff that he had to classify his recirculating tank farm as a swimming pool in order to get a permit. (see http://www.southernfriedscience.com/?p=12762). Wading his way through the various odds and ends of ill-fitting regulations, Ellis now has a thriving tilapia farm, selling to restaurants and farmer's markets.

With the increasing interest in urban agriculture, efforts are underway to identify and update city regulations to support local aquaculture as well. (See, for example, the SPUR Report "Public harvest: Expanding the Use of Public Land for Urban Agriculture in San Francisco" (2012), at page 26-27.

AN AQUAPONICS FARM IN MOUNT KISCO, NY
Photo taken by author at Cabbage Hill Farm, NY

A RECIRCULATING TANK FARM IN TURNER FALLS, MASSACHUSSETTS
Photo courtesy of Australis Aquaculture

A Model
The Common Market, Philadelphia

From *Good Food for All People: Food Hubs at Work in Philadelphia*, January 27, 2012, by James Barham, Agricultural Economist, Agricultural Marketing Service, USDA

"There are many communities across the country grappling with limited access to affordable, fresh fruits and vegetables at a time when these same communities are fighting rising rates of childhood obesity, type 2 diabetes, and other diet-related illnesses. The very definition of community —that inter-connectedness between residents, businesses, hospitals and schools— means that health or food issues that affect one part of the community can have a negative impact on the rest.

"At USDA's Agricultural Marketing Service (AMS), we are examining food hub distribution models of all shapes and sizes —finding ways to compliment and supplement existing food systems as a way to overcome these challenges."

"A food hub model like the one being used in Philadelphia can work to everyone's advantage, using the community as a whole to make the system viable. By leveraging the buying power of schools, hospitals, elderly care centers and corner markets to create consistent demand, you can then harness the growing power of local farms to create consistent supply."

See more at: http://blogs.usda.gov/2012/01/27/good-food-for-all-people-food-hubs-at-work-in-philadelphia/#sthash.qyKRebsq.dpuf

It's the Network

Distribution is a key to affordability and scale in the food system, agrees Cheryl Dahle. Building on a career in journalism and philanthropy, Cheryl turned her attention to fish as an important area for the application of socially conscious innovation. In 2010, after a few years researching how to bring sustainable fish production to scale, Cheryl Dahle founded Future of Fish, a non-profit accelerator for entrepreneurs in the seafood supply chain, working to bring greater sustainability and traceability to the seafood supply chain. Barriers to the affordability of U.S. fish are labor costs (primarily in processing), and the complexity of the existing distribution model, which favors large-scale production practices. The result is a system that turns all fish into a commodity, and there is little opportunity for more responsibly caught or raised local fish to be distinguished in the market place.

One idea is to use the efficiencies of computer software to create a networked hub with real time access for farmers to help with collection and distribution of supply. On the other end, a cooperative purchasing group of small grocers could develop new markets for the hub, which would be buoyed by demand from large purchasers. This design could bring sustainable production to affordable scale by providing an alternative pathway for responsibly caught or farmed local fish to get to markets. Cooperative purchasing forms could also include a model similar to the CSA (community supported agriculture, or a subscription service for purchasing directly from a farm) familiar to the local food movement. In the case of fish, it could be a community-supported fishery (CSF), purchasing directly from a fish farm or through forward contracting agreements.

THE 21ST CENTURY FOOD HUB In Boston, Red's Best has reeled in the fish hub concept. Jared Auerbach founded the company in 2008, after a few years of commercial fishing experience and with a good amount of computer savvy. He developed a software system that helps him network with around 200 small boat forage fisherman. This model offers sustainability, in aggregating small-scale supply and creating markets for the randomly wild caught fish from the day boats of Boston. The system eliminates the need for paperwork and offers complete traceability. In other words, there's an app for that.

The USDA has supported regional food hubs as a priority for the last few years, although primarily for specialty crops (i.e. fruits, nuts, and vegetables). Food hubs are seen as critical infrastructure for expanding local and regional food systems, as well as providing economic development, job creation, public health, and environmental benefits. The USDA supports the development of regional food hubs as leverage points for building robust regional food systems. There are over 200 of them throughout the U.S.[36]

Ownership structures, management practices, intermediary functions and community benefits differentiate food hubs from traditional farmers' markets, public markets or terminal markets. Regional Food Hubs include the following defining characteristics:

- Increased access to healthy food for underserved communities and expanded direct-to consumer sales, connecting farmers with residents in food desert neighborhoods;
- Supply chain infrastructure development that enables local institutions such as schools, municipal agencies, hospitals, restaurants, corner stores, and other retail outlets to increase their local food procurement;
- Expanded markets for small and midsize local growers;
- Creation of jobs throughout the food chain, including incubation of community kitchens developing value added food products;
- Streamlined local purchasing for customers to purchase source-verified local foods, which are grown and distributed with decreased environmental impact.

Some have permanent market and distribution facilities which contribute to the local economy through job creation and the economic multipliers of local purchasing.

Regional food hubs add value to the system

Regional food hubs complement and add considerable value to the current food distribution system:

→ **For institutional and retail buyers that would like to "buy local," food hubs can reduce transaction costs by providing a single point of purchase for consistent and reliable supplies of source-identified products from local and regional producers.**

→ **By fulfilling small farm aggregation functions, regional food hubs can add significant value to the more traditional distribution channels by partnering with regional food distributors —along with their national food distribution clients and partners—enabling them to offer a broader and more diverse selection of local or regional products than they would be able to source otherwise.**

(USDA, Regional Food Hub Resource Guide, Barham et. al., April 2012)

The President's Council of Economic Advisors identifies the support of such local food systems as a priority of the Administration:

Local food systems promote healthful living through increased availability of fresh food to underserved areas and the provision of better information on where food was grown. Locally grown food also may have greater nutrition value, since it does not have to be picked as early or treated to maintain freshness for transport to distant places. Finally, local food systems may reduce income variability and increase the share of the final product price that goes to farmers.[37]

It is essentially a small business strategy, which is important on a number of levels, including the fact that it is where the jobs are. According to the Small Business Administration, small business accounts for 54% of all U.S. sales, providing 55% of all jobs, and 66% of all net new jobs since the 1970's. Since 1990, "big business" lost 4 million jobs while small business added 8 million.[38]

Support of the small scale farm is in the public interest. Around 90% of farms are classified as small; yet, because of consolidated landholdings and intensive crop production methods in the large-scale farms, they account for less than 25% of total agricultural production value. It is difficult for the smaller scale and mid-sized farmer to compete in the global market place. A food hub can provide critical infrastructure to support the small farm business, whether it produces fish or other food. In a recent study of food hubs funded by the USDA, it was found for every dollar spent at a food hub, 63% was returned to the local economy.[39]

In addition to the potential of scaling up supply of local food, food hubs offer important environmental benefits in shortening the supply chain and reducing trip miles from farmer to consumer. They also promote the adoption or use of sustainable or environmentally sound agricultural production practices from smaller scale farmers who generally use less intensive farming methods.[40] Food hubs make it easier for municipal agencies, hospitals, schools and neighborhood markets to purchase high-quality, healthy and local food more affordably. By providing services such as food safety quality control, distribution, processing, and marketing relationships among buyers, food hubs help eliminate the barriers along the supply chain that make it difficult for smaller producers to meet the requirements of these wholesale buyers that operate in food desert neighborhoods.

Jared Auerbach is selling Red's Best fish at Boston farmers markets, bringing his catch in line with the Farm to Fork movement gaining traction around the country. The same is happening in California, with the Santa Barbara based Community Seafood, a community supported fish enterprise. Their local catch is being sold at Santa Monica farmers markets, and through a Los Angeles based CSA called Silverlake Farms.

Of course, processing and handling of live fish add a complex layer of regulatory issues that a food hub would have to manage. But if aquaculture and aquaponically raised fish were incorporated into these CSFs, or to a food hub, it will become increasingly possible to not only know your fish, but to know your fish farm.

The Fish Food Chain

Part of knowing what fish to eat requires knowing about what the fish eat. Mark Spalding, fisheries expert and President of the Ocean Foundation, observed that "we have the technology to do all kinds of things with renewable energy to power our fish farms, but we still haven't figured out feed." Feed costs can be one-third to one-half the cost of raising fish. Fish need high amounts of omega 3 fatty acids in order to survive in their aquatic environment. Fishmeal and fish oil have traditionally been used for this ingredient in feed for farmed fish (along with soy and corn), but the costs associated with these products is increasing.[41] Consumers pay a price for U.S. farmed fish that reflects these high costs. In addition, there is a significant environmental cost to current feed formulas. Simply put, it requires killing fish to make fishmeal or fish oil to feed other fish. As Michael Weber reported in 2003, at that time it took 2.9 pounds of wild fish to produce one pound of farmed salmon.[42] Although improvements have been made to reduce that ratio, with the increasing demand for seafood, wild or farmed, fisheries are stressed and the cost of fishmeal is rising. Reducing the need for fishmeal or fishoil is an environmental as well as an economic necessity.[43]

Dr. Rick Barrows is a research scientist for the Agricultural Research Service of the USDA. If you catch him before he steps out of his lab in Bozeman to hunt elk, you will be treated to a fascinating conversation about the possibilities for new feed formulations in aquaculture. A goal of his research is to reduce and eventually eliminate fishmeal use in feed formulas for farmed fish. The organic standard being considered for aquaculture by the USDA's National Organic Standards Program requires the eventual replacement of fishmeal in fish feed in order to qualify, and the National Oceanic Atmospheric Administration (NOAA) is actively engaged in research to identify replacements and alternatives for fishmeal in aquaculture feeds.

Rick Barrows is leading the research into such possibilities as the use of barley protein, leftovers from nut processing, black solider fly larvae, and algae. It's a complicated process, as getting the balance of proteins and the right kind of fatty acids is critical to fish health and its nutritional value to humans.[44] Rick's research has advanced the state of nutritional science in proving that fishmeal free feed can be fed to several species of fish, including arctic char, Atlantic salmon, Coho salmon, Florida pompano, rainbow trout, white sea bass, and yellowtail.

Will Allen of Growing Power is growing millions of black soldier fly larvae at his facilities in Milwaukee. Will Allen was a recipient of the coveted MacArthur genius award and a well-known national leader in urban agriculture. He sees aquaponics as a necessary part of urban aquaculture, and is also concerned about the cost and content of feed for fish. His answer is to grow black soldier fly from food waste, and harvest the larvae —rich in protein and fat— at peak grub chubbiness, as feed.

At the University of Southern California, microbiology scientist Radu Popa is developing pilot projects that would take Will Allen's idea to scale. He developed a system in the lab of Dr. Ken Nealson that will use large quantities of agricultural or municipal food waste as the source for black soldier fly larvae.

The efforts to use agricultural waste as an ingredient, and municipal waste to grow an ingredient, are closing the loop. It takes what might have been waste and makes it a resource. It reduces the reliance on using wild caught fish to feed farmed fish. There is a long road from experimentation to successful production, but in an increasingly resource challenged environment, this particular way of closing the loop might be an option worth exploring.

Making this path commercially viable will require investment dollars. As investment analyst Zack Porter explains, the amount of working capital needed for fish farming is largely in feed. In order

Vegetarian Fish

The Seafood Distributor

On the website for the San Fransciso company TwoXSea, is the explanation that it was "born out frustration of lack of honesty and accountability in the seafood marketplace and fair pay for the fishing industry." The company sources line caught fish and a pond-raised trout that is fed algae derived oil instead of fishmeal.

Kenny Belov and Bill Foss are co-founders of TwoXSea. They were concerned about the pollution impacts of fishmeal as feed in farmed fish because of the impacts on fisheries, and were worried about the bio-accumulation (concentration up the food chain) of mercury and other contaminants. Kenny and Bill undertook research into feed formulas and came across Dr. Rick Barrows of the USDA. They were interested in his formula for an algae derived oil to replace fish oil, and convinced Dave MacFarland, a trout farmer in Lassen County, California, to try it out. They contracted with a mill to prepare it into pellets and now, the vegetarian fed MacFarland Springs Trout is selling in white tablecloth restaurants throughout the Bay Area.

for feed manufacturers to take a risk on new feed ingredients, most large companies would need to see a demonstration project showing how the change in formula can work in a commercial environment. In many sectors, federal research and development grants are needed to fund a demonstration project in an emerging field of public significance, particularly for start-ups. The U.S has supported this risk in the development of renewable energy. However we have not demonstrated support for aquaculture through federal investments, in the same way.

Animal feeds are the purview of the USDA. About 15 million tons of feed grains were produced in the U.S. for 2012-2013.[45] But according to one study, in 2006 the U.S. produced only 750,000 to 850,000 tons of compound aquafeed, ranking us sixth in production in the world behind China, Thailand, Chile, Norway and Indonesia.[46]

The amount of money the USDA receives for research and development for agriculture is a mere 2% of the nation's total R&D budget ($2,378,000,000 out of $130,952,400,000);[47] of that small percent, only a fraction, or 0.4%, is spent on research in aquaculture.

As investment advisor Zack Porter said: "There isn't a strong seafood lobby like there is with chicken or beef, so no one pays attention to aquaculture."

Other countries have provided significant subsidy to their aquaculture industry, notably the salmon farming giants Norway, Chile and British Columbia, which help maintain the competitiveness of their product. Catfish is by far the leading farmed fish in the US, and since it does not require as much fishmeal or fish oil as do marine species, it is in some ways better for the environment and should be more competitively priced. But the current political dynamics with which the catfish industry is wrestling portend a complicated path to greater political support for not only the catfish industry, but for the overall U.S. aquaculture industry as well.

From the website of the National Oceanic Atmospheric Administration

What Are the Potential Alternatives to Feeding Fish to Fish?

Potential alternative include meals and oils from plants (the greatest source of protein and edible oil on earth), fish processing waste, yeast, bugs and other special meals, and even seaweed. Potential alternative ingredients already in use include soybeans, barley, rice, peas, canola, lupine, wheat gluten, corn gluten, other various plant proteins, yeast, insects and algae. Other sources that show great promise include waste from bio-energy and bio-plastic production and fish processing waste (trimmings). Farmed seaweed has significant growth potential as a source of food and fiber for both aquaculture feed and human consumption. Researchers have been successful in identifying alternatives that grow fish and help maintain the human health benefits of eating seafood.

The Dog Days of Catfish

Once a dominant force in the U.S. aquaculture industry, many catfish farmers are now struggling with bankruptcy. It is a long way from the heyday of 1980's, when President Ronald Reagan declared June 25, 1987 National Catfish Day, to promote the "uniquely American food delicacy," the production of which "created thousands of permanent jobs."[48] In the last 8 years imports of catfish to the U.S. from Vietnam have increased exponentially, so that nearly 80% of all imported catfish is from Vietnam. At the same time, U.S. production of catfish has plummeted and is now half of what it was in 2005.

In 2002 catfish producers lobbied to get a special label law passed, which would require that only the fish within the Ictaluridae family (the American catfish breed) could be labeled as catfish. The Vietnamese variety, known technically as Pangasius but called swai or basa, could not be labeled as catfish. Despite the law, Vietnamese catfish imports continued to rise. Some suspected mislabeling and fraud. With the imbalance continuing to rocket out of control, in 2008 the American catfish industry lobbied for a rule to require that the USDA, rather than the Food and Drug Administration (FDA), have primary responsibility to conduct inspections of catfish imports.

The FDA inspects only about 2% of imported seafood, and less than 1% of imported seafood specifically for fraud.[49] According to a study by the non-profit Oceana, seafood fraud is rampant, with mislabeling of seafood found to be taking place about a third of the time (more than half of the time for tuna), resulting in consumers being served a different fish than the one they thought they were buying.[50]

The 2008 rule to move catfish inspections to the USDA highlighted a significant debate within the aquaculture community: where does fish farming belong, in the array of government agencies? Farmed fish are not just fisheries, and not just agriculture, but both. Although the USDA has been designated the lead agency for aquaculture, jurisdiction over fish is also with those agencies that manage fisheries and regulate species protection, such as the Department of Fish and Wildlife. If the fish are raised in the ocean, the National Atmospheric Administration (NOAA) has jurisdiction. For fish that are not wild caught but are raised on land in ponds and tanks, many think that jurisdiction should fall more dominantly within the purview of the USDA, which oversees other forms of farmed animal protein such as beef, pork and poultry. The USDA also has a robust inspection program designed to protect US agricultural products.

What has now become known as "the catfish rule" passed as part of the 2008 farm bill, but it has yet to be implemented even though the USDA has repeatedly announced that it is ready, willing and able to do so. The catfish rule touched off a political battle between Vietnam and the US, such that Senator John McCain submitted a bill to repeal the catfish rule as a protectionist tactic and an example of government waste, abuse and mismanagement. The bill died in committee in that congressional session[51] but was re-introduced March 21, 2013. It is difficult to imagine this taking place if the other American livestock sectors were at issue. In fact, some speculate that it was the Vietnamese threat to throw an equivalent barrier around imports of beef to Vietnam that led to catfish being the sacrificed animal.

Hanging in the balance of this struggle is a struggling industry. Unlike the monolithic beef or chicken industries, the US farmed fish industry has difficulty organizing because of its diversity of species and the multiplicity of governmental organizations with oversight. It has not been able to come to scale and coalesce into a political force. Also, public support for aquaculture has not been strong recently. Aquaculture's height in the US was seen around 1980, when Congress passed the National Aquaculture Act, coordinating the various programs, policies and agencies with jurisdiction over aquaculture, under the USDA, and creating a Joint Subcommittee on Aquaculture. However, even though funds were authorized in order to carry out the provisions of the Act, they were not appropriated.[52] Since then, our imports from other countries have continued to increase.

Less than 1% of the 300-billion taxpayer dollars in the farm bill has been spent to support specialty crop (fruits, nuts and vegetable) production. Even less has been spent on fish. "Fish is an efficient animal to raise [in terms of feed input], because it doesn't have to support its weight. It's a healthy form of animal protein, and from a resource standpoint, it's more efficient. It doesn't make sense to ignore, for all intents and purposes, aquaculture," says Zack Porter.

Bringing Fish to Scale

The Policy Advisor

Justin Malan still carries South Africa in his accent, though he has not lived there since he sailed a 30-foot boat to the U.S. from South Africa at the age of 28. Now a political advisor to environmental causes, he was the Executive Director of the California Aquaculture Association (CAA) from 1991 to 2003.

The cultural diversity that is characteristic of California is true for its aquaculture production as well, but in the case of farmed fish it prevents the market from coming to scale. Unlike Mississippi, which had commoditized catfish, or Idaho trout, California produces mostly for niche markets, he said, and has a variety of species in production, such as tilapia, trout, bass, and shellfish such as oysters and abalone. Not all of the fish is for food; some of it is for bait or is raised to stock lakes and rivers.

Another issue is the regulatory confusion that aquaculture operators often face.

"Aquaculture doesn't know if it's fish or fowl," he says. "It straddles being a natural resource is some cases —for example, when fish are found in streams— and then completely different jurisdictions when it's farm raised, and then if in the ocean or on land. The jurisdictions are often completely at odds with each other."

When he was at CAA, he worked to streamline the permitting process, and advanced changes in the codes to have aquaculture be classified as agriculture so that it could qualify for specialty crop funding from the USDA.

He continues to advocate for sustainable practices in the aquaculture industry, along with his other work on environmental issues in California.

Know Your Fish Farm

While the U.S. aquaculture industry struggles to regain its footing, the American consumer is faced with a complicated array of choice with very little easily accessible information about how the fish are raised. Certification programs are a helpful guide for consumers, so that they can make choices based on the investigation of the third party certifier. The USDA organic label is a significant brand, and has helped propel the organic industry to a market in the U.S. at around $30 billion and apparently growing.

Organic standards for aquaculture have been in place throughout Europe, Canada, and in Australia for a few years now, but the progress has been stalled in the United States since the rule was first proposed at the turn of this century. The development of an organic standard for aquaculture has become a process in which the different schools of thought around aquaculture in general are playing out in fierce debate. They are locked in at the first step: what would qualify as organic feed?

Environmental organizations are pointing out the problems with trying to develop an organic standard for open ocean aquaculture, which is receiving criticism similar to that leveled against confined animal feeding operations on land, regarding high stocking densities, parasitic and other diseases, the use of antibiotics, and concentrated waste runoff. Aquaculture producers are pushing back, pointing out the advances in best management practices. Organic agriculture advocates argue that the proposed rules on aquaculture are stretching the definition of organic if any amount of wild caught fish is allowed, and that the production methods should be certified as well as the feed.

Despite these differences of opinion, there seems to be agreement among environmentalists that organic standards could be developed for closed systems, "where inputs, outputs, health and animal welfare can be monitored and controlled." In other words, aquaponics and recirculating tank systems could be the right place to start. (Pond farming could follow. It is the currently prevalent method in the U.S. and university extension research in best management practices has been improving the pond production methods).

Getting this rule right could mean a lot to the aquaculture industry, because it would mean a lot to consumers who want to make a wise choice at the seafood counter. When shopping for beef and chicken, the informed consumer can currently opt for USDA certified organic, as those standards have been in place for a few years, with a robust promotional and technical assistance program to support it. When shopping for fish, however, the choices are far less clear. Wild caught or farm raised? From China or Chile? Is catfish better than cod?

Until the USDA National Organic Program has a widely accepted rule for aquaculture in place, a number of organizations could provide guidance, most well-known among them being Seafood Watch and the Aquaculture Stewardship Council. Helene York, Director of Responsible Business Practices for Bon Appétit Management Company and its owner Compass Group, has worked closely with Seafood Watch in developing her sourcing guidelines.

Created by the Monterey Bay Aquarium in 1999, Seafood Watch researches and evaluates the sustainability practices of fisheries and aquaculture around the world. They have created a numerical scoring system which ranks the operations according to a matrix of their criteria, and then translates those scores into easy to follow categories of Red (Avoid), Yellow (Good Alternative) or Green (Best Choice). Among the green or Best Choices, are farm-raised fish or shrimp grown in closed recirculating systems.

Even though we have country of origin label requirements for livestock (including fish) in effect in the United States, there is a need for greater transparency in the food system. It is a complex web of production, distribution and processing entities, most of which engage through the global marketplace, Increasing the certification and improving labeling of food products would help consumers make more informed choices.

Seafood Watch Categories evaluated

- → **Production data** —industry or farm size and production volumes, species, number and locations of farms or sites
- → **Effluent** —water quality testing, impact monitoring, regulatory control and enforcement
- → **Habitat** —farm locations, habitat types, impact assessments, history of conversion, habitat monitoring, habitat regulatory control and enforcement
- → **Predator and wildlife mortality rates and population impacts**
- → **Chemical use** —type, frequency, dose and discharge
- → **Feed use** —ingredients and sources, economic feed conversion ratio, inclusion rates of fishmeal and oil (including by-products), vegetable or crop meals and oils, land animal products and by-products
- → **Escape numbers and size of animals, recapture or survival rates, international live animal movements, species and domestication status**
- → **Disease outbreaks, mortalities, pathogen and parasite levels and treatments, biosecurity characteristics**
- → **Source of farm stocks, use of wild fisheries for broodstock, larvae or juveniles**
- → **Energy use for water pumping or aeration**

Hitting a Moving Target

The Sustainability Advisor

"We used to think the issues were as simple as overfishing or 'bad' aquaculture," says Helene York of the Compass Group. Helene developed the sustainable seafood procurement policy for Compass Group in 2005, and is a nationally respected expert and leader on sustainable food sourcing. The big game changers, she says, are climate change and ocean acidification. Fishing patterns, fisheries management, species balance are all deeply impacted by the larger forces at work in our oceans, creating a need to look more deeply at aquaculture. "Beef and pork have a greater impact on the global environment than almost any farmed fish species, therefore, we are not only talking about sustainable seafood, but about what is sustainable food; what kind of protein belongs in a sustainable food system. The more I've come to understand the impacts of aquaculture and animal agriculture, the more I've come to see the importance of good aquaculture as part of a sustainable food system."

Due to the complex regulatory and labeling issues around the sale of fish in our global trade system, finding a sustainable source is not easy. York compares it to a moving target. "It's not easy to know what is good, what is excellent, and what is masquerading as good," she said. York created partnerships with the Monterey Bay Aquarium (their Seafood Watch program) and the Environmental Defense Fund, and assessed shrimp imports from Thailand, tilapia from China, and other farms around the world. Although initially hesitant to source from Asia, in the past few years she has seen some improvement in their production practices. The policy she developed for Bon Appetit Management Company, a subsidiary of Compass, is that only those seafood products that are rated yellow or green may be used throughout their company, which provides food service for over 500 entities.

A few years ago, she produced a national Fish to Fork day, to encourage the sourcing of more local (meaning, within 500 miles of the kitchen) fish. While the event was considered a success in creating awareness of local fisheries and farms, it also highlighted for York the fact that there is not enough local supply...yet. Concerned that increased demand from fisheries could lead to higher prices, York believes that aquaculture is the key to building local supply.

Reeling It In

As the farmer and writer Wendell Berry has said, "How we eat determines how the earth is used."

Cities, states, and countries around the world are realizing the importance of creating regional, sustainable food systems to address the most vexing issues stemming from a conventionally linear model of food production and distribution that favors the large scale. While the conventional system works well for many, its edges are frayed, with the struggles of small-scale farms occurring on the production end, and the problems of hunger and obesity on the consumer end. Sustainable production of food can, and should, include the cradle-to-cradle model of production that puts the environment at the heart of the system, and puts to full use the natural cycles of feeding and growth at the various food chain levels of life.

It is more necessary than ever for us to apply ourselves to developing these new forms of ecological models in agriculture and aquaculture. As the oceanographer Sylvia Earle said: "We need to convey a sense of urgency because the world is changing. The next ten years is likely to be the most important time in the next 10,000 years."

Aquaculture, like any form of agriculture, can be done sustainably. It is a matter of how the farmer chooses to farm, and it is as valuable with farmed fish as it is with other food, to know your farmer.

Recirculating tank and aquaponics systems are a type of closed loop system that offer efficient water use, productive yields, and a controlled environment that buffers against climate change or invasive pests. Its energy use would be lower in mild climates such as California, and could in any event be offset by renewable energy. In short, it's a sustainable system for a city. Food production can take place at a neighborhood level, and can be linked through a distribution system that serves the larger community. Designed with social impact principles, food hubs are emerging as a new business model, one that could provide networks for smaller scale farms, could serve communities of need, and can support sustainable production of food. It is being embraced by a generation of entrepreneurs with a deeply ingrained social and environmental consciousness.

The following are some recommendations to encourage recirculating tank and aquaponics systems in warehouses and greenhouses in urban areas, and to strengthen the policy infrastructure for sustainable production of farmed fish.

Increase Support for State and Federal Agricultural Offices for Research, Marketing and Promotion

→ Support continuing collaboration across federal, state and local jurisdictions to promote efficiency and cost-minimization in permitting requirements with a strong lead by the USDA

→ Step up support for university research to develop best practices in sustainable farming methods

Increase Investment for Innovations in Feed Research and Use

→ Increase funding for research and development in the production of nutritionally sufficient feeds that are from sustainable sources, and help new formulas with targeted market development.

→ Encourage adoption of organic certification for fish raised in recirculating tank systems

Develop Policies to Encourage Urban Aquaculture

→ Modify zoning and building ordinances where needed, and streamline process to permit aquaculture and aquaponics.

→ Government incentives should be offered to encourage the development of aquaculture projects

Increase Transparency in the Supply Chain

→ Support certification of farming methods and feed

→ Support labels with information on fish origin and farm method

Know Your Fish Farm

→ Call on the USDA National Organic Program to complete their rulemaking for aquaculture

→ Support your local fishery and fish farm

→ Read the labels and follow the Seafood Watch or Marine Stewardship Council guidelines

→ Talk about it. Ask your restaurant and seafood seller to help you #KnowYourFishFarm

“What We Do or Don’t Do Will Make a Difference”

Sylvia Earle is an American oceanographer, author, explorer and lecturer. The following is an excerpt from an interview of her for National Geographic.

The ocean is the cornerstone of our life support system and the cornerstone of the ocean’s life support system is life in the ocean. The ocean is alive. Oxygen is generated by living creatures. They are part of the system and food chains in the sea drive those systems. Every fish fertilizes the water in a way that generates the plankton that ultimately leads back into the food chain, but also yields oxygen, grabs carbon —it’s a part of what makes the ocean function and what makes the planet function.

Take away the ocean and we don’t have a planet that works. Take away life in the ocean and we don’t have a planet that works. All life needs water, but all life needs other forms of life to have the prosperous, complex communities of life, ecosystems of life that ultimately over four-and-a-half billion years arrived at a state that is just right for humankind.

There is a terribly terrestrial mindset about what we need to do to take care of the planet —as if the ocean somehow doesn’t matter or is so big, so vast that it can take care of itself, or that there is nothing that we could possibly do that we could harm the ocean. I have heard endlessly that fish are so resilient that there is no way that you could exterminate a species. We are learning otherwise.

The ocean is vulnerable.
What we do or don’t do will make a difference.

http://kids.nationalgeographic.com/kids/stories/peopleplaces/sylvia-earle/

By the Numbers

Aquaculture includes fish for: food, sport fish, bait fish, ornamental fish, crustaceans, mollusks, and miscellaneous. Aquaponics sytems are not yet counted by the USDA

NUMBER OF FISH FARMS IN THE USA

Total → **4,309**

Total number of recirculating tank farms → **415**

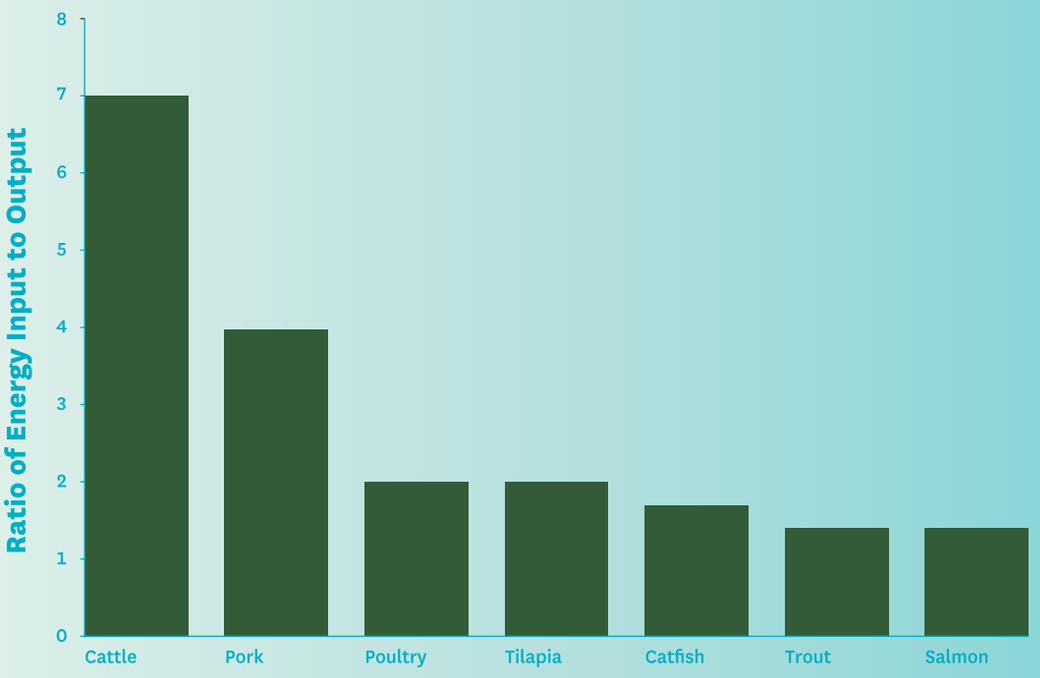
Total number of tanks in all recirculating tank farms → **15,059**

TOP FIVE STATES WITH THE MOST RECIRCULATING TANK FARMS

Florida → **61**
Virginia → **35**
California → **33**
Hawaii → **21**
North Carolina → **17**

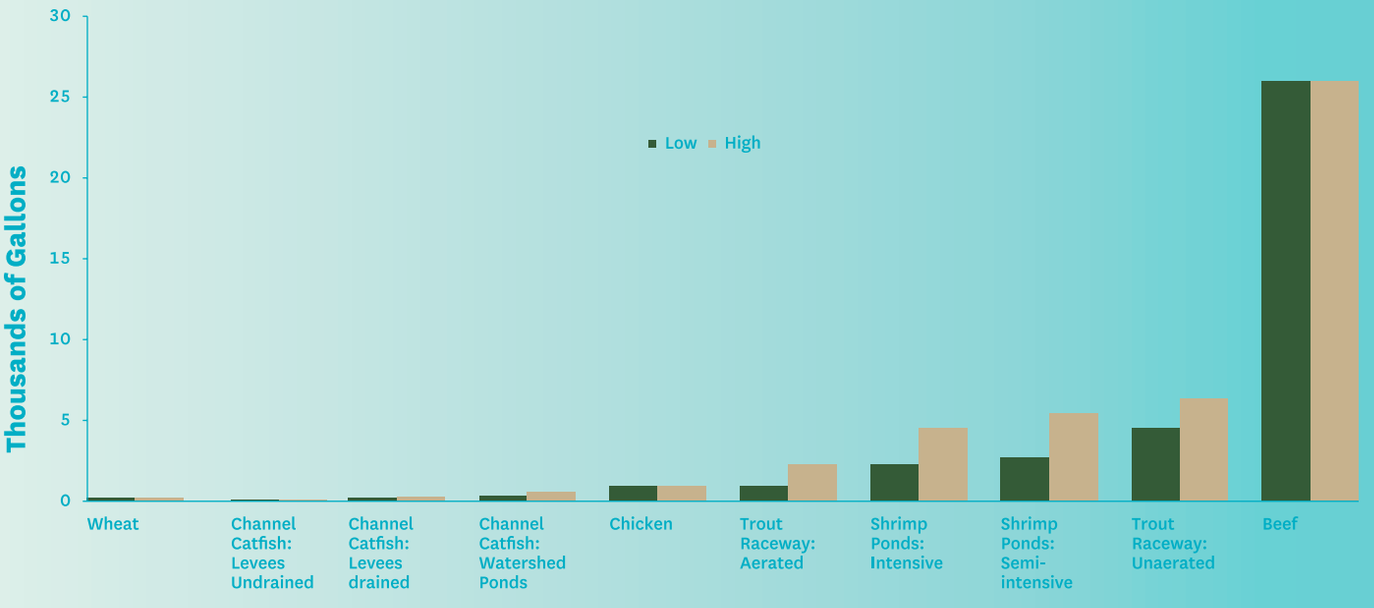
(Per the USDA 2005 Census)

Feed Conversion Ratios (This means the amount of feed consumed for every pound produced)



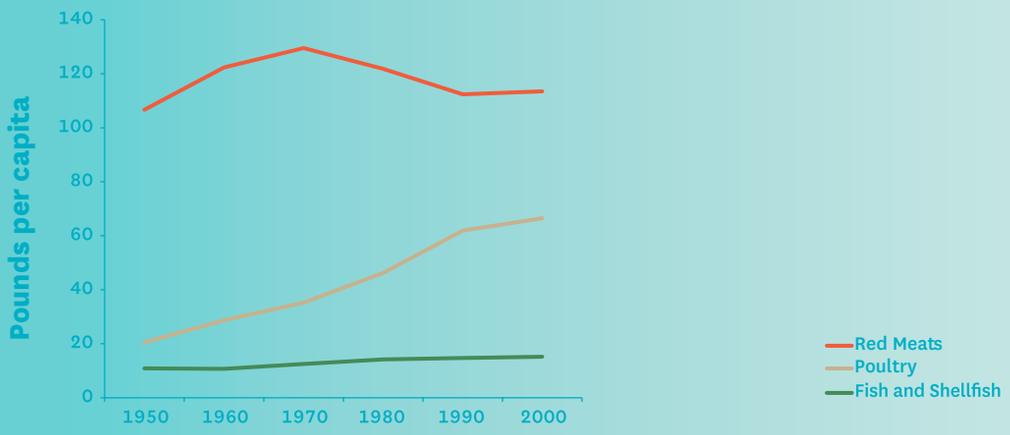
Sources: Brown, L.R. (1999). Feeding nine billion. In Starke, L. (Ed.) State of the World. New York, NY: W.W. Norton Company; U.N. Food and Agriculture Organization (2002). Use of Fishmeal and Fish Oil in Aquafeeds. Retrieved from: ftp://ftp.fao.org/docrep/fao/005/y3781e/y3781e00.pdf
(Data based on 1999 estimates for cattle, pork and poultry; 2000 estimates for fish species)

Comparative Water Use



Water used for livestock feed adapted from: Pimentel, Berger, et al. (2004). Water Resources, Agriculture, and the Environment. Ithaca, NY: College of Agriculture and Life Sciences, Cornell University. Water used in aquaculture systems adapted from: Yoo, K.H. (1994). Hydrology and Water Supply for Pond Aquaculture. New York, NY: Springer.

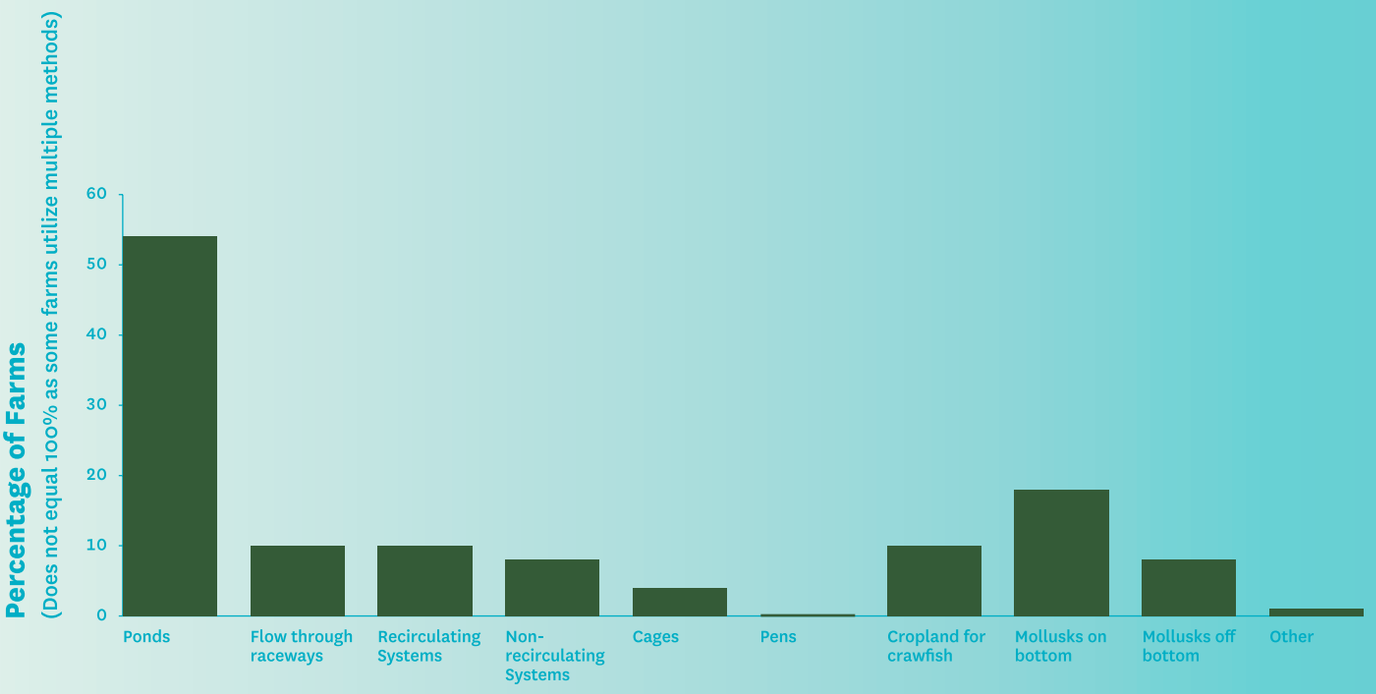
American Meat Consumption per Capita



	Annual Averages					
Item	**1950-59**	**1960-69**	**1970-79**	**1980-89**	**1990-99**	**2000**
	Pounds per capita, boneless-trimmed weight					
Total meats	138.2	161.7	177.2	182.2	189.0	195.2
Red meats	106.7	122.34	129.5	121.8	112.4	113.5
Beef	52.8	69.2	80.9	71.7	63.2	64.4
Pork	45.4	46.9	45.0	47.7	47.6	47.7
Veal & lamb	8.5	6.2	3.5	2.4	1.7	1.4
Poultry	20.5	28.7	35.2	46.2	61.9	66.5
Chicken	16.4	22.7	58.4	36.3	47.9	52.9
Turkey	4.1	6.0	6.8	9.9	13.9	13.6
Fish & shellfish	10.9	10.7	12.5	14.2	14.7	15.2
	Number per capita					
Eggs	374	320	285	257	236	250

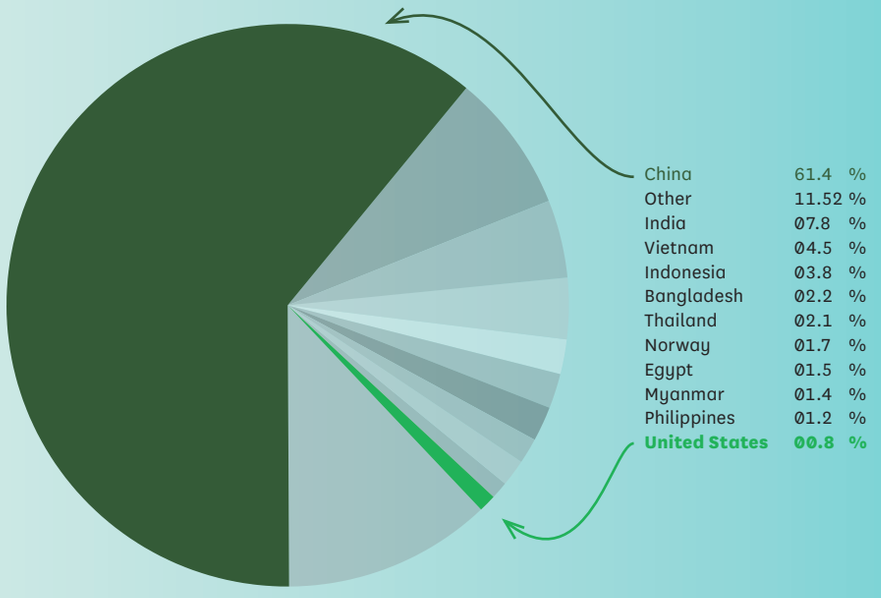
Source: USDA Economic Research Service

US Aquaculture Methods



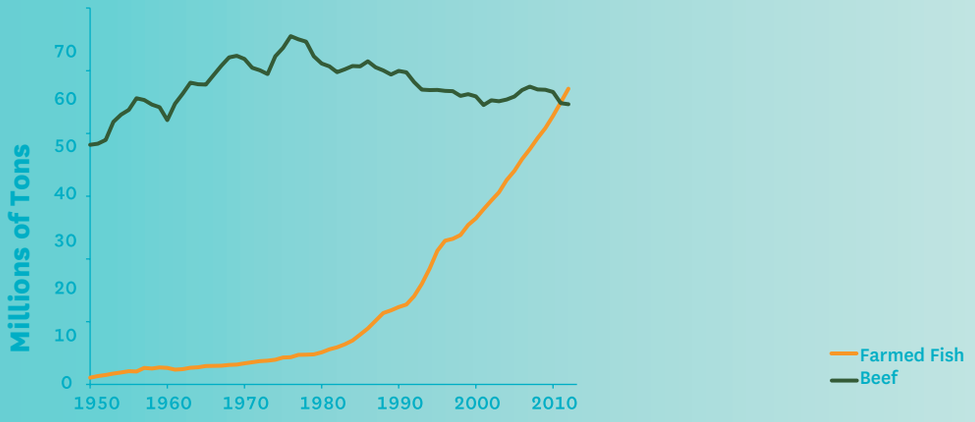
USDA Agriculture Census, 2005

US and World Aquaculture Production, 2012



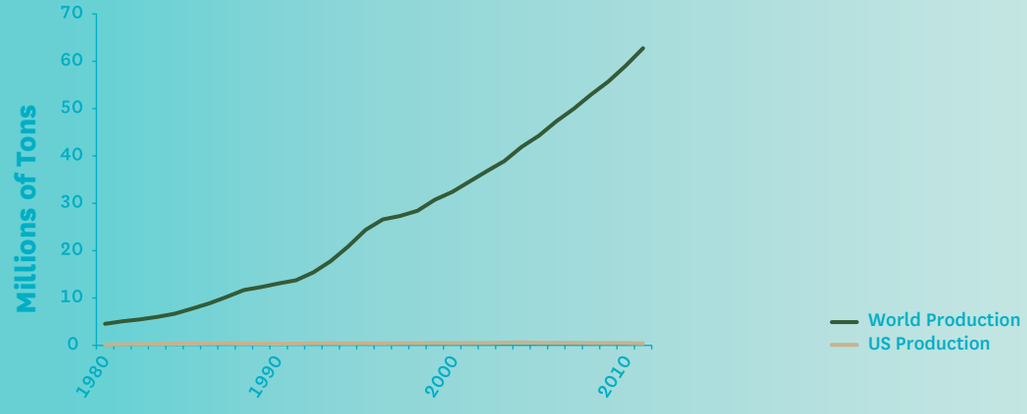
Source: UN FAO (2012). *State of World Fisheries and Aquaculture.*

Aquaculture Production Surpassing Beef Production Worldwide in 2012



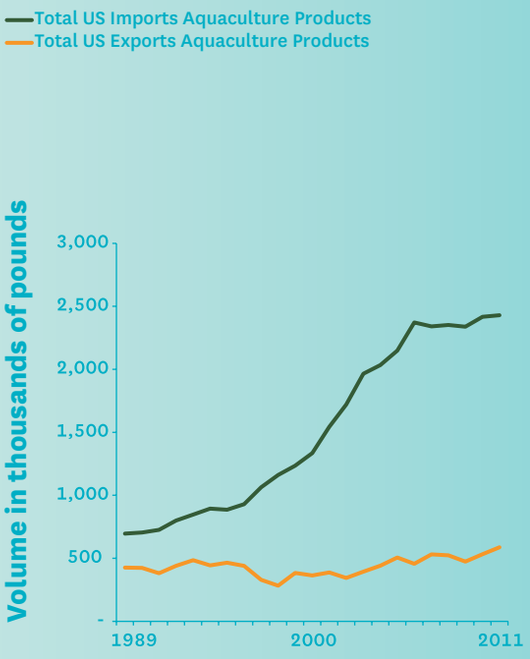
Source: EPI based on FAO, USDA
Adapted from Earth Policy Institute, www.earth-policy.org

US and World Aquaculture Production Since 1980

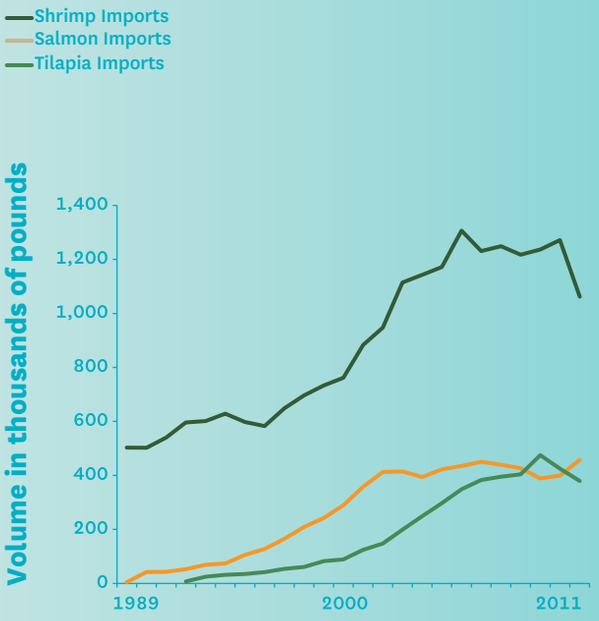


Source: UN FAO (2013). Global aquaculture production 1950-2011,
available at www.fao.org/fishery/statistics/global-aquaculture-production/query.en

US Trade Deficit in Aquaculture

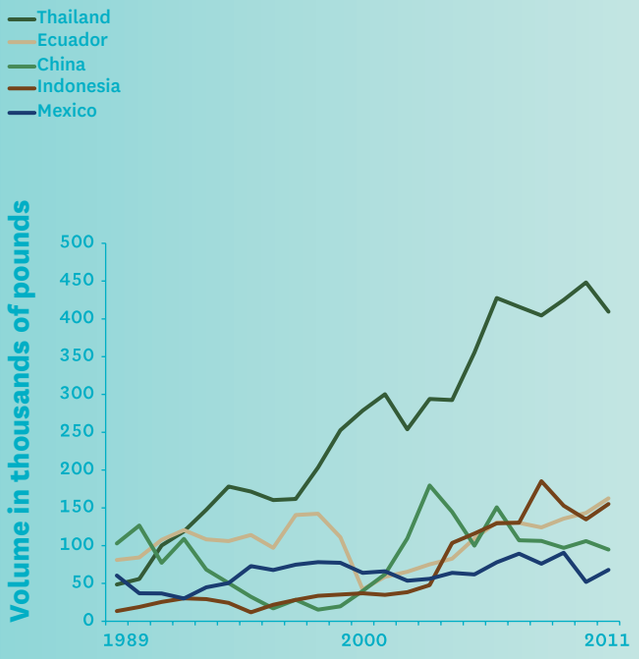


US Imports of Salmon, Tilapia, & Shrimp

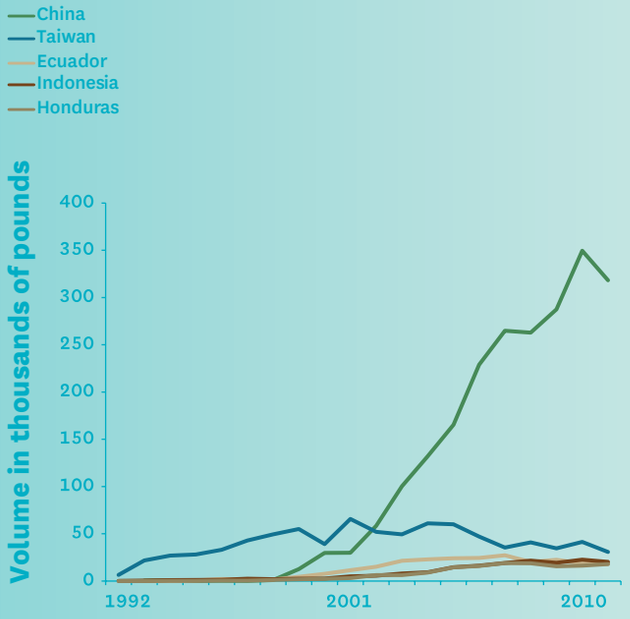


Source: USDA Economic Research Service. (2013). Aquaculture data. Retrieved from www.ers.usda.gov/data-products/aquaculture-data.aspx#.UebnbdIipIE

US Suppliers of Shrimp

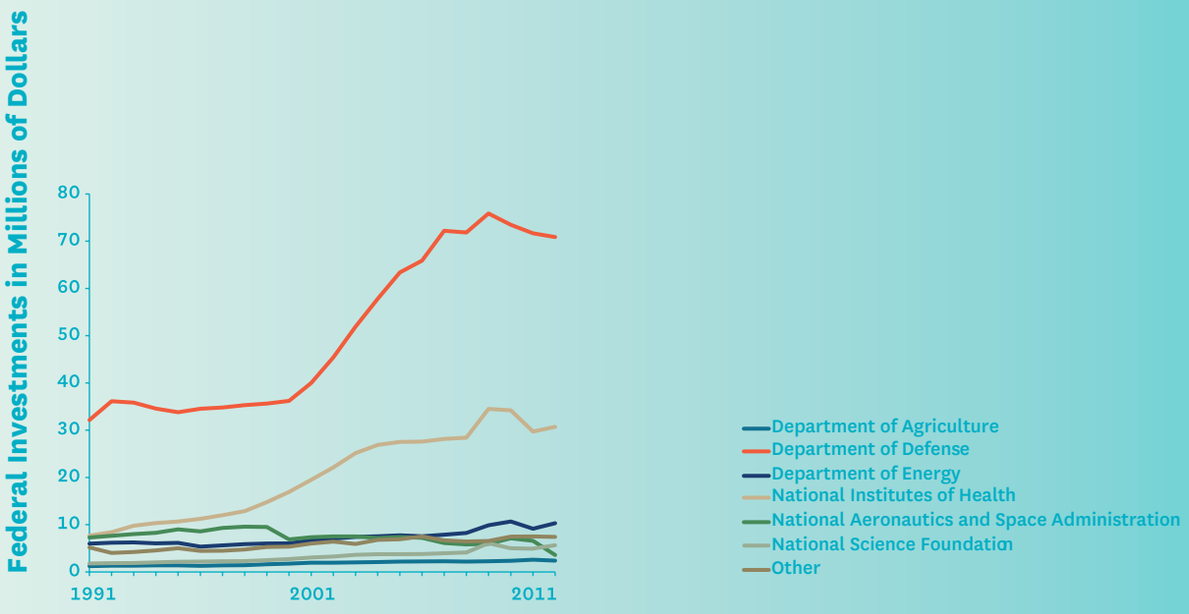


US Suppliers of Tilapia



Source: USDA Economic Research Service. (2013). Aquaculture data. Retrieved from www.ers.usda.gov/data-products/aquaculture-data.aspx#.UebnbdIipIE

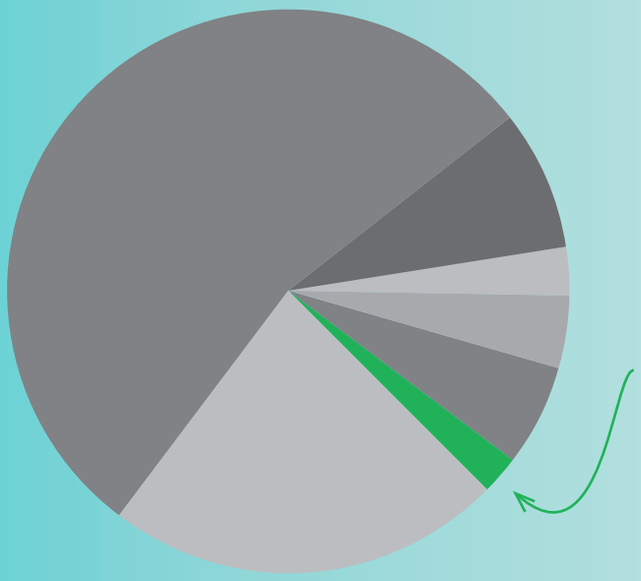
US Research Dollars in 1991–2011



US Development Dollars in 1991–2011

National Science Foundation, National Center for Science and Engineering Statistics. (2012). Federal funds for research and development: fiscal years 2010-2012.

Federal Funding for Research and Development in 2012



Department of Defense	54 %
National Institutes of Health	23 %
Department of Energy	8 %
Other	6 %
National Science Foundation	4 %
National Aeronautics and Space Administration	3 %
Department of Agriculture	**2 %**

National Science Foundation, National Center for Science and Engineering Statistics. (2012). Federal funds for research and development: fiscal years 2010-2012.

First Federal Facility for Aquaculture
USDA & DOI create Fish Farming Experimental Station at Stuttgart, AR

1954

National Aquaculture Development Act
Authorized appropriations for aquaculture R&D

1976

1970

National Marine Fisheries Service
created at NOAA and assigned responsibility for developing aquaculture

1977

Food & Agriculture Act of 1977
USDA authorized as lead on aquaculture R&D

National Aquaculture Act
Aimed at coordinating federal policies and programs affecting the aquaculture industry

1980

1981

Subtitle L: Aquaculture Added to National Agricultural Research, Extension and Teaching Policy of 1977
Authorized research and established four (later five) regional aquaculture research centers

USDA Designated Administrative Chair of Joint Subcommittee on Aquaculture
Is lead agency for purposes of coordination and dissemination of information
—
Authorized appropriations for aquaculture R&D

1985

2005

Aquaculture Working Group Created through National Organic Standards Board
National Organic Program to develop production and handling standards for organic agriculture

National Organic Standards Board Recommendation
Suggested inclusion of aquaculture standards in National Organic Program

2007

2012

National Aquaculture Research and Development Strategic Plan
NOAA & USDA included 5- and 10-year plans

Jenson, Gary L. (2007). "The Evolutionary Role of Federal Policies and Actions to Support the Sustainable Development of Aquaculture in the United States." Chapter 13, Species and System Selection for Sustainable Aquaculture.

Biography

Paula Daniels is the founder of the Los Angeles Food Policy Council, a collective impact initiative that is advancing innovative policy initiatives and programs designed to increase the production and availability of food that is healthy, affordable, and grown locally, sustainably. She was a Senior Advisor to Mayor Villaraigosa of Los Angeles on Food Policy and Special Projects in Water, and was a Los Angeles Public Works Commissioner where she led the development of a vertically integrated suite of green infrastructure ordinances, standards, policies, best practices, reports, and workforce tools. Actively engaged in California environmental policy issues for over 20 years, Paula was also commissioner with the California Coastal Commission, and a gubernatorial appointee on the governing board of the California Bay-Delta Authority. She has had academic appointments at UC Berkeley and UCLA, and is a Stanton Fellow.

DEDICATION This paper is dedicated to my grandfather, Harry V. Daniels. Sr., after whom my father and brother were named. Grandpa Daniels was of a long line of Hawai'ians of Maui. He spent his working life maintaining the sugar mill at the Pu'unene plantation, and his spare time teaching us respect for the ways of the ancient Hawai'ians. He taught us the wisdom of *malama* —the importance of being careful stewards of the land (*malama aina*), and the oceans (*malama kai*). And he taught me the complex and evolving meaning of this saying: *Ua Mau ke Ea o ka ʻĀina i ka Pono* —the life of the land is perpetuated in right action.

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