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August / September 2018 Volume 44 Number 4

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AIN Project in Bangladesh.
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COLUMNS

Editor's Comments

Maybe it's just me… or maybe it's the ever-increasing online access to industry "news." But recently I've noticed some uptake in high-profile investments in aquaculture.

By C. Greg Lutz

However, it's more important than ever that investors and entrepreneurs have a clear understanding of what they are buying into. I recently read where a promoter had emphasized that operating costs for an indoor RAS project would be comparable to those of a traditional aquaculture operation for the same species. But the numbers in the article suggested fixed costs (depreciation of which must be considered in the break-even price) would be many times higher. Every failure of a poorly planned or potentially fraudulent venture makes it more difficult for the industry as a whole to advance.

Much of the uncertainty and potential for scams involves unfamiliarity with what aquaculture is, and what the limits of available technology actually are. If I try to raise capital (in good faith or otherwise) to develop a pineapple plantation outside of Edmonton, Alberta (Canada), most people will realize the folly inherent in the concept. No matter how I might argue about the use of high-tech greenhouses and the proximity to an urban market that will pay a premium for fresh pineapple… there is sufficient understanding among the general public of the basic constraints (both biological and economic) on such a venture to prevent me from finding funding.

Unfortunately, we have seen time and again that this is not necessarily the case in the realm of aquaculture. Instead of my Canadian pineapple plantation, I might decide to pitch a cold-water RAS lobster production facility in Puerto Rico. I could flash a lot of fancy graphics and slick spreadsheets around and it's possible, I might pull together some serious funding from investors who would take me at my word because they are enamored with the concept of "aquaculture" …or maybe they just like lobster. AND…it wouldn't be surprising, actually, if their first response to my pitch was to ask whether the power grid on the island was restored yet, rather than addressing the technical and economic feasibility of the proposal.

And so it goes. Industry development is fundamentally limited of course by the available technology and capital… but in many localities it is also limited by the whim of policy-makers. New initiatives in U.S. aquaculture these days often involve high profile private investments in high tech facilities (many of which benefit to varying degrees from public resources while much less frequently managing to produce any meaningful return on public investment).

One has only to look at the advances our industry is making in other countries and regions, including many that might not be considered to have open or representative governments, to see the influence

the current political climate in the United States has had on aquaculture development. Polling analysis clearly shows that politicians in this country have reached a point where they prefer to ignore issues that are "somewhat important" to a majority of their constituents, in order to focus on issues that a minority of voters are passionate about. And who can blame them? This is how the U.S. political system has devolved.

When a group of scientifically illiterate stakeholders expresses outrage over the possibility of offshore cages "destroying entire ecosystems," or when fears are stoked that some fish or crustacean that has been cultured here and sold in interstate commerce for decades could potentially decimate native species or when shellfish beds simply threaten to spoil the view from mansions along the coastline… aquaculture loses. And here, unfortunately, aquaculture almost always loses.

There are exceptions. In places like the Mississippi delta or Idaho or North Carolina, where local communities understand the economic benefits and minimal ecological impacts of aquaculture, local politicians do what they can to keep the industry moving forward. But, as they say, all politics are local. On the flip side, if a modern day flimflam artist shows up in an economically depressed community promoting a scheme to convert abandoned real estate into a high-tech aquaculture operation that will produce lots of jobs, many politicians and citizens will sit up and take notice. If the con is sophisticated enough, sorely needed public funds will be diverted to make the dream a reality. Of course, not all projects fall into this category, but – once again – a lack of scientific literacy at all levels of society often allows the sham projects to tarnish the public's perception of the legitimate ones.

This sad state of affairs for U.S. aquaculture is largely because science plays little, if any role in these types of public discussions. In fact, savvy politicians understand that increasingly, the typical American has little grasp of science or how it works. The effort to try to explain an objective, science-based position on issues such as these would be counter-productive politically. And so, aquaculturists in the USA will continue to watch the industry advance in other parts of the globe. Perhaps with more than a bit of envy.

And in many of those 'other parts of the globe,' in contrast to the high-tech world of industrial RAS, there are organizations like Worldfish… and many others. These are dedicated individuals using basic aquaculture practices to improve the lives of people in developing nations – nations many of our friends and neighbors are entirely unaware of. Many organizations and governments are collaborating with Worldfish to "advance knowledge, promote sustainable, evidence-based solutions and strengthen policy design and implementation, while sustaining the underlying natural resources and ecosystems on which aquaculture systems depend." Check them out.

Dr. C. Greg Lutz has a B.A. in Biology and Spanish by the Earlham College at Richmond, Indiana, a M.S. in Fisheries and a Ph.D. in Wildlife and Fisheries Science by the Louisiana State University. His interests include recirculating system technology and population dynamics, quantitative genetics and multivariate analyses and the use of web based technology for result-demonstration methods.

First ASIC Verified Shrimp Enters US Market

Bali, Indonesia — The first shrimp verified by the Asian Seafood Improvement Collaborative (ASIC) is hitting US markets. True Food Kitchen is one of the first US buyers to initiate an ASIC partnership to source whiteleg shrimp from Thailand from ASIC Shrimp Level 1 verified farms, which are equivalent to a Monterey Bay Aquarium Seafood Watch® program "Good Alternative" recommendation.

"Environmental and social well-being are closely linked. ASIC shrimp reflects that relationship between livelihoods and sustainability," says Wendy Norden, Seafood Watch Science Director.

At a time when the seafood industry is fraught with negative headlines, ASIC approaches shrimp aquaculture improvement differently than most by fostering improvement with the farmers and stakeholders themselves. As a result, ASIC farms and processors are providing environmentally and socially responsible shrimp with fully traceable supply chains.

"ASIC is the first improvement program that's built by stakeholders from the Southeast Asian region, which fosters greater change and stewardship," said Rosanna Contreras, ASIC Chair. Shrimp is one of America's favorite seafood products with the majority of shrimp found in US markets imported from farms overseas. Roxanne Nanninga, Sustainability Director, Thai Union North America stated, "We are excited to be bringing the first ASIC shrimp to the US market. We plan to continue to grow and develop the farms taking part in this innovative program."

True Food Kitchen, known for its health-driven menu items, prides itself on offering high quality, sustainably sourced ingredients. As a growing business, flavor and consistency are paramount for True Food Kitchen. "ASIC shrimp checks all of the boxes for our priorities," stated Taylor Domet, Director of Culinary Standards at True Food Kitchen. "The industry has been turning a blind eye to shrimp aquaculture for too long. ASIC is a groundbreaking initiative that is leading the way to revolutionize shrimp aquaculture and we're thrilled to be a part of it," Domet stated.

ASIC has a unique approach to improvements in three key ways: First, it was developed by those who are most affected by it so that their realities are accounted for in its development and there is a certain homegrown effect that matters for the stakeholders who are attempting to use it. Second, ASIC tools seek to incentivize producers to perform better and ideally reward them for doing so. Third, ASIC is seeking to set up partnerships between buyers and supply chain actors in ways that foster understanding, equity, and proper incentives to drive improvement in the supply chain along with celebrating the stories that go along with the improvements.

RWA Invests in Trifecta Ecosystems to Fuel Sustainable Food Production and Economic Growth in Connecticut

United States. – On July 16th, the South Central Connecticut Regional Water Authority (RWA) announced an investment to bring innovative, sustainable farming and new economic growth to the Greater New Haven region. The RWA will provide an investment to Meriden-based Trifecta Ecosystems, allowing them to establish a regional aquaponics program in the Greater New Haven Region. Aquaponics farms are designed to ensure that families living in cities and other population centers have access to fresh, affordable, and healthy produce.

L. vannamei con enfe rmedad de las branquias negras (BGD)

The RWA's $500,000 investment will allow for the creation of a series of custom-controlled environment agriculture aquaponics systems, an urban farming technology platform, and workforce training programs aimed at improving food security and sustainable practices in the agriculture and fish-farming sectors. The RWA has the option to invest up to an additional $1.5 million with board approval.

Trifecta Ecosystems sells a range of products including a fully modular aquaponics farm capable of feeding at least 150 people per week, software to empower farmers to sell their produce, and smaller gardens and growing stations designed for schools and households. They also offer job-training for community members and engagement-based learning for students. Trifecta Ecosystems recently announced a partnership with the Capitol Region Education Council so that Connecticut's teachers will soon provide a hands-on aquaponics education to enhance the STEM education of their students.

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FAO – The State of World Fisheries and Aquaculture

Global fish production will continue to expand over the next decade even though the amount of fish being captured in the wild has levelled off and aquaculture's previously explosive growth is now slowing, says a new report by the Food and Agriculture Organization of the United Nations (FAO).

The latest edition of the agency's The State of World Fisheries and Aquaculture (SOFIA) report projects that by 2030 combined production from capture fisheries and aquaculture will grow to 201 million tonnes. That's an 18 percent increase over the current production level of 171 million tonnes. But future growth will require continued progress in strengthening fisheries management regimes, reducing loss and waste, and tackling problems like illegal fishing, pollution of aquatic environments, and climate change, the report adds.

"The fisheries sector is crucial in meeting FAO's goal of a world without hunger and malnutrition, and its contribution to economic growth and the fight against poverty is growing," said FAO Director-General José Graziano da Silva. "The sector is not without its challenges, however, including the need to reduce the percentage of fish stocks fished beyond biological sustainability," he continued.

Trends in global fish supply

Generally, the amount of fish being captured in the wild plateaued starting in the 1990s and has remained largely stable since. Despite that fact, the world has for decades been consuming ever greater amounts of fish - 20.3 kg per capita in 2016 versus just under 10 kg/pc in the 1960s — thanks in no small part to increased production via aquaculture, a sector which expanded rapidly during the 1980s and 1990s.

In 2016, production from aquaculture reached 80 million tonnes, according to SOFIA 2018 — providing 53 percent of all fish consumed by humans as food. While aquaculture's growth has slowed — it experienced 5.8 percent annual growth between 2010 and 2016, down from 10 percent in the 1980s and 1990s — it will still continue to expand in the coming decades, especially in Africa. Efforts to reduce the amount of fish being discarded at sea or thrown out post-capture — for example by using discards and trimmings to produce fishmeal — will also help meet ongoing increases in demand for fish products.

The status of wild fish stocks

Some 59.9 percent of the major commercial fish species that FAO monitors are now being fished at biologically sustainable levels, while 33.1 percent are being fished at biologically unsustainable levels — a situation that SOFIA 2018 describes as "worrying." (The other 7 percent are underfished). Just 40 years ago, 90 percent of FAO-monitored fisheries were being utilized at biologically sustainable levels, and just 10 percent were being fished unsustainably.

FAO's report warns that the world has diverged in its approach to sustainable fisheries, with worsening overcapacity and stock status — too many boats chasing too few fish — in developing countries offsetting improved fisheries management and stock statuses in developed ones.

Other challenges

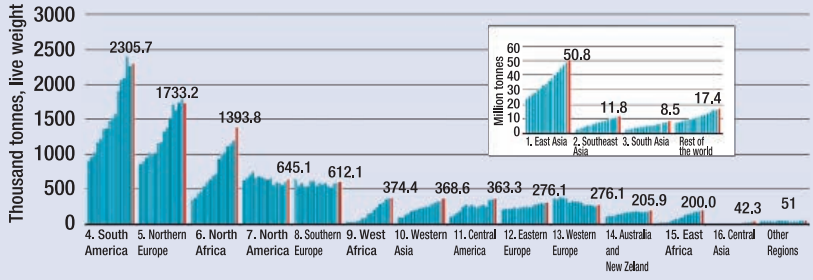
Climate change and pollution are also cause for concern. While research suggests that climate change might cause overall global fish catch levels to vary by under 10 percent, significant shifts in where fish are caught are anticipated, SOFIA 2018 notes. Catches are likely to drop in many fisheries-dependent tropical regions and rise in temperate areas of the north.

Shifts in the distribution of fisheries will have major operational, managerial, and jurisdictional implications, the report says. Research will be needed to develop strategies for allowing both fisheries and the species they exploit to adapt smoothly to climate change.

Also needed: strengthened collaboration to address the problems that abandoned fishing gear debris and pollution by microplastics are causing in aquatic ecosystems. Priority should be given to preventive measures that reduce marine litter and microplastics, efforts to upgrade recycling schemes to "circular economies" as well as phasing out single-use plastic, says FAO's report.

Fig. 1

Aquaculture production distribution among geographic regions (excluding aquatic plants)



Key numbers from *The State of World Fisheries and Aquaculture 2018*

• Total global fish production in 2016: 171 million tonnes

- Share of that from marine capture fisheries: 79.3 million tonnes

- From freshwater capture fisheries: 11.6 million tonnes

- From aquaculture: 80 million tonnes

• Amount of production consumed by humans as food: 151.2 million tonnes

• Amount of production lost to spoilage a/o thrown away after landing and prior to consumption: 27 percent of all landings.

• First-sale value of all fisheries and aquaculture production in 2016: $362 billion

- Share of that from aquaculture: $232 billion

• Number of people employed in fisheries and aquaculture: 59.6 million

- Percentage of those who are women: 14 percent

- Region with the most fishers and fish farmers: Asia (85 percent of the total)

• World's largest import market of fish and fish products: The European Union. Number two: The United States; Number three: Japan.

€566 BILLION AND GROWING: THE EU BLUE ECONOMY IS THRIVING

The blue economy represents all economic activities related to oceans, seas or coastal areas. It covers established sectors such as fisheries, shipbuilding and tourism as well as emerging industries, including ocean energy and biotechnology. In several EU member states, the blue economy has grown faster than the national economy in the last decade. During the financial crisis, the blue economy proved more resilient in those member states, softening the effects of the downturn on coastal economies.

The report presents the current status and recent trends in the six established blue economy sectors in different EU Member States, to gain insight into where new opportunities and sustainable competitive advantage may be found. The UK, Spain, Italy, France and Greece have Europe's biggest blue economies. Spain accounts for one fifth of total employment, followed by Italy, the United Kingdom and Greece. Combined, these four Member States account for more than half of the total blue economy-related jobs. Among Gross Value Added (GVA) of the different sectors, that of the 'living resources' (i.e. fisheries, aquaculture and processing) has grown by 22% between 2009 and 2016. Increased sustainability, thanks to the EU common fisheries policy, plays an important role in this positive development.

A prior Economic Report on the Performance of the EU Aquaculture Sector (2016) provides some background, with an overview of the sector's structure and economic per-

The EU's Blue Economy – all economic activities related to oceans, seas and coastal areas – is growing steadily, according to the EU's first annual report on the blue economy. With a turnover of € 566 billion (662.1 billion USD), the sector generates € 174 billion (203.5 billion USD) of value added and creates jobs for nearly 3.5 million people.

Fig. 1

European Maritime and Fisheries Fund (EMFF).
EMFF funding allocated to sustainable aquaculture.

Investments allocated to the aquaculture sector amount to €1.2 billion out of a total €6.4 billion.

The EMFF can also contribute to the competitiveness of the aquaculture sector by promoting marketing actions, Producers Organizations undertaken though Community-Led Local Development (CLLD).

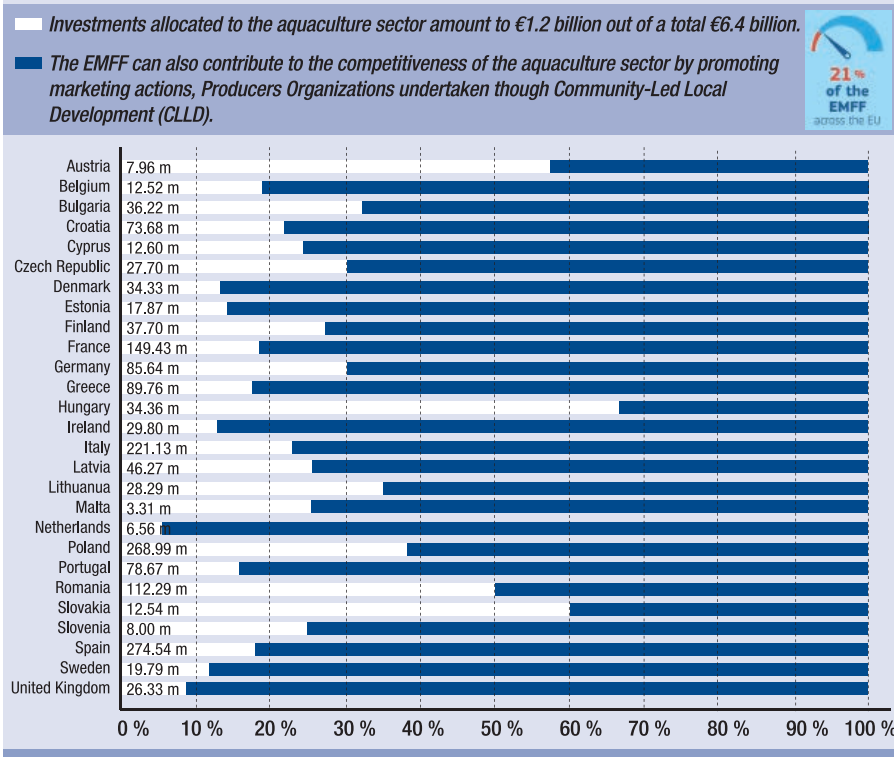


Fig. 2

Living resources - Value added (million EUR)

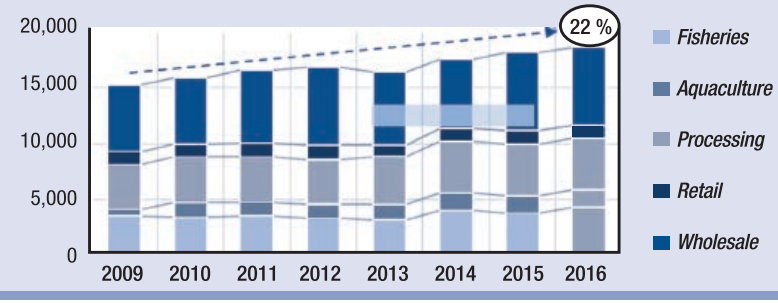


Table 1

Value added at factor cost (million euro)	Aquaculture		
	2016	%Δ 2016-2018	% over EU28 Total
Austria	-		
Belgium	-		
Bulgaria	12	170%	0.7%
Croatia	-39		
Cyprus	12	90%	0.7%
Czech Republic	-		0.0%
Denmark	37	30%	2.3%
Estonia	0	-81%	0.0%
Finland	17	-11%	1.0%
France	473		29.6%
Germany	9	248%	0.6%
Greece	119		7.5%
Hungary	-		0.0%
Ireland	49	48%	3.1%
Italy	231	10%	14.5%
Latvia	-		0.0%
Lithuania	-		0.0%
Luxembour	-		0.0%
Malta	14	168%	0.9%
Netherlands	41	-9%	2.6%
Poland	-		0.0%
Portugal	24	49%	1.5%
Romania	43	72%	2.7%
Slovakia	-		0.0%
Slovenia	1	-68%	0.0%
Spain	196	106%	12.3%
Sweden	18	109%	1.1%
United Kingdom	341	165%	21.4%
EU28	1,596	174%	

Table 2

Persons employed (number)	Aquaculture		
	2016	%Δ 2016-2018	% over EU28 Total
Austria	-		
Belgium	-		
Bulgaria	924	-33%	1.5%
Croatia	2,231		3.60%
Cyprus	388	55%	0.6%
Czech Republic	-		
Denmark	506	3%	0.8%
Estonia	36	80%	0.1%
Finland	515	15%	0.8%
France	16,454		26.5%
Germany	60	3%	0.1%
Greece	5,129		8.3%
Hungary	-		
Ireland	1,821	-7%	2.9%
Italy	5,112	-13%	8.2%
Latvia	-		
Lithuania	-		
Luxembour	-		
Malta	179	3%	0.3%
Netherlands	212	-46%	0.3%
Poland	-		
Portugal	2,357	2%	3.8%
Romania	2,542	-5%	4.1%
Slovakia			
Slovenia	20	-43%	0.0%
Spain	19,914	-31%	32.1%
Sweden	411	-3%	-0.7%
United Kingdom	3,310	9%	5.3%
EU28	62,121	28%	

formance for 2008-2014. EU aquaculture production was mainly concentrated in five countries: Spain, the United Kingdom, France, Italy and Greece, with 76 % by weight and 75 % by value of the EU-28 total. EU-28 employment in the sector in was estimated to be around 80,000 people, with the average yearly wage estimated at EUR 23,400 (6 % higher than 2012). The overall picture was of a sector with sluggish growth compared to the rest of the world in production weight terms, but faster growth in production value terms.

These reports assess aquaculture in three main sectors:

• The shellfish sector: profit EUR 165 million (193.02 million USD). The main countries are France (mostly oysters), Spain (mussels) and Italy (clams).

• The marine sector: profit EUR 99 million (115.81 million USD). The United Kingdom is the main salmon producer, with Greece covering mostly seabass and seabream.

• The freshwater sector: profit EUR 87 million (101.87 million USD). Italy, France and Denmark are the main producers of trout and, Eastern Europe, particularly Poland, is the main producer of carp.

The 2016 report indicated that in 2014 European aquaculture sales volume and value reached 1.3 million tons and €4.5 billion (5.26 billion USD). This corresponded to a decrease of 4% in sales volume since 2012; however, the sales value increased by 3% due to increasing prices compared to 2012. EU Data Collection Framework (DCF) data was complemented with Eurostat data to provide a full overview for all EU28 Member States. Looking only at the data provided under DCF the sales volume was the same as in 2012, whereas the sales value increased by 8% from 2012 to 2014 partly due to better coverage of the Greek aquaculture sector. The 20 countries covered under the DCF reported almost 12 thousand aquaculture enterprises. It was estimated that the total number of enterprises in EU28 was between 14 and 15 thousand. Almost 90% of the enterprises in the aquaculture sector were considered micro-enterprises, employing less than 10 employees.

Editor's note: In contrast, the USDA's Census of Aquaculture reported only 3,093 farms and a total value of sales of approximately $1.37 billion (roughly €1.1 billion at the time) for 2013.

NOTE

AquAdvantage® Salmon's Journey to Market: Still Making History

Making History is what AquaBounty Technologies has been doing ever since it was created in 1991. Originally named AF Protein (for antifreeze protein, the original focus of research), the Company was created to commercialize a fast-growing Atlantic salmon.

*By Dave Conley**

This salmon, created using recombinant DNA technology by a team of scientists based at Memorial University of Newfoundland, in St. John's, NL, Canada, grows to market size (4-5 kg) in about 18 months, instead of the 28-36 months it takes for conventional farmed Atlantic salmon. The basis for the rapid growth is the AquAdvantage gene construct. This single growth hormone gene from Chinook salmon and promoter sequence from ocean pout, when integrated into the Atlantic salmon genome, enabled the Atlantic salmon to grow continuously to adult size in record time, with the added advantage of using 25% less feed. This product was named AquAdvantage® Salmon (AAS).

It turns out that the science of creating the AAS was the easy part, taking only three years (1986-89). Developing and commercializing AAS has taken a journey that is now in its 29th year! For a start-up, that is an extremely long time to go without a market presence and a return on investment.

AquaBounty first approached the U.S. Food and Drug Administration (FDA) in 1993 to find out what the agency would require for AAS to be approved for human consumption. There was no regulatory pathway at

Interior of R&D Hatchery, Rollo Bay, PEI

R&D Hatchery in Rollo Bay, PEI

AquaBounty's salmon grows to market size (4-5 kg) in about 18 months, instead of the 28-36 months it takes for conventional farmed Atlantic salmon.

the time, and the Company initiated research which it assumed would be responsive to any eventual requirements. Many years later, but still before any clear regulatory path had been established, AquaBounty decided to create all-female populations of sterile AAS and grow them in land-based aquaculture systems. These all-female populations are created using conventional Atlantic salmon eggs fertilized with the milt from sex-reversed females that carry the AquAdvantage gene construct. Shortly after fertilization, the eggs are subjected to a pressure shock, which makes them triploid (three sets of chromosomes), thus sterile. AquaBounty proposed this product definition in hopes it would address concerns over the potential release of AAS to the environment.

Progress was slow until 2009, when FDA finally established Guidance 187 for the regulation of genetically engineered animals. Still, it was more than 6 years later when the product was finally approved on November 19, 2015. In Canada, approval came six months later, on May 19, 2016, when AAS was found to be safe to consume by people and livestock.

Backing up a bit, why was AAS approved as a drug? At the time of the application in 1995, there was no clear pathway for approval of a transgenic food animal. There were many discussions, stakeholder meetings and other activities intended to identify a regulatory pathway, but there was no consensus. Only in 2009, when a pharmaceutical product (Atryn) produced in the milk of a transgenic goat was about to be approved by FDA, did the regulatory pathway for animals crystallize. In Canada, AAS was approved as a novel food. Both FDA and Health Canada processes were based upon the Codex Alimentarius *Guideline for the Conduct of Food Safety Assessment of Foods Derived from Recombinant-DNA Animals.*

Grow-out Tanks, Albany, Indiana

One would think that with approval from U.S. FDA and Health Canada, the road to commercialization would now be straight-forward. It wasn't. Immediately after the U.S. approval, Senator Murkowski from Alaska, a long-time opponent of AAS, succeeded in having language inserted in the 2016 Omnibus Appropriations Bill that said AAS could not enter commerce until FDA issued labeling guidelines. AAS or any other fish resulting from genetic engineering would require labeling as "genetically modified." Consequently, FDA issued an Import Alert that prevented the Company from importing AAS eggs and fish into the U.S. This was done to comply with the language in the appropriations bill. Since the Company at that time did not have an approved U.S. broodstock or produc-

Early Rearing Tanks, Albany, Indiana.

tion facility, eggs or fish would have to be imported from either Canada or Panama, where the Company has a small production farm.

Fast-forward to 2018 and the Company now has two commercial production facilities ready to commence farming AAS. One near Albany, Indiana, the site of a former yellow perch producer, has been fully upgraded to produce 1200 metric tons per year, while another in Rollo Bay, PEI, Canada has been newly constructed to produce 250 metric tons per year. Both use state-of-the-art recirculating aquaculture system (RAS) technology that recycles more than 95% of the water and both deploy multiple and redundant escape barriers.

Approval of the facilities by the federal regulatory agencies in each country is the last requirement. The approval of the Indiana facility was received from FDA on April 26, 2018. However, the Import Alert issued in 2016 is still in effect and remains the last barrier to commercial AAS production in the U.S. It may be that approval in Canada comes before the impasse in the U.S. is resolved. But either way, 2018 will be the year that AquaBounty Technologies makes history by commencing the large-scale farming of an innovation that has taken far too long to reach the market. If all goes according to plan, the first commercial harvests in Canada and the U.S. will be in 2020. Until then, the limited production from our Panama R&D facility will be sold in Canada where 4.5 metric tons were sold in a test market in June 2017. Feedback from buyers was very positive and tastings at the recent Aquaculture Canada 2018 conference in Quebec City (Quebec, Canada) and the TasteTECH event during the INVENTURE$ conference in Calgary (Alberta, Canada) garnered great reviews. We anticipate consumers will be pleasantly surprised when they have the chance to eat our AquAdvantage Salmon.

RAS Broodstock Facility, Rollo Bay, PEI

*Dave Conley is Director of Corporate Communications at AquaBounty Technologies, Inc. He holds B.S. and M.S. degrees from McGill University, and is a Senior Consultant and Founding Partner of The Aquaculture Communications Group, LLC. He also serves as a Director for Aquaculture without Frontiers.

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STOUT & OYSTERS
OR OYSTER STOUT

There is some conjecture that this was an English idea – pairing Stout with Oysters – but the Irish took it to a higher level for sure. If you ever get the opportunity of visiting Dublin a visit to the Guinness Brewery is must!

But now an Australian company (Beer Garden Brewing) has recently launched the 'Angasi Coffin Bay Oyster Stout' and have created a true Oyster Stout. The launch took place on 24 June at 1802 Oyster Bar – Coffin Bay, South Australia.

One of the great promotions of our time was pairing Guinness (an Irish dry stout that originated in the brewery of Arthur Guinness at St. James's Gate brewery in the capital city of Dublin, Ireland and one of the most successful beer brands worldwide) with Oysters.

The Angasi Oyster *(Ostrea angasi)* used to have several other names (now obsolete since the inception of the Australian Fish Names Standard) such as southern mud oyster, Australian flat oyster, native flat oyster is endemic to southern Australia, ranging from Western Australia to southeast New South Wales and around Tasmania.

Extensive oyster reefs in southern Australia were largely destroyed

by over-exploitation during the 19th and early 20th Centuries when Oysters were dredged directly from the seabed. In recent times commercial oyster growers in southern Australia have started experimentally farming *O. angasi* to diversify their businesses. This was prompted by other growers suffering massive stock losses of *Crassostrea gigas* (Pacific Oysters) resulting from outbreaks of Pacific Oyster Mortality Syndrome (POMS).

Now we are seeing the birth of some great innovation through an interesting brew, this one based on a flavour pairing that can be traced back to 19th-century times.

The brewery launched its Angasi Coffin Bay Oyster Stout at the Great Australian Beer Spectacular (GABS) Festival. This festival showcases the best Australian and New Zealand craft breweries and cider producers and features hundreds of beers and ciders – including nearly 200 made just for the event.

The co-owners and brewers of Port Lincoln, South Australia based Beer Garden Brewing, Janie and Mark Butterworth, were reported to have said it was the brewery's first foray into the event and they would have kegs at the Melbourne and Sydney legs of the festival.

"The idea is that all the GABS beers are unique and brewed especially for the festival. Our Angasi has been getting quite a bit of interest due to the provenance of the ingredients and while we have conducted in-house tasting sessions of it we are really looking forward to the feedback from the broader craft beer community."

Odyssey Oysters, supplies and shucks the native Angasi and Pacific oysters, which were added in a permeable sack during the boil and removed prior to ferment of the beer.

The strong word is that the oysters were there to add depth to the stout and the result was a beer rich in flavour with a silky finish. The brewery is limiting the local release of the stout to 915 640-millilitre bottles with a label designed by Daniel Wells-Smith.

The Brewing company owners indicated that they were hoping to be able to showcase the region's well-known seafood products, something they pride themselves on by using other local products as well.

The Butterworths were reported as saying "Coffin Bay is such a famous region for the quality oysters that are produced there, and they employ a lot of people. We didn't invent the oyster stout, but we are keen to brew one and do it justice. There are a few other breweries that have also tried it, but we thought being right on the doorstep of Coffin Bay, it makes sense for us to give it a crack."

Often when the Butterworths explain they have brewed an oyster stout, people picture an oyster swimming around in their glass. But you will not even see an oyster at all due to the process currently engaged. You will, however, get the taste and flavour that comes from the Oyster input.

The options that craft breweries are bringing to the market enables more people to try new and adventurous beverages. In recent times this prevalence of craft beers in the market and different breweries and different styles, people are starting to get a bit more educated about what beer is and what beer can be.

Finding the product will not be so easy though. The Angasi Coffin Bay Oyster Stout; individually numbered, wax dipped and brewed with 40 dozen Coffin Bay Angasi and Pacific oysters is a limited release and the best way to obtain is communicating direct with the brewery.

Angasi bears the recently released certified independent seal of the Independent Brewers Association, available only to truly independent crafty brewers. It's the company's first beer to bear the logo and is one of, if not the first, to display the seal nationally. (#askforindiebeer - www.askforindiebeer.com.au)

ARTICLE

Intake Water – A Critical Component

of Success at Large-Scale Grow Out Facilities

By Chuck Blumenschein and TJ Willetts, Veolia Water Technologies

Inland fish farms utilizing recirculating aquaculture systems (RAS) will be key players to help meet the global demand for fish production.

Some industry observers expect the number of inland RAS systems to skyrocket in the near future. According to the independent research and advisory firm, Luxresearch, by the year 2030 more than 40% of the world's global aquaculture production volume will be grown in advanced RAS systems.

There are numerous factors for fish farmers to consider as they develop RAS projects and evaluate potential site locations. An experienced workforce, geographic proximity to key markets, climate, environmental regulations, and of course, available water sources and the ability to discharge water are a few of these considerations. Therefore, it is important to undertake an in-depth analysis of the physical, chemical, and biological characteristics of a potential site's water source.

The Importance of Intake Water Quality

Water quality is the most critical element of a RAS system. It helps ensure satisfactory fish health and can even affect the quality of the harvested product. The newest generation of large-scale RAS systems are engineered to be very efficient in recycling and maintaining water quality within the system. Though these systems are considered to be "closed-loop" and can recirculate more than 99.5% of the water, they still require a large amount of high-quality intake water to continually replenish the RAS system. Even in the most advanced RAS systems, the amount of intake water can range between 100 to 500 liters/kg of fish produced.

"Because inland fish farms rely heavily on their water source, it is vital for companies to thoroughly evaluate their make-up water sources in the early stages when developing a new aquaculture project," says Frédéric Gaumet, Ph.D., business development manager of aquaculture for Krüger Kaldnes (Norway). "Doing so can help ensure accurate project capital costs and prevent a negative impact on the health of the fish. Not to mention, performing this analysis at the start of the project can help companies avoid an expensive retrofit of equipment to properly treat incoming water."

Understanding Your Water Source

Though aquaculture has a very low water footprint when compared to other agribusinesses, it still depends heavily on a reliable source of water. Managing water resources efficiently can contribute to the overall success of a facility's operation. Because of this, water should always be a leading factor during the site selection process. It is important that aquaculture companies analyze all possible sources of water when considering site locations. Not only is the available volume of water important, but the physical, chemical, and biological characteristics are equally significant. Also critical is biosecurity. Regardless of the water source, there should always be some type of upfront water treatment process to ensure the water is disinfected to maintain the biosecurity at the facility. Depending on the water source, additional treatment may be needed to ensure a successful RAS operation.

Most likely, water sources at a potential site will include one or more of these: groundwater, surface water (rivers, streams, and lakes), seawater, or municipal (potable) water. Each water source has its own particular treatment challenges for RAS systems. For instance, surface and seawater may have contaminants and other biohazards that can create biosecurity concerns. It is possible to use sea or surface water as a supply source, but in all cases, the costs to treat this water should be closely evaluated.

If the site location is in a developed or urban area, facilities will likely be able to connect to a municipal water source. These sources are relatively consistent in terms of quality and quantity. Though this water source is very reliable, it still has treatment challenges. At the minimum, municipal water will need to be treated to remove residual chlorine and potentially trihalomethanes. The

RAS2020 at Swiss Alpine Fish, Switzerland.

largest downside of municipal water as a source for aquaculture is the cost. Water treated by the municipality can add operational expenditures that negatively affect the economics of the project. "Most new freshwater aquaculture installations will likely look to tap into available groundwater sources to fulfill their water intake needs, especially in installations that are away from coastal areas," according to Jonathan Moir, an aquaculture consultant based in Newfoundland, Canada.

Groundwater is usually the preferred source of water for inland aquaculture. Firms must ensure that the groundwater source can support the volume of water an aquaculture operation consumes year-round. The water supply should also be able to accommodate future production expansions and tertiary water needs, such as fish processing and hatchery and fingerling/fry additions. If considering a location based in a water-stressed area, companies need to be prepared to navigate government regulations that cap the total amount of water that can be used at a specific site. In some cases, these water usage quotas or rights can vary from year to year. According to Gaumet, "Capacity and flexibility is very important. You need to secure enough capacity in order to fill in systems within reasonable time at start up, between quarantine periods, cleaning, and other events. In most cases, a farm uses much more water than calculated only for the RAS."

At greenfield sites without an existing well, there are challenges in gathering information about the flow and water characterization, but there are usually resources available to help evaluate the available water. "Local municipalities, water boards, and environmental agencies typically collect and maintain historical data on groundwater reserves. These entities will likely be able to provide information about the water availability and quality for a particular area," says Moir. He adds, "It has been my experience that these agencies are very accommodating and support aquaculture companies by providing data that they can use when considering a particular location." Using this information, companies with the support of their RAS technology suppliers can understand the treatment challenges for the water and estimate the potential capital costs.

What are some of the key elements to identify related to intake water? Although required water characteristics vary greatly depending on fish species and type of system (fresh vs. saltwater), modern RAS's are able to highly control the water characteristics to maintain a very specific aquatic environment. These systems are able to monitor and adjust temperature, pH, dissolved gases, suspended solids, and ammonia in real time. When it comes to intake water, some key constituents can negatively impact the RAS's performance and jeopardize fish health.

Below are some of the most important water characteristics to evaluate when analyzing available water sources:

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) are inorganic salts and small fractions of organic material within the water supply. These include calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates. Though many fresh water fish can withstand relatively high levels of TDS (>400 mg/l) (Timmons et al., 2013), aquaculture facilities may face challenges discharging this water to the municipality or the environment. The sites most affected by this issue are those in inland regions that would prefer to discharge to surface waters. Many states have water quality standards that restrict the discharge of TDS to fresh water rivers and streams. Groundwater sources can have higher levels of TDS, depending on the depth of groundwater and the local geology. The cost to treat or responsibly dispose of higher TDS wastewater can significantly add to the CAPEX and OPEX of the farm.

Hardness (Calcium and Magnesium Levels)

Depending on the geographic location, both groundwater and municipal water are susceptible to having high hardness levels. Water hardness is a natural occurrence resulting from minerals that are dissolved in the water while flowing through underground geological formations. In most cases, hardness is not harmful to fish health; however, calcium carbonate can precipitate and create deposits within the various RAS components. Over time, these deposits can build up on equipment and prevent the RAS from maintaining suitable water quality to sustain fish health and maximize production. One area most susceptible to hard water is the RAS's biofiltration system. For RAS that use fixed film bioreactors, scaling can significantly restrict flow and prevent proper biological treatment. If a moving bed biofilm reactor (MBBR) is utilized, deposit build-up on the carriers can weigh down the media and reduce circulation inside the reactor. In all cases, this can result in poor performance of the biological process and result in an increase in ammonia levels, causing unsafe conditions for the fish. Another area susceptible to scaling is the degasser. Depending on the design of the sys-

RAS2020 at Swiss Alpine Fish, Switzerland.

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What You Should Know About Producing Both Floating and Sinking Feeds

Dana Nelson, Market Development - Aquaculture specialist, Extru-Tech, Inc.

Controlling the final bulk density of feed is not always as simple as it seems. Learn some of the lessons learned from the challenges of past and discuss equipment solutions directed at solving these problems.

Advanced Process Technologies for Micro Feed Production

Spencer Lawson, Process Technologist, Wenger Manufacturing Inc.

While specifically focusing on micro aquatic feed, twin screw extruder technology exists that will allow for production of direct extruded feed as small as 0.5 mm. With proper pre-conditioning and extruder die technology, production rates that were once very difficult to achieve, are now possible.

FORMULATION

Albert Tacon (CHAIRMAN)

Gilberto Hernandez - Gonzales

Bart Dunsford

Biosecure Shrimp Feeds and On-Farm Feeding Strategies

Albert GJ Tacon, PhD., Aquaculture Nutrition & Feed Expert, Aquatic Farms Ltd.

This presentation reviews the different feeds commonly used to produce farmed shrimp and discusses their potential risks, including the use of live hatchery and nursery feeds and the use of live and/or fresh food organisms for broodstock, and dry formulated shrimp feeds for shrimp grow-out operations.

The Use of Specifically Selected Probiotics in Shrimp Mariculture

Bart R. Dunsford, Ph.D., PAS., Business Development Manager, Lallemand Animal Nutrition

Pre- and probiotics have often been a potential solution to meeting disease challenges. However, the frequent use of random products can lead to variable and inconsistent results. Understanding the products is key to ensuring that the desired results are achieved.

Functional Feeds, Strategy for Reduction of Risks and Diseases in Aquaculture Under Challenging Times

Gilberto Hernandez-Gonzales, Aquaculture Manager N&CA, Nutriad

A most important feeding strategy to tackle complex disease problems is feed management. Functional feeds are positioned as part of a preventive strategy to reduce risk and impact of disease in aquaculture.

tem, scaling of the equipment can increase and result in harmful levels of dissolved gases within the RAS.

In most cases, intake water concentrations for hardness (CaCO3) should be under 200 mg/L. If not, water should be treated prior to entering the RAS. One common method to reduce hardness is to utilize a high-rate softener that can efficiently remove scale-forming constituents within the intake water before it enters the RAS. This treatment will significantly reduce the possibility of scaling throughout the system, resulting in favorable conditions for fish health and reduced maintenance costs.

Sulfate Levels

The water's sulfate (SO4) level is another parameter to analyze in preparation for a RAS project. Sulfate commonly occurs in water sources and usually poses no immediate concern for fish health. However, if intake water is high in sulfates and there is an accumulation of biodegradable material from spent food or fish waste, it can promote the growth of hydrogen sulfide-producing bacteria. Fish are very sensitive to hydrogen sulfide (H2S), and the RAS design should anticipate the potential for this condition to occur. "If there are elevated sulfate levels in the incoming water, it is important to ensure that the RAS is designed to prevent the build-up of solids in the system," says Michael Bech, Ph.D., of Krüger Denmark. He adds, "RAS designs that minimize hydraulic dead-spots will ensure that solids are not deposited and can be filtered out before they begin to cause a problem."

Organic Contaminants

Another characteristic that is sometimes overlooked in a water supply is organic contaminants. Agricultural runoff of pesticides and herbicides from nearby farms can infiltrate the groundwater. This is a greater concern if the water tables are shallow. Since the application of these on crops is seasonal, it will be important to monitor the water throughout the year to identify if this condition exists. If so, the water needs to be treated prior to entering the RAS to avoid fish harm or accumulation of these organics in the muscle tissue of the fish that can result in poor taste and possible odors. Organic contaminants can typically be removed with the help of an activated carbon filtration system.

Ensuring Success with Intake Water

Building a strong partnership with an experienced RAS technology provider that has an in-depth understanding and experience in water chemistry and treatment will help to ensure the success of an aquaculture facility. "It is important to engage a RAS technology partner as early as possible when developing a project and selecting a site," according to Moir. He adds, "Not only should your RAS

partner be experienced in RAS systems, but they should also have a thorough knowledge of water chemistry and the available water treatment." Through careful analysis of the water and pairing the technological mix to ensure the RAS performance, companies can prevent significant oversights that result in unexpected operational and capital costs.

The stakes are high as inland aquaculture transforms itself to be a staple agribusiness. Bioplans and business plans need to be accurate and executable for emerging companies to succeed. Water is a foundational element within these plans. Understanding how water affects a RAS's operation and the fish living inside of it can provide a competitive advantage for future aquaculture companies.

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Aquaculture certification:

A path towards sustainable aquaculture in Mexico

Georgia Born-Schmidt, Jordi Parpal Servole, Viviana Reyes Gómez and Marisol Gallardo Ángeles

The demand for products from sustainable aquaculture and fisheries is increasing rapidly, which is why many food companies and retailers request reliable certification from their suppliers, both producers and processors.

Currently there are international standards for many of the main species grown for human consumption such as shrimp, salmon, bivalves, pangasius, tilapia, freshwater trout and recently a joint standard between the Aquaculture- and Marine Stewardship Councils for seaweed. Worldwide, 621 farms, 1,524 suppliers and 11,904 products in 66 countries are certified by the Aquaculture Stewardship Council.[1]

While there are remarkable advances in the above described industries, another growing productive sector, the cultivation of ornamental fish, hasn't yet even begun to develop specific certification standards at the international level. First efforts began as early as 2008, based on a series of conferences on green certification of ornamental fish production in Brazil and India, countries with important production in this sector.[2] However, these schemes were focused on the sustainable capture of native ornamental fish in the wild. It is important to go one step further in these schemes including important aspects such as the traceability of organisms and the incorporation of tools like Hazard Analysis and Critical Control points (HACCP) as well as biosecurity

mechanisms to prevent the escape of individuals to the natural environment.

The species cultivated for the pet trade are often exotic invasive species. Invasives are currently recognized by the scientific community as the second biggest cause for loss of global biodiversity, evolving rapidly as a major concern for food security of developing nations.[3] In Mexico, national efforts for standard development are being advanced by the project "Enhancing Mexico's capacities to manage invasive alien species (IAS) by implementing the National Strategy on IAS." This project is being funded by the Global Environment Facility (GEF), guided by the United Nations Development Program (UNDP) and implemented by the National Commission for Knowledge and Use of Biodiversity (CONABIO).[5]

In Mexico, aquaculture began in the late nineteenth century, with the objective to feed the local population. Over time, new species such as tilapia, catfish and oysters have been introduced, all originating from other parts of the world, turning aquaculture into an important sector of the Mexican economy, and generating many jobs. According to the Agro-alimentary Atlas of Mexico, 61 different species totaling a production of 387,732 tons (over 850 million pounds) of fish are now produced in aquaculture in the country. Of these, 66.6% come from breeding facilities in national maritime waters and 33.4% in freshwater. Among the range of species bred, the Mojarra (tilapia) is the most important product in freshwater production. In 2016 its production increased by an annual rate of 35.5%, reaching a volume of 183.1 tons representing 10.4% of total fish production,[6] followed by freshwater trout production which reached 8,655 tons with an estimated value of 656 million pesos (roughly 35 million USD).[7]

Worldwide 26 thousand ornamental aquaculture farms are registered, many located on the Asian continent (Singapore, China, Taiwan, Malaysia, Indonesia), but also in countries such as the Czech Republic and the United States. All together, these produce 2,500 million organisms which represent a value of $56 billion dollars. In Latin America, specifically in Colombia, Brazil, Peru, Argentina and Venezuela, about 300 million organisms are produced in 3,532 farms.[8] In Mexico, aquarists started in the 1950s with the assembly of the first public aquariums and in the seventies, the first commercial fish farms were established. At the moment, the national production is spread over 23 of the 32 Mexican States, where 160 fish species are cultivated and around 66 million live organisms in 711 fish farms are produced per year. The State of Morelos with an annual production of approximately 32 million organisms is leading the ornamental fish production, followed by Yucatán with a production of 15 million individuals. These figures show a growth of 250% in the aquarium industry over the last 10 years, generating an estimated income of 120 million pesos (roughly 6 million USD) for producers in 2017.[8, 9]

Photo Balachandar Subramaniam (CC BY 2.0)

Why Get Certified?

A certification scheme, in addition to highlighting producers with higher quality production systems, can help improve operational efficiency, reach a greater market share and gain access to new markets while fetching higher prices. It also contributes to satisfying the buyers' demand for high-quality and environmentally-friendly products, and ultimately supports the long-term sustainability and prosperity of the industry. Through a certificate, responsible aquaculture is recognized and rewarded and the best socioeconomic and environmental choices are promoted when buying aquaculture products. In this way, a rigorous certification contributes to the transformation of aquaculture markets towards sustainability, in its social, economic and environmental aspects. A recognized certificate, whether national or international, sends a powerful message to consumers about the social and environmental integrity of the product they are buying.

The application of a certification scheme promotes legal compliance, preserves water resources and the environment, ensures the responsible use of foods of animal origin, as well as that of antibiotics and chemicals,[10] and, finally, through biosecurity measures prevents escapes which could pose a threat to native fish populations and aquatic biodiversity in general, as well as to the production facilities themselves due to the risk of spreading diseases. In the specific case of ornamental fish production, a certification also guarantees that relevant information about the species, regarding their needs, care instructions or risks, is passed along the value chain to the final consumer, which potentially leads to better animal welfare and diminishes the risk of intentional releases.

Koi carp Photo Bernard Spragg (CC0 1.0).

Why is a Certification by Third Parties Required?

Often the daily farm work does not allow one to perceive existing defects or opportunities for improvement. That

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is why it is necessary to have an external perspective to detect those opportunities. A certification audit verifies the implementation of the quality standard at the farm, and ensures that the established processes are followed and that they are functional and serve their purpose. Through the use of HACCP, they also offer the opportunity to reassess present risks and threats, and allow processes to be adjusted appropriately. "In the long term, this adaptive capacity helps to ensure that production processes provide maximum protection, even when emerging or new diseases are present".[11]

Status of Certification in Mexico

Despite the benefits mentioned above, in Mexico only a few production facilities are certified. This may be due to several reasons. On the one hand in recent years the subject was not included in the agendas of national aquaculture industry events and apparently there are no support schemes for the industry. On the other hand, international certifications are very expensive and the producers need to have a certain size / volume of production so that certification leads to a good cost to benefit ratio. In addition to this, there is a lack of interest of producers in certification due to a very short-term vision, but also, sadly still very little demand for certified products. Internationally, there is a clear trend in demand for certified fishery products but this trend hasn't yet percolated to the Mexican market. Therefore, an outreach campaign is required, aimed at both marketers and consumers of ornamental fish.

Promoting the certification of sustainable aquaculture production should guarantee good nutrition of the population, excellent quality of the products that facilitate its export, and environmental protection that helps comply with the Sustainable Development Goals (SDGs)[12] promoted by the United Nations. Additionally, efforts are required to make national certification schemes accessible to small producers. As already mentioned above, the first steps toward a standard and certification scheme for ornamental fish are under way. However, the desired change is not only achieved through incentives, but also requires the willingness of each of the producers, as well as the whole society as consumers of these products, to achieve this goal. Individual actions take strength in their sum, so it is important for the producers to get organized in associations that facilitate communication within the sector, as well as with society, academia and the government. Only if progress is made towards this direction, the Mexican productive sector of consumer and ornamental fish can achieve a competitive position in an increasingly tight and demanding market.

References are available from the authors.

Georgia Born-Schmidt, Jordi Parpal, Viviana Reyes Gomez: Project Coordination Unit *"Enhancing Mexico's Capacities to manage invasive alien species by implementing the National Strategy for IAS"* financed by the Global Environmental Facility (GEF), guided by the United Nations Development Program (UNDP) Mexico and implemented by the Invasive Species Program of CONABIO. Email: gborn@conabio.gob.mx Marisol Gallardo Ángeles: ISO Ambiental, email: gallardoangeles-marisol@gmail.com

Aquaculture
with floating and submersible nets

The cage-aquaculture industry has grown rapidly in the last 20 years and is evolving in response to globalisation pressures and the growing demand for aquatic products.

by Gianluigi Negroni

There has been an orientation towards the development and use of more modern cage systems in recent years. Modern cage design and construction has allowed access and expansion of aquaculture cages in new areas not previously used, such as lakes, water retention reservoirs, rivers and brackish, coastal and offshore marine waters.

Although the origins of the use of cages for the containment and transport of fish for short periods were almost two centuries ago in the Asian region, we know of their use even earlier in the indigenous practices of nomadic fishermen living on boats throughout Southeast Asia. Today, cage farming systems are very diversified, like the number of species bred. Rearing operations in traditional cages (typical of most Southeast Asian countries) consist of small cages, in contrast to modern production operations of using industrial cages for salmon and trout in Northern Europe and the Americas (with cages of more than 50 metres diameter and 20 meters deep).

The types and uses of different cages are generally adapted to the production environment and the economic objectives. The various production environments must, in turn, accommodate the cages and related mooring equipment. It is important to understand the challenges for cage culture development and in particular the need to minimise the rapidly growing potential environmental and ecosystem impacts and user group conflicts. An emerging trend is the adaptation of cage systems to withstand conditions in the open ocean.

Challenges of using aquaculture cages

We have a number of general issues to consider when approaching the challenges of using aquaculture cages. It is important to consider the breeding system and the consequent real and/or perceived effects of this system for the aquatic environment, the social and economic systems and the ecosystem:

• Nutrient water dispersion originating from dietary waste, from faecal waste from caged fish and the possible impacts (negative and/or positive) on water quality on the water surrounding the environment that affects the health of ecosystems.

• A risk of disease occurring within cage-fed fish and of the potential risk of disease transfer to wild fish;

• The dependence of carnivorous fish species reared in cages on fishery resources such as fish oil and fishmeal. Note that this dependence is not unique to cage systems, and also applies to various fish and crustacean species;

• An increase in the dependence of some cage breeding systems on the capture of wild fry and larvae currently not sufficiently available to satisfy the demand;

• The risk of fish escaping from cages and consequent potential genetic and ecological impacts on wild fish populations, and social impacts;

• Potential impact of cage activities on other animal species, including predatory birds and mammals attracted to fish inside cages;

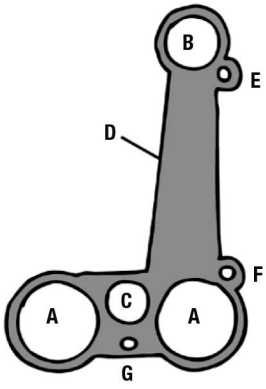
• Community concerns regarding the use of internal public and coastal water bodies for cages (due to the possible displacement of fishermen and others and/or perceived visual pollution); consequent need for greater consultation with all interested parties;

• A greater need to establish and implement appropriate government controls on the development of the sector, including environmental planning and monitoring, as well as the implementation of good management practices in cage farming companies;

• Greater public concern (in some developed countries and markets) regarding the environmental and ecological sustainability of intensive farming systems and in particular regarding the long-term ecological sustainability of breeding of carnivorous fish species.

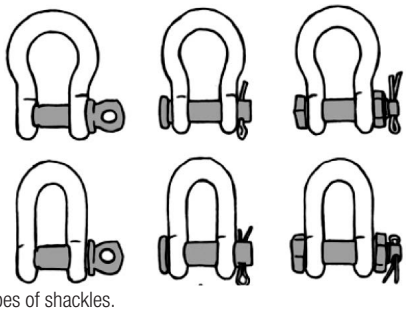
Fish breeding cages "use" the aquatic space and their environmental impact must be considered appropriately. Considering the Environmental Impact Assessment, an obligatory step in the development of any cage farm, some of the main considerations include: Modification of natural currents; Available historical data and the assessment of the potential risks associated with the location; Chemical pollution; Soluble wastes; the use of copper and zinc based antifouling on the network and moorings; Discharge of organic substances - this can represent a danger for the benthic population under

HDPE (High Density Polyethylene) collars and brackets.



Example of two-collar cage with working space for operator. Notes: (A) main floating pipe seats; (B) handrail pipe seat; (C) additional walkway pipe seat; (D) stanchion; (E) top-rail/handrail/jump net rope attachment point; (F) waterline rope attachment point; and (G) sinkers or sinker tube attachment point or seat for perimeter safety chain.

Shackles connected to the mooring plate.



Types of shackles.

and around the cages; Visual modification of scenic places; Farmed fish interaction with local species - escapes pose a risk to the environment as fish may behave predatorily. In the case of a large number of escaping individuals, the prey / predation ratio in surrounding ecosystems can be critically altered. Moreover, fugitives can induce "genetic pollution", i.e. "interbreeding" with wild fish.

The cage system

It is now accepted that cage culture systems can evolve further, moving into deeper waters and more extreme operating conditions. In certain environmental conditions (offshore) they minimise environmental impacts through a greater dilution of effluents, produce less visual pollution and through integration with low trophic species such as algae, molluscs and other benthic invertebrates (holothurians, annelids or echinoderms) can recycle part of the effluent in the immediate vicinity. The technical specifications and design options must be calculated for the key elements of the floating cage system, to meet the needs of the operator. Cage systems must be suitable and resist the forces of the environment in which they will be placed. The specifications of ropes, netting and other stressed structures are very important for resistance to marine energy forces and the finalisation of the system. The final design of the cage system must be calculated with an appropriate sizing for the quantity of fish to be raised per cycle.

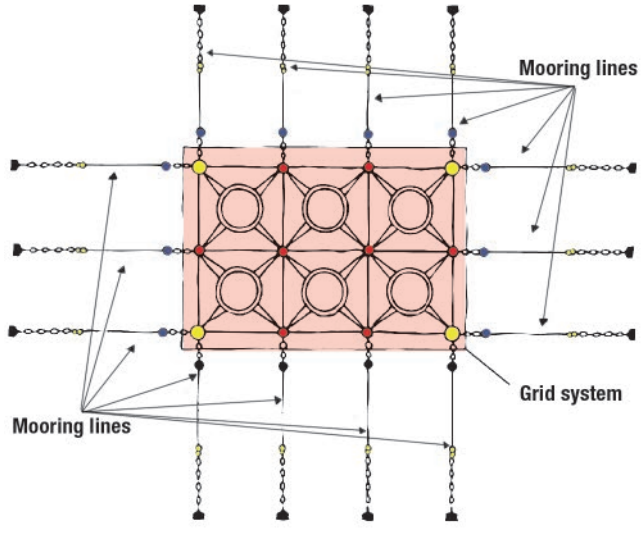
Floating cage system components

Ditching lines ("Mooring lines") and grid system for cages ("Grid system") typically include:

• Anchors (typically of 800 Kg); grills of various kinds with bolts and pins to connect the chains between them and the grid cages (yellow and red points in the accompanying drawing) and corner plates;
• Bottom chains for the ditching system;
• Signalling buoys for anchors and cages;
• Polyester ropes to connect the grid to the cages.

HDPE cage components

• The collar made of HDPE (High Density Polyethylene) pipes with a circular shape (can be more than one ring, can be filled with a floating material like polyurethane);
• Brackets that fix the collar and the walking area;



Mooring system.

• Ropes (including cables, nets and ligatures) connected to the collar;
• Weights of various shapes and dimensions to keep the nets in shape.

The migration of industrial cages to the "Offshore" areas

Protected sites have always been preferred for the installation of a cage. These are the easiest places to practice aquaculture in cages, both for the lower initial cost of investment and for the management of the farm. A protected place allows the use of less expensive cages that require a simple mooring system. The farms are generally close to the coast, so no powerful and fast boats are needed and the routine production activities can be carried out with easy logistics. However, a protected site is usually in shallow water with little current and with a low capacity to disperse waste, obliging the producer to consider lower fish density per cubic meter of cage.

Offshore disadvantages

Cages, mooring systems and nets must be more robust and suitable for exposed sites and are therefore more expensive. Logistics are also more complex and expensive, and the divers who perform the checks face challenges in approaching the cages in difficult climatic conditions.

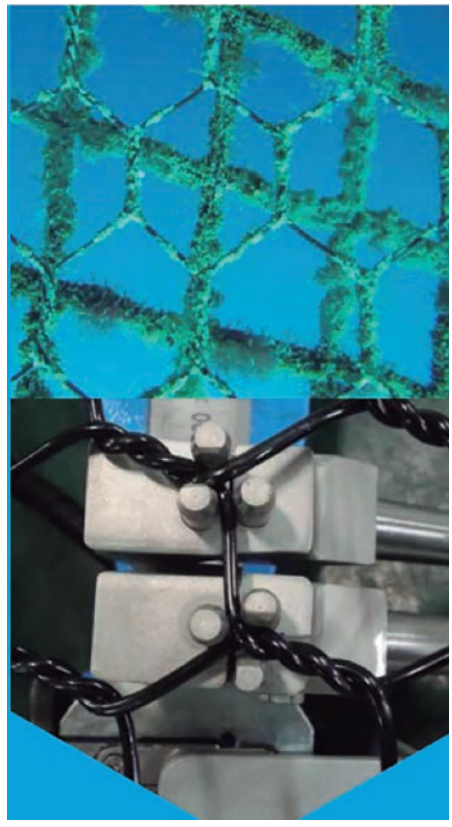
There are reduced numbers of feeding days when sea conditions are adverse, in the absence of automatic feeding systems, as well as strong currents increasing the dispersion of feeds. Finally, there are greater risks of escapes and bio-fouling on the nets will require more frequent cleaning.

Offshore advantages

The constraints listed above certainly contribute to an increase in capital and operating costs, however they are largely offset by a number of advantages. Cages moored in deeper water (> 35 m) and exposed to stronger currents promote waste dispersion and minimise the risk of localized pollution. Better water quality and faster renewal imply better breeding conditions and animal welfare including a lesser risk of epidemics and use of chemicals. Other advantages include higher oxygen saturation, consequent improved growth and lower feed conversion rates, minor visual impacts, reduction of conflicts with other resource users and lower fat/meat ratio in the harvested fish.

The correct placement of a cage farm is of fundamental importance as regards the overall technical and economic success of the commercial operation and the reduction of the ecological footprint of the farm. The nets of the cages are considered the weakest part both for their large surface exposed to the energies of the sea, and due to the fact that they are generally composed of less resistant materials (there are steel cages but at very high costs). As with other elements of the cage system, the nets are exposed to intense static and dynamic forces. They can also suffer more than other elements as

KikkoNet installation in Norway.

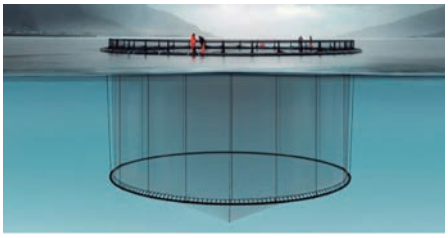


KikkoNet in water compared to nylon net (above) and while being tested (below).

Parameters to be considered in the selection of a cage site

Breeding animals important parameters	*Environmental factor important for the cage structure*	*Logistic and legal criteria*
Temperature	Depth	Legal and policy
Salinity	Wave frequency and protection	Accessibility
Pollution	Sea bottom	Security
Water suspended solids	Currents	Market proximity
Algal blooms	Fouling	Traditional territorial claims
Pathogenic organisms	Pollution	Permission procedures
Water change	-	-
Currents and waves	-	-
Fouling organisms	-	-
Oxygen	-	-

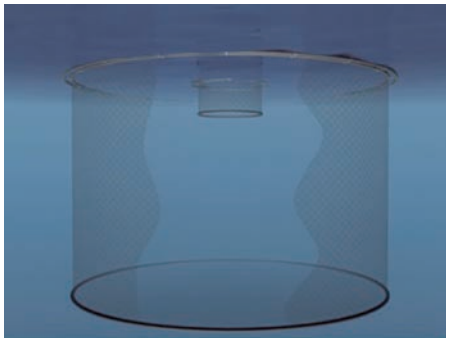
Source: Cardia, F. and Lovatelli, A. - FAO Fisheries Technical Paper. No. 498. Rome, FAO. 2007



Aquaculture cage, net pen and sinker tube.

Aquaculture cage, net pen and sinker tube drawing.

Aquaculture cage system 1.



Aquaculture cage system 2.

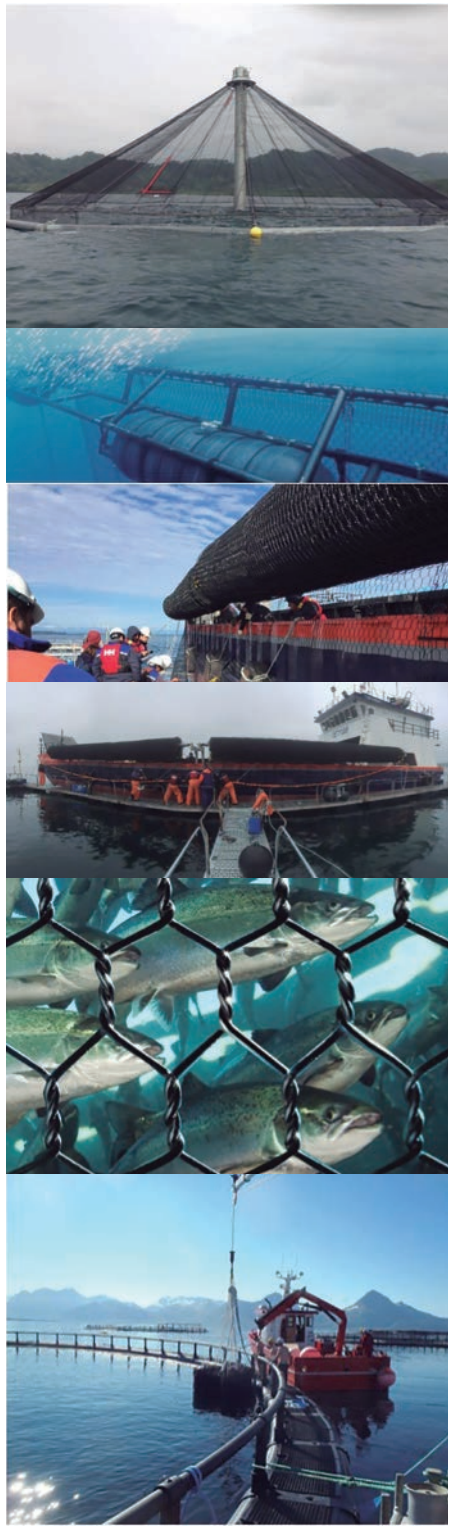
a result of bio-fouling. Nets can be damaged both by the fish that they contain and by the surrounding marine fauna, as well as subjected to mechanical accidents, theft or vandalism.

The industry has responded with various innovations to these problems, and new solutions continue to emerge. One of these is the "KikkoNet," a patented UV-stabilised monofilament material with characteristics designed to adapt to sites with a lot of marine energy and the accompanying possibility of breakage. Field tests and detailed studies indicate KikkoNet has physical characteristics of robustness suitable for the most exposed aquaculture sites. Currently the material is used in various countries of the world with different species of farmed fish. The salmon industry uses KikkoNet in Norway, Chile, Scotland and Australia (in these markets it is called Econet). For predator problems, especially marine mammals, special nets have been produced. SeaStation cages mount KikkoNet nets for their submarine cages.

Since polyester has less resistance to water, the semi-rigid structure allows the mesh to remain open without collapsing due to currents. Because the material is constructed from monofilament without pores, bio-fouling is greatly reduced. Additionally, since the netting is comprised of recyclable material, disposal costs are reduced for retired nets, and the environmental footprint is further reduced.

Conclusion

The solution for many problems currently associated with cage culture lies in the removal of farms from the coasts and their location in sites located in the open sea. The weakest parts that require more control and maintenance in the structure of an offshore farm are without doubt the fish containment networks. With new manufacturing technologies, there are new tools to solve the problems of net materials in exposed sites. The growing demand for aquacultured fish products will make it mandatory to develop industrial-scale ocean farms that will accommodate these types of high-energy resistant networks.



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WorldFish

Harnessing Research that Makes a Difference

In the developing world, more than 1 billion poor people obtain most of their animal protein from fish. Over 800 million depend on fishing and aquaculture for their livelihoods. WorldFish is an international, nonprofit research organization that harnesses the potential of fisheries and aquaculture to reduce hunger and poverty.

History

Researchers started discussing as early as 1971 the need for a concerted research effort on aquatic resources directed at low-income producers and consumers in developing countries. However, it was not until 2000 that the World Fish Center (WorldFish) was established in Penang, Malaysia, as a center of the Consultative Group on International Agricultural Research (CGIAR), a global agriculture research partnership for a food-secure future. Now, it has offices in Asia, Africa and the Pacific.

Scope

WorldFish has become one of the largest scientific research organizations in the world that concentrates on fisheries and aquaculture systems in developing economies. It works to advance knowledge, promote sustainable, evidence-based solutions and strengthen policy design and implementation, while sustaining the underlying natural resources and ecosystems on which both systems depend. The WorldFish research agenda focuses on three interconnected challenges:

- Sustainable aquaculture: to enable sustainable increases in livelihoods from aquaculture production without creating adverse socioeconomic or environmental impacts.
- Resilient small-scale fisheries: to secure and enhance the contribution of small-scale fisheries to poverty reduction and food security in priority geographies.
- Value chains and nutrition: to increase the availability, access and consumption of nutrient-rich, safe fish, especially for women of reproductive age, infants and young children.

With an annual budget of over USD 25 million, WorldFish conducts research in 19 countries in Africa, Asia and the Pacific, much of the time in partnership with an extensive network of national research institutions, universities, the private sector, NGOs and development agencies. All share a vision to help the millions of people who depend on fish for food, nutrition and income. The geographic focus of WorldFish is based on the current status and projected future potential for aquaculture and small-scale fisheries in developing countries, the probability that the program and its partners can effectively respond to demands for research and deliver impacts at scale, and striking a balance between the needs of regions where fish production and supply chains are more developed and must adapt, versus regions where they are less developed and offer promise.

Impact

WorldFish, with its partners, has raised incomes for millions of poor people by integrating aquaculture with agriculture and has empowered poor communities to participate in the sustainable co-management of their fisheries.

Drying fish in Zambia. A woman processor holds dried fish in a solar tent dryer, a simple technology that WorldFish scientists are developing, in Tangatanga fishing camp, Senanga district, Western Province, Zambia. Photo by Olek Kaminski, 2016, ©WorldFish, used with permission.

Fishing for hilsa in Barisal, Bangladesh. Photo by Balaram Mahalder, ©WorldFish, used with permission.

Sustainable Aquaculture

WorldFish and its partners have been breeding genetically improved farmed tilapia (GIFT) since the late 1980s. The latest GIFT generation shows that selective breeding for increased growth is still delivering gains of about 10 percent per generation. In Egypt, the Abbassa strain of Nile tilapia is also showing strong performance. A 2017 WorldFish survey conducted at 83 farms in four major tilapia-producing districts showed that the Abbassa strain had higher growth and required 13.2 percent less feed than another commercial strain to achieve the same production. It can also reduce greenhouse emissions by up to 36 percent over its production lifecycle. As a result, the Abbassa strain generated significantly higher profits (47.8 percent) per *feddan* (0.42 ha) compared to the other strain.

Now disseminated in more than 14 countries, WorldFish improved strains provide hundreds of thousands of small-scale farmers with an income and millions of households with a sustainable source of food and nutrition.

In Bangladesh, WorldFish has increased productivity and incomes by training and supporting more than 100,000 rural farmers to improve the productivity of their homestead ponds. This innovative approach has generated more than USD 120 million worth of additional production

> **"Last year,** my production using the common strain [of tilapia] was around 9.5 metric tons per hectare," says Mohamed Gamal, an Egyptian fish farmer who received the improved Abbassa strain in 2016. "This year, the production of the Abbassa strain reached 12 metric tons per hectare."

Putul Rani, Bangladesh. Putul Rani and her family depend on income from fishing to meet their basic costs. Putul and her husband are members of a hilsa conservation group, which aimed to raise awareness of the fishing ban and help protect hilsa stocks. In Hosenpur, Pakhimara, Kalapara, Potuakhali, Bangladesh. ©WorldFish, used with permission.

Aquaculture enclosures in Egypt. ©WorldFish, used with permission.

of tilapia, carp and shrimp, benefiting more than 500,000 farmers. In Cambodia, WorldFish has helped communities to improve the management of 40 community fish refuges, which provide a dry season sanctuary for brood fish. Despite drought, this has boosted the average fish catch from rice field fisheries by 9 percent, directly benefiting over 300,000 people and supporting effective implementation of government policies on fisheries, climate adaptation, and food and nutrition security.

Resilient Small-Scale Fisheries

WorldFish research aims to improve the resilience and productivity of small-scale fisheries, a critical source of food for people in developing countries. Hilsa is the national fish of Bangladesh and the country's most important single-species fishery. Approximately half a million artisanal fishers are directly involved in hilsa fishing, mostly in the Meghna River estuarine system in southern Bangladesh, and 2 million more are indirectly involved in the hilsa fish value chain. Hilsa yields declined rapidly in the early 2000s because of habitat degradation, overfishing and use of illegal fishing gear. The government introduced various conservation measures but many

Putul Rani is a member of a hilsa conservation group in her area. Since receiving training from the project, she has become a passionate advocate for hilsa conservation. "We tell people not to catch the juvenile and mother fish because one mother fish lays 2.2 to 2.3 million eggs. If the mother fish survive, we can save millions of hilsa for the next generation," she says.

An Egyptian farmer checks the condition of tilapia fry before releasing them into his ponds, Egypt. Photo by Heba El Begawi, ©WorldFish, used with permission.

fishers—who have few alternative sources of income—continued to fish illegally. Through the USAID-funded Enhanced Coastal Fisheries in Bangladesh (ECOFISHBD) project (2014–2019), WorldFish is working with the Bangladesh Department of Fisheries and other partners to support research-led decision-making in fisheries co-management and improve the livelihoods of communities reliant on hilsa.

More than 448 conservation groups in 125 villages have been established since 2014, with women making up 30 percent of members. The project has also recruited and trained 200 community fish guards to patrol sanctuary areas. Data collected by WorldFish from three hilsa sanctuaries over two harvest seasons (July 2015–June 2016 and July 2016–June 2017) showed that the total hilsa catch increased by 28 percent, from 387,211 metric tons to 496,417 metric tons. The catch is expected to exceed 500,000 metric tons in 2018, prompting the Bangladesh government to lift the ban on hilsa exports that has been in place since 2012.

The relatively cheaper price—brought down by the greater availability—also saw household consumption of hilsa almost double. Particularly notable was consumption by women, who in rural households often sacrifice their own dietary needs for other family members. In the study area, women's hilsa consumption rose by more than 60 percent.

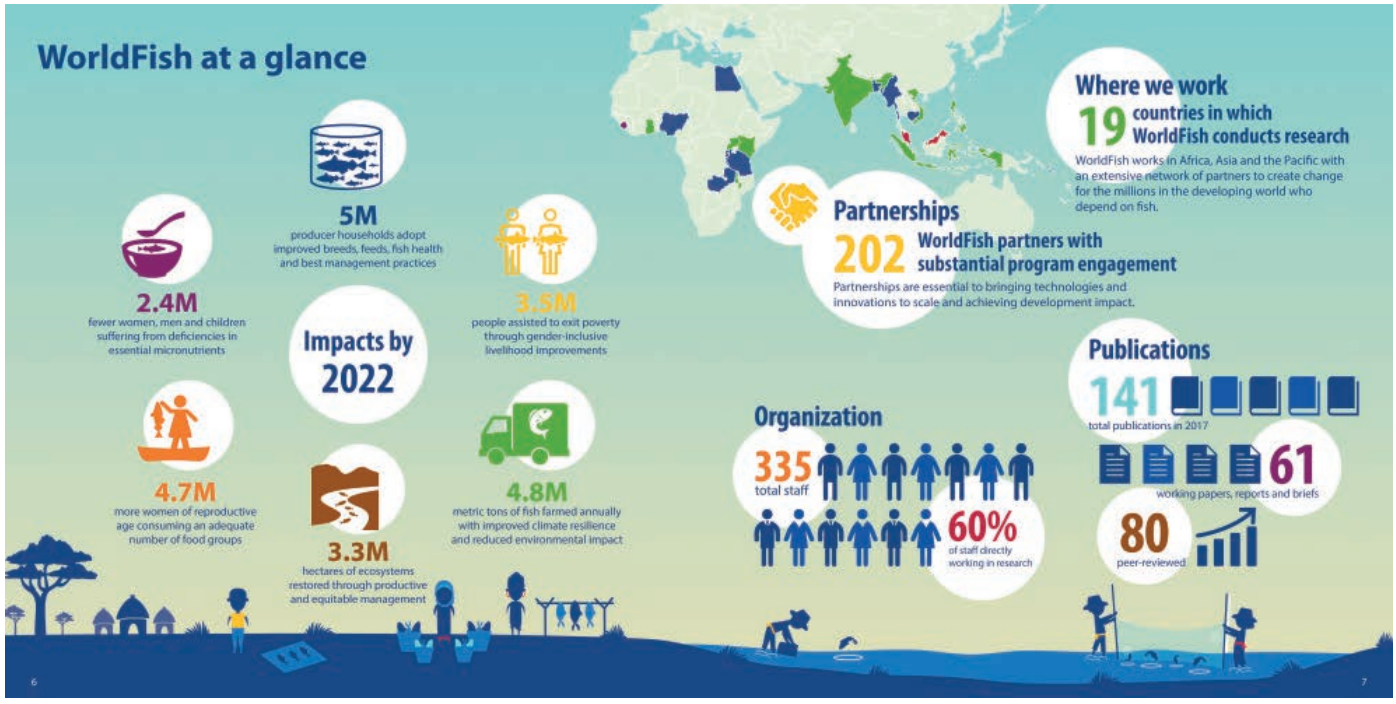
Value chains and nutrition

Efforts to boost cross-border trade have become increasingly prominent elements of African regional integration and economic development agendas. Trade across the borders of many African countries is often difficult and slow, leading to high transport costs and risks to merchandise. Fish, which are highly perishable, are particularly vulnerable to delays.

Data gathered at various border posts in the four trade corridors of Southern, Eastern, Central and West Africa showed a massive movement of fish between countries. Yet the research also showed how customs and bureaucratic formalities at the border posts hampered this movement. For instance, at a border post between Zambia and Namibia, an inspector from the Zambia Bureau of Standards reported that cross-border trucks carrying fish products sometimes spend six to seven days waiting for their goods to be cleared.

Working with the Southern Africa Development Community (SADC), WorldFish supported the concept of one-stop border posts, which give neighboring countries authority to enact their rule on the other country's side of the border. This means only one stop for people and goods crossing the border. WorldFish also helped to formulate 11 harmonized standards covering several fish products and areas, including fresh, frozen, farmed, salted and smoked fish, fish snack products, fish sausages, canned sardines and tilapia, which were approved by SADC member states in 2017. The next step is for the countries to implement the policies. Zambia is currently leading the way, with the Zambia Bureau of Standards launching the country's harmonized fish stan-

AIN Project in Bangladesh. Photo by Habibul Haque. ©WorldFish, used with permission.



dards and implementation plan in November 2017. Once the implementation process is complete, the expected benefits from better access to intraregional markets on competitiveness and food security, and a more rational exploitation of natural resources, could be immense.

Crosscurrent

To achieve impact, WorldFish uses results-based management focused on research and development outcomes, with rigorous external evaluation and impact assessment. Targets are calculated using data from outcomes of prior aquaculture and small-scale fisheries research, including external impact evaluations, and the knowledge of WorldFish researchers and partners in aquaculture, small-scale fisheries and fish value chains.

> **"Manufacturers can import or export** their fish and fisheries-related products without non-tariff barriers because there is equivalence in the treatment of both local products and imports within the region," says Manuel Mutale, Director of the Zambia Bureau of Standards.

Future

WorldFish is committed to the UN's Sustainable Development Goals (SDGs). These global challenges are reflected in its strategy. WorldFish work contributes directly to 13 of the SDGs, particularly SDG 1 No Poverty and SDG 2 Zero Hunger. Fish, particularly small fish, are rich in micronutrients such as vitamin A, iron, calcium, zinc and essential fatty acids. WorldFish strives to make fish available and affordable to the poor, helping to combat malnutrition and alleviate nutritional deficiencies that often occur in developing countries, thereby contributing to SDG 3 Good Health and Well-being. The cross-cutting theme of gender in its work allows the organization to contribute to SDG 5 Gender Equality. Rural women have a major role in fisheries and aquaculture, but they often have unequal access to the resources and services they need to be successful. By closing this gender gap, WorldFish helps to improve productivity and increase incomes and food security for all.

WorldFish has been recognized with a Tech Museum Award and several World Bank Development Marketplace Awards. Dr. Modadugu Vijay Gupta, retired Assistant Director General of WorldFish, won the 2005 World Food Prize for his life's achievements in enriching the diets and lives of the world's most impoverished families.

WorldFish has clear impact targets mapped out. By 2022, it intends to assist 5 million producer households to adopt improved varieties of fish, lift 3.5 million people out of poverty, prevent 2.4 million people from suffering from micronutrient deficiencies, restore 3.3 million hectares of ecosystems, see 4.7 million more women eating nutritious diets and have 4.8 million metric tons of fish farmed per year.

These are ambitious but necessary targets. Let's hope that WorldFish can rise to the challenge. am

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Latin America Report: Recent News and Events

By: Staff / Aquaculture Magazine

CESAIBC and CICESE sign a General Collaboration Agreement in Baja California

Mexico. - In July 2018, a General Collaboration Agreement between the State Committee on Aquaculture Health and Safety of Baja California (CESAIBC) and the Ensenada Center for Scientific Research and Higher Education (CICESE) was signed, aiming to open new spaces for courses, academic stays and student's and academic's projects with the productive sector of the State. The agreement, in turn, will provide Committee staff with training opportunities, with special attention to problems in terms of production, health and farming of aquatic organisms.

In a release, Héctor Manuel González, president of CESAIBC, said that the Committee was formed in 2005 and that it is currently comprised 100 percent by aquaculture producers of Baja California, representing 85 mollusk, crustacean and fish production operations. He also emphasized that the agreement has as its main objective "to establish academic cooperation programs, combine efforts and resources, share knowledge and information to improve the capabilities of related and complementary institutions and ensure the development of the activities of both institutions."

In detail, the actions considered include conducting scientific research, technological development and linking projects, as well as providing advisory and consulting services. Training and exchange of human resources, evaluation of technologies and techniques related to the areas of interest will be emphasized. The identification, concentration and diffusion of technical or scientific information, the transfer of related technology and the realization of academic stays and laboratory and field practices of master and doctorate students in Aquaculture sciences of the CICESE will also be addressed.

Héctor Manuel González Alcalá and Alfonso Fajer Zamora, president and director of CESAIBC; and Guido Marinone Moschetto, general director of CICESE. Source: CONACYT.

Rufina Hernández Martínez, director of Postgraduate Studies, said: "Much of the work we do in aquaculture is applicable in the short and medium term. That's why it's important to involve our students in real life. "

SUBPESCA performs seminar on the impact of climate change in fisheries and aquaculture sectors

Chile. - The impact of climate change on fishing and aquaculture activities was the focus of a seminar that the Fisheries and Aquaculture Undersecretary (SUBPESCA) held in July in Valparaíso. Chile is the first country in Latin America that has an Adaptation Plan for Climate Change in Fisheries and Aquaculture. During the seminar, the economic importance of fishing and aquaculture in the country was underlined. Together these activities generate average annual landings of 3.7 million tons.

The Undersecretary of SUBPESCA, Eduardo Riquelme stated: "Climate change is quite evident and has an impact on fisheries and aquaculture, and it is very important that we can deepen our understanding of this matter."

Doris Soto, member of the Interdisciplinary Center for Aquaculture Research, made a projection about

the phenomenon: "Predictions in the area suggest, for the middle of the century, at best, a reduction in fishing potential between 2% and 5%; while, in the most dramatic scenario, it will decrease by 7% to 12%." In relation to aquaculture, she warned that the consequences might be ambivalent: "The increase in sea temperature may mean more growth for some species, but the increase in acidification of the oceans may hinder the production of mollusks or crustaceans."

For his part, Luis Cubillos, a researcher at the University of Concepcion, highlighted the fact that multiple communities depend on fishing and aquaculture, and pointed out the need of implementing adaptation plans in fisheries and aquaculture, over mitigation, as well as including them in an ecosystem approach.

Skretting Ecuador teams with shrimp farmers to deliver maximum profit

Ecuador. - Skretting Ecuador has launched Skretting 360+, a groundbreaking precision shrimp-farming concept that maximizes profit per hectare per day. This is in keeping with its long-term commitment to allow the country's shrimp industry to sustainably increase its production while at the same time reducing its exposure to risk, and also to empower farmers and reduce costs. This concept has shown to significantly increase profitability at the farm level.

Skretting 360+ is a complete package of precision-based innovative tools, incorporating precision nutrition, farm management practices and proactive technical support, all delivered via the Skretting AquaSim app. It provides a complete overview of the business, with full control of the total cycle. The development process began 20 years ago, with growth models for salmon and other fish species – the original AquaSim. Over the past 5 years, Skretting has been developing the concept for shrimp based on research, experimentation and validation.

It has the capability to benchmark the performance of each cycle and manage feed and harvest predictions customized to every pond. The collection of essential real-time data enables teams to take proactive and preventive action to help customers get the maximum value from their farm in a sustainable and cost-effective way.

Carlos Miranda, Managing Director Skretting Latin America said "We can't do this without the commitment from our customers. The future is in our hands and the opportunity is now."

Argentina and Norway Sign Aquaculture Cooperation Agreement

Argentina. – During the last days of May 2018, the Ministry of Agribusiness of the Nation signed a cooperation agreement with Norway, to study the feasibility of the development of sustainable aquaculture in the country, more specifically in the waters of the Beagle Canal, with a focus on salmon aquaculture.

The Ministry of Economy authorized the release of 95 thousand dollars for the Ministry of Agriculture, Livestock and Fisheries, to carry out the studies. The Norwegian company "Innovation Norway" will be in charge. The study of environmental conditions includes the analysis of marine currents, temperature, pollution, waves, measurements and surveys of marine topography.

It was stated that prior to the installation of the "salmon farms," studies will be carried out "to evaluate the carrying capacity of the area" so it will be possible to generate a "sustainable fishery."

News from the Aquaculture Stewardship Council

Sales of ASC-certified products in the Netherlands rise by a third to 200 million euros

Total sales of ASC-certified products in Dutch supermarkets increased by a third in 2017 as shoppers continue to embrace responsibly sourced seafood. Analysis by research agency IRI found that sales of ASC-certified seafood in supermarkets was over 200 million euros in 2017 – a 33 percent increase on 2016. That's 50 million euros more being spent on responsibly sourced seafood in Dutch supermarkets.

The robust growth in the value of ASC-certified sales is part of a wider trend of rising awareness of the importance of certification among Dutch shoppers, with seafood leading the way. In the Netherlands in 2017 one in every seven euros spent on supermarket food was on the purchase of products with a certification mark. For seafood, the figure is even higher, with two in every three euros spent on a product with the ASC or MSC certification mark – that's 66% of supermarket seafood sales.

The figures show that even though shoppers in the Netherlands are among the most aware of the importance of responsible seafood in the world, there remains a great deal of potential for growth in this area for retailers and producers.

Anne-Marie Kats, Commercial Marketing Manager of the ASC in the Netherlands, said: "These results are a huge vote of confidence from Dutch consumers in the importance of ASC-certification and responsibly sourced seafood. The big growth in sales proves the value of credible certification for retailers and consumers alike. For shoppers who want to know their food is produced by farmers that protect the environment and safeguard workers and communities, there is more choice than ever in Dutch supermarkets. For retailers and producers, certification is an effective way to demonstrate quality.

"Many suppliers and retailers in the Netherlands have led the way when it comes to embracing certification and these sales figures show that this has been appreciated by their customers. Hopefully this will encourage many more to follow suit."

Largest chain of sushi restaurants in the Nordic region becomes first to serve ASC certified sushi in Sweden

The Swedish chain Sushi Yama has become the first sushi restaurant in the Nordic region to achieve ASC certification. The restaurant chain attained Chain of Custody certificate following a rigorous assessment by the independent certifier Kiwa Sverige.

"Sushi Yama is proud to gain our ASC certificate. We are committed to serving seafood that has been pro-

duced with care for the environment, for workers and for local communities," said Danny Barsoum, Chief Brand Officer at Sushi Yama.

"I am delighted to welcome Sushi Yama to our programme for responsible aquaculture," said Inger Melander, ASC's Commercial Marketing Manager Northern Europe. "We have seen a growing interest in seafood certification from restaurants and food service in Northern Europe. Sushi Yama's pledge to source and serve responsibly produced seafood is a sign that we are heading in the right direction and that our hard work to promote responsible aquaculture is paying off. I look forward to other restaurants following suit."

Commitment to responsibly sourced sushi

Sushi Yama is the largest sushi chain in the Nordic region. Having opened the doors to its first restaurant in Stockholm in 2008, the chain has expanded its reach to include 35 outlets across Sweden, whilst also running its own academy for in-service training over the last decade.

"We see more customers asking about the origin of their sushi and how it has been produced," according to Danny Barsoum.

Such customer interest is confirmation that responsibly produced sushi is not just a passing trend; it is an important aspect for those who love seafood and Japanese cuisine, also for those who serve it. Certified sushi has become an ever-growing success globally, especially in those parts of the world where traceability and provenance of ingredients is strictly regulated.

ASC Staff
http://www.asc-aqua.org/

Gorjan's Lament

No, Gorjan, you're wrong … we DO have another Norway!

*By Neil Anthony Sims**

Gorjan Nikolik of Rabobank is indisputably one of the world's most insightful and authoritative aquaculture economists. His pronouncements are always worth pondering. If you based your investment strategy on Gorjan's projections, you would probably have more peace of mind than if you were investing alongside Warren Buffet. But … none of us are perfect.

Recently, Gorjan shared his assessment of the future salmon market demand ("… we need another 1.4 million metric tons by 2028"), and he bemoaned the fact that "we need another Norway, but we don't have another Norway"[1].

This once, Gorjan, you are mistaken. We actually *do* have another Norway. We have multiples of other Norways. You are just looking at it all wrong. But it's a common misperception. Here, for example, is what most people think of, when they think of Norway:

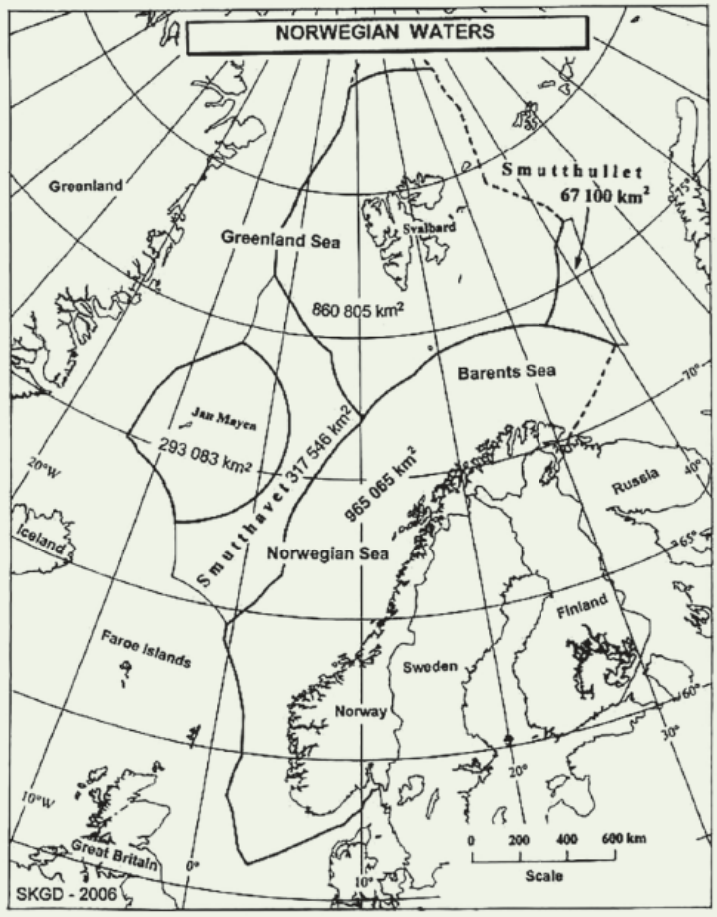
Fig. 1

Map of Norway's land area.

Fig. 2

Norwegian Exclusive Economic Zone.

— 200 nm or agreed delimitation line - - - computed median line — 200 nm zone for other nations



The total land area of Norway is a mere 385,252 square kilometers. From end-to-end, in a straight line, Norway's coastline extends only 2,650 kilometers. But it is deeply indented, so if you measure Norway's coastline on 30 m intervals, it extends for 83,281 kilometers (51,748 miles).

That sounds like a lot, but it is still finite. And Gorjan's lament was that the coastline of Norway was of fixed, determined length. Most salmon net pens are tucked away within a few kilometers of that coast.

Gorjan assumes – as would most people knowledgeable in the art – that the current number of salmon net pens around the coast could not be increased, without increasing the attendant risks of ecological impact or compromising farmed fish health.

Open Blue

But it's all a question of perspective, really. Here, for example, is how you might think of Norway when you think of the expansion opportunities offshore[2].

It's a little over 2 million square kilometers, or around 5 times Norway's land area, when you count the EEZ waters around Jan Mayen and Svalbard (Figure 2).

"Well, sure!" you might say, "But that is out in the middle of the North Sea. Who would possibly want to grow fish out there?" Who, indeed?

Many of us have previously thought of Open Blue – the cobia operation that is located 12 kilometers offshore of Panama – as the epitome of offshore aquaculture. It is a phenomenal operation, with capacity for up to 22 Sea Station net pens, each over 6,000 cubic meters in volume, and with a total production capacity of over 3,000 tons of cobia per annum. This site is regularly exposed to short period storm waves between 15-25 ft (5-8 meters).

(Parenthetically, speaking of Open Blue, let's please offer a round of applause for their recognition at the recent Barcelona Seafood Summit as a SeaWeb Seafood Champion. This is a richly deserved reward, and I believe is the most obvious representation of the growing recognition among the environmental and NGO community of the importance of offshore aquaculture in the scale-up of sustainable seafood. Well done, Open Blue!)

But that's generally what we think of, when we think of offshore aquaculture. Cobia or Seriola or snapper in Sea Stations or Aquapods, or one of the new styles of submersible Polar-Cirkel net pens, usually in tropical waters, where the water temperatures and clarity are more amenable to the SCUBA-diving that we all believe is an essential part of the work. When we think of "exposed water" aquaculture, we also think of tuna ranches, and the Mediterranean seabass and sea bream operations. Turkey, for example, has mandated that all new net pens must be located at least 1 km offshore, in waters at least 30 m deep. And the Mediterranean has a reputation for brutally steep, short-period storm swells.

For exposed water aquaculture, however, the reality is that the most challenging engineering, and the greatest volume of production, comes from the salmon sector. Polar-Cirkel style surface pens are being proposed or deployed for salmon farming in increasingly exposed sites, from Norway and Scotland to Newfoundland (where some salmon sites are fully exposed to the Atlantic, with fetch stretching to Antarctica), Bass Strait (some of the roughest waters along the southern coast of Australia) and sites in Chile that face the full wrath of the Roaring Forties, whipping across the Southern Ocean.

Salmon farming is so profitable at the moment, however, that wherever there is an opportunity to grow more salmon, you can trust our Norwegian colleagues to pursue it with utmost vigor! A recent auction for salmon licenses in Norway resulted in an average price of NOK 150 million (around USD $18 million) per license[3]. That's just for the permission to grow the fish, before you even think of the net pens and moorings and feed and staffing … And the Norwegian government, recognizing the perils of piling fish pens ever-more closely upon each other, is now actively encouraging the development of innovative engineering to empower salmon farming in deeper waters, further offshore – in the so-called "Green" development licenses.

And so … hark, ladies and gentlemen, the future of offshore aquaculture is now upon us! Salmar's Fish Farm 1 – the oil-rig-like contraption that seems carved from a science fiction comic - is now a reality, already deployed into the North Sea, and stocked with over 150 million fish. Nordlaks reportedly has under construction a system that seems like a hybridization of Wave-Master-style steel pens and a supertanker, that will be over 430 meters in length. AKVA is developing their own submersible Polar-Cirkel-style net pen, and Cermaq is relaunching their concrete floating closed containment system, this time with a steel rim to provide additional strength and floatation.

Salmar is also reportedly doubling down on their concept, with a "Smart Fish Farm" design that is double the size of Fish Farm 1, over 150 meters in diameter[4]. It will be engineered to withstand waves over 31 meters in height (the accuracy of that estimate is both reassuring, and somewhat unsettling) and should be

able to hold 3 million salmon at a single stocking. The capital cost for the system is anticipated to be over 150 million Euros.

Fish Farm 1 was constructed in China, and then towed to Norway. The Chinese have watched the Norwegians, and of course, are now seeking to emulate them. A Chinese copy – a so-called "intelligent fish farm" – is now under construction in Qingdao, China[5]. This consists of three integrated platforms, each 110 m in diameter, and 250,000 cubic meters in capacity. Each platform will be stocked with 10 million pompano, yielding a harvest of 6,000 metric tons. That's twice the production capacity of the Open Blue site in Panama, from just a single cage.

So when Halley Froehlich, and her colleagues at UCSB's National Center for Ecological Analysis and Synthesis, recently prognosticated that offshore aquaculture had the potential to produce 100 times the current global seafood consumption (around 15 billion tonnes),[6] everyone was mightily impressed. It is worthwhile remembering, however, that this estimate was limited to waters that were shallower than 200 m. Given the developments in Norway and China, we have to start asking – what kind of world could we envision if we had not one more Norway, but 100 x 100 more Norways

We seem to be only constrained by our limited imaginations. We should try to fix that first, perhaps …

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Recent news from around the globe by Aquafeed.com

*By Suzi Dominy**

Mergers, takeovers and rumored acquisitions abound in the world of feed and nutrition this year.

Consolidations continue as industry matures: Business moves, ingredient views and market trends in aquaculture feed

Overshadowing all of them in terms of scale is Bayer's acquisition of Monsanto, for $66 billion, although quite how that will affect feed commodities is not certain. Of more obvious impact is the move by Archer Daniels Midland (ADM), one of the world's largest agricultural processors and food ingredient providers, to buy Neovia for €1.535 billion (USD 1.79 billion) cash. The acquisition will substantially increase ADM's aquaculture footprint.

Bayer AG Chief Executive Werner Baumann, and Monsanto Co. CEO Hugh Grant.

Neovia manufactures and sells a wide range of nutrition solutions for the feed industry, operating in business lines that include premix and value-added services, additives and ingredients, aquaculture and complete feed. Through acquisition, the current portfolio includes Epicore and BernAqua hatchery feeds and specialty feed firm, Pancosma. The company, which is currently majority owned by leading French agricultural cooperative group InVivo, has about 8,200 employees. It has extensive innovation capabilities, with 11 R&D centers in six countries. It had global sales of €1.7bn (USD 1.98 billion) in 2017, and, with very limited presence in the United States and more than 75 percent of its sales coming from outside Western Europe, the company's footprint complements ADM's.

Over the last four years, ADM has undertaken an extensive portfolio transformation. In its Animal Nutrition business, ADM has added premix and aquaculture capabilities in Asia; built new, modern facilities in North America; and moved into pet treats in 2017. Earlier this year, ADM combined its human and animal nutrition businesses into a single business unit that offers complete nutrition solutions.

Gold Coin, one of the Asia's largest feed manufacturers, is said to be on the market for about $500 million. "People in the know" told Bloomberg that Peter Zuellig's holding company, Golden Springs Group, could find a buyer for the Singapore-based business this year. Other options under consideration include partnerships or an initial public offering, according to Bloomberg's source.

Golden Springs Group's portfolio includes Regal Springs, which comprises tilapia farming and shrimp genetic improvement company, Sy-Aqua, producer of PLs and SPF and SPR *P. vannamei* shrimp broodstock and aquafeed manufacturing in six mills across South East Asia, primarily for shrimp, but also for freshwater

and saltwater fish species, including encapsulated hatchery feeds. Gold Coin's aquaculture business is reported to be worth $90 million in sales.

Established in Singapore in 1953, Gold Coin employs 2,600 people across 19 production facilities, in 9 countries. With a milling capacity of approximately 2.5 million tons per year, Gold Coin offers products for both livestock and aquaculture, including young animals and hatchery feed, premixes, concentrates and compound feed.

In more feed company news, Nutreco announced that it has formed a joint venture with Mumbai-based West Coast Group to supply the growing Indian aquaculture market. The companies will also start building a feed production facility in west India to supply aquaculture farms in the region. The plant is expected to open in the first quarter of 2020.

Nutreco will take a majority share in the joint venture. Until the production facility is operational, Nutreco's aquaculture division Skretting will supply feed from outside India into the region.

The joint venture will be managed by Skretting India's General Manager Puneet Pokhriyal, and is in line with Skretting's strategy to continue expansion into nutritional solutions for warm water aquaculture species.

Less than a year after acquiring the majority stake in Alimentsa, BioMar is accelerating development of the Ecuadorian shrimp feed producer with the commissioning of a fifth production line and reorganization of personnel to strengthen the integration of the two companies.

"We have just commissioned a fifth production line in order to secure sufficient capacity next year" said Danny Velez, who took over the position as General Manager shortly after the acquisition. "It is a relatively small investment as the new line fits into our present facilities,

and thereby we expect it to be ready already early next year. Our new feed trial and development facility announced in November, is also progressing according to schedule and will be operational later this year." Mr. Velez underlined that further investments are planned for the near future in order to fulfil the strategic ambitions of the company.

No fungible replacement for fishmeal

An international team of researchers recently concluded a life cycle assessment of current and emerging protein ingredients for aquafeeds in an effort to evaluate the nutritional value, scalability, and environmental performance of each ingredient.

The study examined a representative subset of aquafeed protein ingredients from different sources, including Peruvian anchoveta meal (a large scale and energy efficient reduction fishery), BC herring byproduct meal (a smaller-scale, less energy efficient fishery), soybean meal and soy protein concentrate from both the United States and Brazil (each with different production conditions and environmental implications), U.S. poultry by-product meal and feather meal (each with different nutritional attributes and energy intensities), krill meal (with unique nutritional attributes and an energy intensive fishery), and black soldier fly meal (an emerging protein source).

Although soy protein concentrate and feather meal have the highest protein levels of the non-fishmeal sources, the study cautions that additional research is needed to identify "semi-essential" nutrients in fishmeal that may need to be replaced or supplemented when utilizing only non-fishmeal proteins.

In addition to nutritional values, production impacts of each ingredient were considered in terms of land use, energy use, and acidifying, eutrophying, and greenhouse gas emissions throughout the supply chain.

The environmental performance profiles of the ingredients vary widely. Overall, U.S. soybean meal and Peruvian anchoveta meal perform quite well across most impact categories relative to the other feed inputs. U.S. soybean meal has the lowest estimated carbon footprint, followed closely by Peruvian anchoveta.

In terms of scalability, the study projected that limited supply and increasing demand will cause fishmeal prices to continue rising beyond 2025, incentivizing the substitution or augmentation of other protein sources. Feather meal and poultry by-products ranked highest in terms of scalability due to the expected expansion of poultry meat production by 1.8% per year to 2050.

The market price of soybean meal, which has remained substantially lower than fishmeal, is also favorable for scalability in higher value aquaculture species, although the varying cost of inputs for growing soybeans is uncertain. Because the majority of soybean meal is used in other animal agriculture, increased use of soy in aquaculture must be supported by either diversion of use from other sectors or through global expansion of production.

Soy protein concentrate plays a small but increasing role in aquaculture feeds, especially for high value carnivorous species. However, its higher price can exclude it from many lower value aquaculture species and make it less favorable for scalability as a general aquafeed ingredient.

The study concluded that it is unlikely that a single protein source will scale up to meet all demand for protein from aquaculture feeds. Access to a multitude of alternative protein sources, coupled with an improved understanding of how to formulate diets to balance tradeoffs between animal nutrition, profit, resource intensity, and environmental impact, will increase the resiliency of the global aquaculture industry.

Dane Klinger, a co-author on the study and Aquaculture Innovation Fellow at Conservation International, cautioned that this analysis should be seen only as a preliminary treatment of this subject area.

"We considered a small subset of commercially important aquaculture species, protein feed inputs, and resource use and emissions of potential concern," he said.

"On the basis of these considerations, we nonetheless underscore that decision making that seeks to satisfy multiple objectives must necessarily confront multiple trade-offs that span nutritional, economic, and environmental concerns."

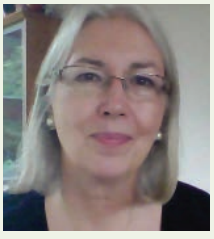
Aquaponics alive and well

Aquaponics has brought aquaculture to the people. Embraced by urban yuppies, locavores, hippies, restauranteurs, prisons, high schools and backyard foodies, it is seen as the Nirvana of sustainable, full-circle food production. But it has proved less than profitable for many serious producers, who have come to wonder if passing expensive feed through fish to produce fertilizer might not make a lot of economic sense. Couple that with the risky business of fish husbandry, and hydroponics seems a simpler and more viable option for growing veggies in water.

But then along came Superior Fresh. The Wanek family, owners of US furniture outlet Ashley Furniture HomeStore, built a state-of-the-art greenhouse facility with an investment close to $100 million. This massive aquaponics facility isn't growing freshwater, hardy fish like tilapia or catfish but Atlantic salmon.

The flagship facility, situated on a 720-acre property in the Coulee Region of Wisconsin, is the largest of its kind in the world, and is the first Atlantic salmon recirculating aquaculture system in the United States. The facility contains a 40,000 sq. ft. fish house with the capacity to produce 160,000 lbs. of fish.(It's truly massive – Google their website!)

The RAS system operates with zero discharge of production water, using leftover water to grow alfalfa for hay production. All other wastes from the Superior Fresh fish house and greenhouse are composted on-site, creating a nutrient dense fertilizer for its own farm and other local farmers. Fish harvesting began this summer and the RAS facility plans to harvest salmon and steelhead on a weekly basis.



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Opportunity Costs:

When Does the Bill Come Due for Aquaculture and Aquaponics Producers?

By Carole R. Engle, Ph.D.[1]

Opportunity costs are a part of economics and business management that affects decisions that are made daily, but most people are not aware of these effects. They are not cash costs for which a bill is received each month. Nevertheless, the "bill" does come due in a big way at some point in time, especially if opportunity costs have been ignored. Many economics textbooks refer to opportunity costs as the only types of costs that exist. What are they and why are they so important?

Opportunity costs are a type of non-cash cost. The non-cash cost that is most familiar to many people is that of depreciation. For example, a fish farmer whose business is to supply sportfish for stocking into recreational markets typically has a number of fish hauling trucks that are critical to the success of the business. A truck will not last forever and will need to be replaced when it wears out. The "bill" for the wear-and-tear on that truck comes due when the truck no longer runs; the "bill" represents the cost of replacing it. Fish farmers who account carefully for annual depreciation of such equipment will show lower profits over the years than those who ignore depreciation; thus, they will be less inclined to spend "profits" for personal consumption that are in reality a loss in value of the equipment and facilities (i.e., annual value of depreciation) used in their business. Wiser still are those farmers who develop and maintain a financial plan for replacing equipment when it approaches the end of its useful life.

Opportunity costs are a different type of non-cash cost than depreciation, but also affect the long-term viability of the business. In an aquaculture or aquaponics business, opportunity costs are typically used to account for everything used to produce the farm's crop, particularly those production factors (also referred to by economists as resources) such as land, ponds, labor, and management that are provided by the owner and his/her family. If there is no cash outlay for land, ponds, or time spent by the owner/family, why is this considered a cost? The answer is that economic history demonstrates quite clearly that if a farmer can make more money doing something else with their land, ponds, or time, they will stop raising fish or shellfish and switch to something from which they will make more money. Opportunity costs are defined as the value of the best alternative use of the land, ponds, and unpaid owner/family time. Real-world examples include:

1. A catfish farmer that can make more money growing soybeans than catfish on his/her land is very likely to stop raising catfish and switch to soybeans.
2. A fish farmer that can make more money from his/her ponds by renting them to a fishing club of wealthy doctors and attorneys is likely to stop raising fish and rent the ponds to the club.
3. An aquaponics producer that can make more money from exclusively raising and selling plants will, at some point, likely convert the business entirely to hydroponics and cease to raise fish.

To an economist, a business that is not likely to survive in the long-term (because the opportunity costs of available alternatives are too high) is one that is not profitable. Profits are about more than just the annual revenue and cash expenses for any given year.

Proper accounting for an aquaculture or aquaponics business includes opportunity costs for the value of the land, ponds, greenhouse, interest on operating capital (if borrowed, interest on the operating loan is a cash cost, but the portion of operating capital provided by the owner is charged as an opportunity cost), and the value of unpaid time of the owner and family members. True economic profit of a business is what remains after all cash and non-cash costs are subtracted from revenue and is an es-

sential measure of whether the business is economically viable over the long term.

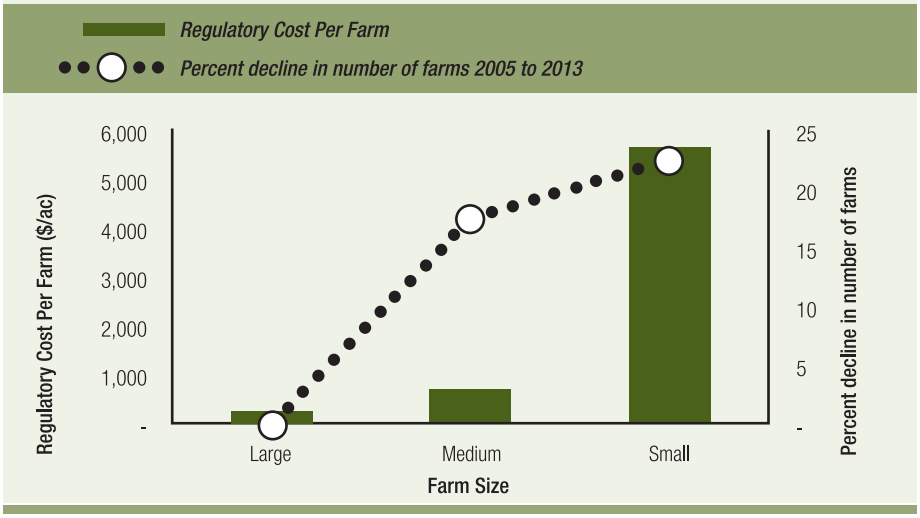
The importance of opportunity costs is evident in the recent studies that have measured the economic effects of regulations on aquaculture producers in the United States. One of the important effects of the regulatory framework is the time that producers and their employees must spend to maintain records, to complete and submit all required reports, to identify what regulatory changes have occurred from the previous year, to seine ponds and otherwise prepare for visits by a veterinarian to collect fish samples for fish health testing, and the time spent to collect, assemble, and deliver water samples for the testing required for discharge permits. Time spent on regulatory activities by the owner, manager, and farm personnel is time not spent on farm improvements or on market development. The opportunity costs associated with manpower required for monitoring and reporting to regulatory agencies can be substantial, and there is evidence that farm-level efficiencies have decreased as a result (van Senten et al. 2018).

Regulations result in additional opportunity costs when portions of raceways must be converted to quiescent zones or when set-aside programs for shellfish reduce the area of a lease that can be planted. The value of lost production is an opportunity cost to the farm that affects the economics of the farm business in several ways: 1) lost revenue reduces cash accounting profit; 2) cash flow is reduced and may require increased borrowing; and 3) lost production capacity reduces the scale of the farm business. Scale effects are important in aquaculture because annual fixed costs tend to be greater than in some other businesses due to the capital-intensive nature of most aquaculture production. Lost production means that there are fewer pounds of fish produced to cover annual fixed costs, increasing total costs per pound, and reducing competitiveness of the business.

Figure 1 shows a graph of regulatory cost per acre for three farm sizes of baitfish/sportfish and super-imposes the percent decline in the number of baitfish/sportfish farms in the U.S. over time. Opportunity costs (in the form of sales lost due to regulatory actions) constituted an important part of the total regulatory costs on baitfish/sportfish farms (van Senten and Engle, 2017) and appear from Figure 1 to have played a role in the demise of a number of small and medium-scale farms. Ignoring opportunity costs, not just by farmers but also by regulatory agencies and policy-makers, to concentrate only on short-term cash-based economics obscures economic effects that can

Fig. 1

Mean regulatory cost per acre and percent decline in number of farms.



be critical to long-term success of businesses.

How does one obtain information on opportunity costs? One good way is by conducting farmer surveys, as was done in the regulatory cost examples. Survey data are sometimes criticized because there are too many examples of improperly designed and implemented surveys with low response and coverage rates. Questionnaires that are poorly worded, with vague, leading, and double-barreled questions lead to invalid and unreliable data. In terms of the regulatory cost surveys, the analysts obtained very high coverage ratios (thus, nonresponse bias was not an issue) from rigorous efforts to contact every (not a sample) producer in the major producing states for that species. Due diligence was exercised in terms of extensive pre-testing of questionnaires to ensure that farmers had the types of records that would enable them to respond accurately. Lost sales, for example, that were recorded in the baitfish/sportfish survey were based on records of sales that had been lost. Similarly, lost production by trout and shellfish producers was based on records of what had been produced before and after regulatory changes.

Opportunity costs are critical to the long-term viability of an aquaculture or aquaponics business. Those who are concerned with whether such businesses succeed or fail need to keep opportunity costs in mind because they explain much about the lack of growth or even the contraction of certain sectors. A portion of the regulatory cost burden consists of opportunity costs; the lack of understanding of how such costs affect farm businesses may result in inadequate attention to their negative effects on farms. Greater attention needs to be paid to opportunity costs not just by farmers but also by policy-makers, regulatory personnel, and research and extension scientists to more accurately evaluate ultimate economic effects of new technologies, policies, and regulations on aquaculture and aquaponics businesses.

[1]Carole Engle holds a B.A. degree in Biology/Rural Development from Friends World College and M.S. and Ph.D. degrees from Auburn University where she specialized in aquaculture economics. Dr. Engle is a past-President of the U.S. Aquaculture Society and the International Association of Aquaculture Economics and Management. She is currently a Principal in Engle-Stone Aquatic$ LLC, and can be reached at cengle8523@gmail.com

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Biofilters

*by Amy Stone**

One of the most important components of a system and in many cases, the least understood is biofiltration.

While the calculations for biofilters are published in several textbooks and a multitude of professionally reviewed papers exist on the sizing of them, there is still a lot of fuzzy logic that gets used in the industry. The challenge is understanding the pitfalls of improperly sized biofiltration.

There are several schools of thought on which type of biofilter is most efficient, most reliable, as well as if both mechanical and biological filtration can occur in the same vessel. I have been rather vocal throughout my career about the last comment of having both biological and mechanical filtration in the same vessel. For the most part, I do not like to have dual filters in systems. There are a couple of reasons why. The first is that mechanical filtration encourages heterotrophic bacteria growth which competes directly with nitrifying bacteria for space. It also means that during the cleaning of this type of filter, the nitrifying bacterial growth is disrupted which can cause a spike in either the ammonia or nitrite levels in the system, or both.

Many conversations have been had over the years discussing this very thing with all schools of thought. While that is my personal opinion, several facilities have been able to use these combination filters successfully. It should be noted that I am pretty risk adverse so many times a conservative approach is the best approach.

Water Quality Concerns

One of the details that usually gets lost in the maintenance of biofilters involves the water quality changes that nitrifying bacteria cause during the conversion process. The actual process of converting ammonia to nitrate is pretty well known. The actual species of bacteria that perform that task have been discussed but in general, the genus *Nitrosomonas* converts ammonia to nitrite and the genus *Nitrobacter* oxidizes the nitrite to nitrate. During that process, the pH is lowered due to the release of the hydrogen ion. This reduction in pH can consume alkalinity which needs to be mitigated with regular water quality maintenance. The choice of buffers should be determined by the type of system that is being used (ie. marine, freshwater, aquaponics, etc.)

Types of Biofilters

While there are a plethora of styles of filters available, we will only go over a few of the most popular.

Moving Bed Bioreactor

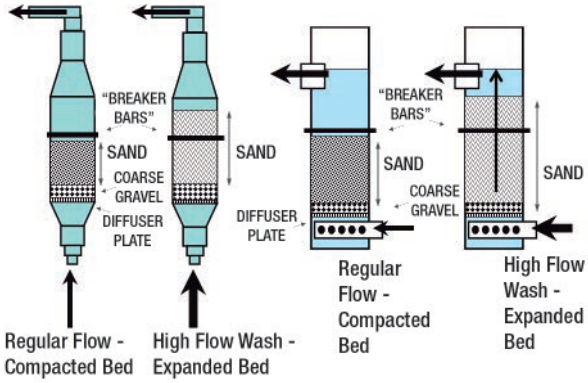
One of my favorite styles of filters is the moving bed bioreactor. This style filter utilizes a neutrally buoyant media that is tumbled using aeration. This movement helps scour the media and keep it from retaining waste which would harbor heterotrophic bacteria.

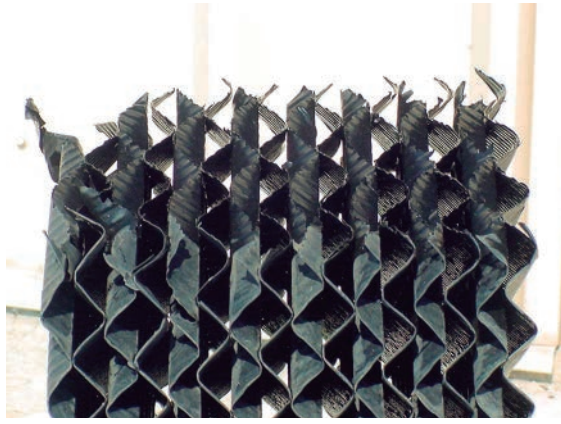
There are several designs of both the media and the vessels that house the media but the concept remains the same. In general, the diameter (or width) should not exceed three times the height of the vessel. The aeration should be sufficient to keep the media in motion and is also sized to handle the oxygen demand of the nitrifying process. When properly sized, these filters keep the oxygen levels stable throughout the process and allow for efficient conversion of nitrogen.

A bonus for this type of filter is that it is one of the most robust styles out there. If the system pumps fail, the aeration will keep the bacteria alive. If the aeration fails, then the water movement will keep the bacteria alive. Lastly, if everything loses power, the media will stay suspended and typically the bacteria stays alive for longer than other types of filters. One of the drawbacks is capital cost. The media for these filters can be expensive depending on which brand is used. The size of the filter vessel can be a bit large in comparison with a fluidized bed sand filter. Or a trickling filter using polystyrene.

Trickle Filter

These are some of the oldest styles of filters still available. They are any vessel in any configuration that holds pretty much any style of media and has water running through it. It is the most flexible in terms of space and style. Some of the more common media used in these filters is Brentwood style corrugated plastic blocks, bio-balls, bio-barrels and some even use soda bottle rings and shaved PVC. Each media has differ-



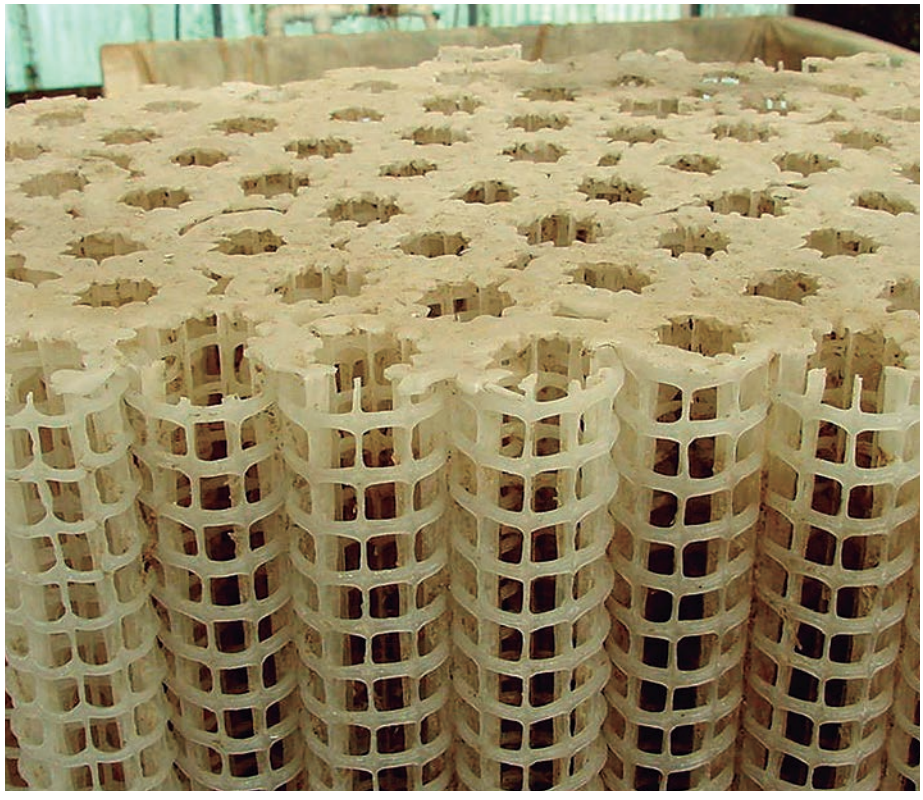


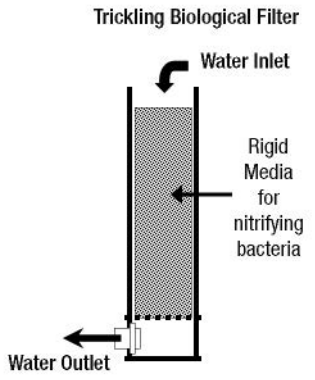
ent levels of available surface area for bacterial growth and is chosen based on availability and preference. Unlike the moving bed bioreactors, the trickle filter can be used in any geometry so long as the media stays moist.

The positives for this filter include its flexibility to fit the space and types of media that can be used. One of the drawbacks for this style filter is that it can collect waste and channel. Over time parts of the filter can become unused as they dry out and they can be difficult to clean. Another concern to keep in mind is that any disruption in water flow can cause the bacteria to die off. A good back up plan with these filters is key.

Fluidized Bed Filters

These filters generally use an aggregate media with reverse water flow. In many cases, the media is a type of sand but other media types will also work. These are high surface area filters, which are helpful in applications that require a small footprint. We really only recommend using these in cool or cold-water applications with good mechanical





filtration prior. The media can also capture solids which can change the dynamics of the filter and cause it to be unable to fluidize evenly which is why mechanical filtration is so critical. In warm water applications, the media can over colonize which also changes the fluid dynamics as well.

Some of the drawbacks to these filters is that when the bed collapses, the media tends to stick together and becomes anoxic which causes the bacteria to die. If the water flow is restored quickly, it can rebound. Another issue to consider is that the flow rate must be stable or the bed can either over expand, sending the media downstream of the filter, or collapse. These filters have a tight tolerance for flow, which must be maintained.

Bead Filter

This is a type of filter that can work as either a biofilter, mechanical filter or both. They come in several configurations and tend to work efficiently as a biofilter. These filters can be either pressurized (like a converted sand filter with reverse flow) or unpressurized. They are also available in a bubble backwash, prop backwash and what is also referred to as a drop backwash. They typically use a plastic bead media which comes in several sizes and shapes.

These filters work well in any temperature but will also collect solids. If they are being used for biological filters only, then proper mechanical filtration should be used prior. They are advertised as a combo filter so that is also an option.

Fuzzy Logic

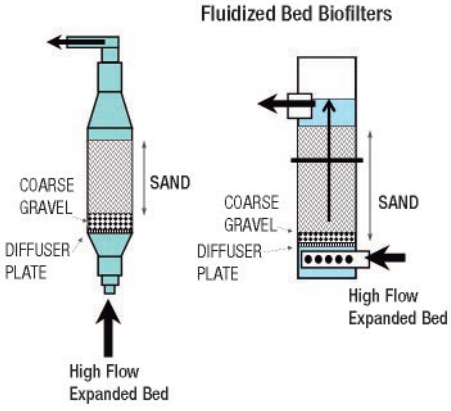
Here come the lesser spoken about details of biofilters. The process for sizing a filter includes total volume of feed, percentage of fat and protein for the feed and the water quality parameters that are expected for the system. In some cases, rules of thumb are used based on the weight of the fish and type of fish which assumes an average feed rate and water quality. While this can work, it is a little dangerous to use this method since there are many variables that are ignored. A true mass balance should be done for proper sizing of your biofilter.

In most cases the result of these calculations is the surface area that is required. That being said, the surface area of media varies greatly by manufacturer. If you add that variability to the fact that some manufacturers advertise usable surface area (which is the surface area that remains open to bacterial growth) while others advertise total surface area, it can get challenging.

> **If bead filters** are being used for biological filters only, then proper mechanical filtration should be used prior.

Think back to the ceramic media that was popular in the 1990's. The advertised surface area was listed at 82,000 ft^2 per ft^3. That surface area included all the void spaces within the ceramic. Once the bacteria colonized the media, the usable surface area is closer to the surface area of the outside of the media only, something close to 1400 ft^2 per ft^3.

If the filters using this media were sized based on total, they would underperform after the voids became clogged. The same is true of other media types as well. That is why it is important to understand the capabilities of the media that is chosen given the application that it will be used for. This can make or break a project in a hurry if an unsuitable media is chosen.



Amy Riedel Stone is President and Owner at Aquatic Equipment and Design, Inc. She was formerly a Manager at Pentair Aquatic Eco-Systems, and she studied Agriculture at Purdue University. She can be reached at amy@aquaticed.com

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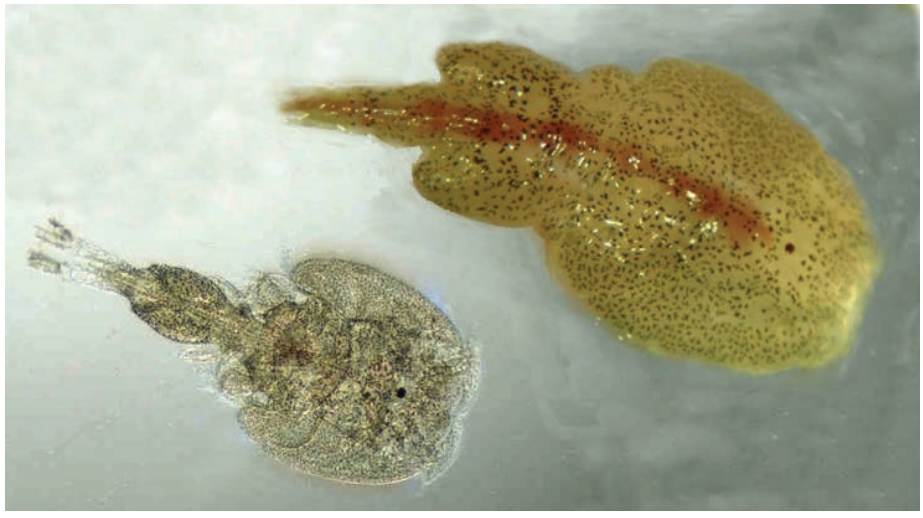
Fish welfare and use of heated water

FOR SEA LICE TREATMENT

*By Asbjørn Bergheim**

Non-medical treatments have become the most common measures to de-louse salmon in Norwegian cages. Let's learn more about them.



Sea lice Photo W.J. Roy (CC BY-NC 2.0)

Thermal de-lousing, which involves exposing salmon to 28 – 34 °C for 30 seconds, is the predominating method, accounting for around ¾ of all lice treatments without the use of medical agents (Table 1). Use of warm water has been shown to remove over 95% (70 - 100%) of the parasite and has been widely adopted by the industry. This strategy is widespread not only in Norway but is increasingly popular in Scotland and Canada also. The approximate number of thermally treated fish in Norwegian cages increased from 10 million in 2014 to more than 300 million last year.

Thermal de-lousing equipment was tested on farmed salmon in Chile in 2013 (Veterinærinstituttet, Report no. 13/2015). This equipment is now in commercial use in Chile. The treatment's effect on lice *(Caligus rogercresseyi)* is reported to be as high as 99% for adult lice and around 60% for juvenile lice. Three-day post treatment mortality levels are low.

Briefly described, thermal de-lousing is not complicated. The fish are crowded in the cage, pumped into the treatment vessel (e.g. Thermolicer®), passed through the heated water unit and finally returned to the cage. Crowding, pumping and high temperature exposure are all stressful to the fish. In spite of its widespread use, observed serious lesions and episodic high mortality associated with thermal sea lice treatment are of concern in the aquaculture industry.

A recent article presents a survey of diagnosed lesions in thermally treated salmon (Norsk veterinærtidsskrift, no. 3/2018). Acute and chronic lesions are frequently observed in gills, skin, thymus and in the nasal cavity in submitted samples. A recurrent observation in treated salmon is occurrence of thrombosis in gill lamellae, and gill haemorrhage (Figure 1). The mechanisms resulting in these lesions may be complex and may include both direct thermal effects, stress and trauma associated with the treatment. Despite concern over fish health and welfare, the average mortality of thermally treated salmon "only" increased by slightly more than 1% compared to the mortality before the treatment. The mortality rate post treatment seemed to be associated with the sea temperature.

In the cited article, the authors indicate that the fish can feel pain and that the temperatures used (28 – 34 °C) during de-lousing are "most likely painful to the fish. This pain will also initiate panic reactions where fish are likely to inflict serious self-damage." Less pronounced stress responses have been observed in other previously performed high-temperature tests. The effects of high temperature on sea lice are nevertheless poorly documented. During the summer of 1997, the parasite was not detected at Norwegian farms when the temperature exceeded 18° C.

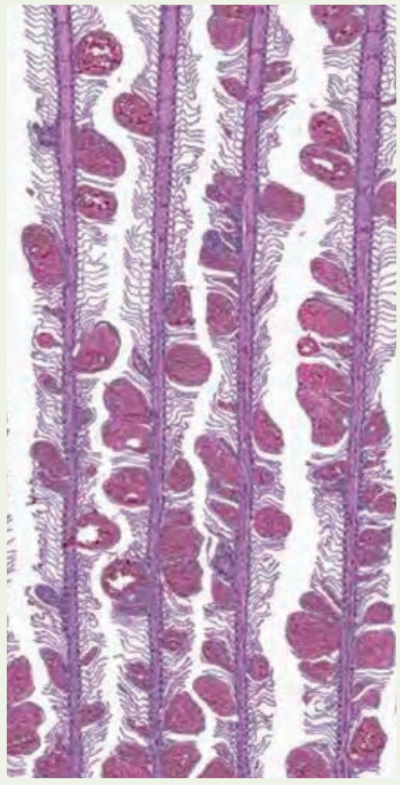
Table 1

Non-medical measures for de-lousing of salmon in Norway 2013-2017 (Norsk Veterinærtidsskrift, no.3, 2018)

Type of treatment	*2013*	*2015*	*2017*
Thermal	*0*	*42*	*1308*
Mechanical	6	38	293
Fresh water	0	31	96
Others (unspecified)	109	106	62
Total	115	217	1759

Fig. 1

Gill damage of thermally de-loused salmon: rupture of blood vessels and thrombus formation in the lamellae (left) and massive aneurism/bleeding (right). Courtesy: Pharmaq Analytiq AS



Sea lice Photo/ Watershed Watch (CC BY-NC-ND 2.0)

Silver Leapers (CC BY 2.0)

According to experts, it seems likely that temperature tolerant lice surviving the treatment will transfer their genes to the next generation.

In some regions, lower lice removal efficiency than expected has recently been observed. Increased treatment temperature above the recommended range is the only way to achieve sufficient de-lousing results. According to experts, it seems likely that temperature tolerant lice surviving the treatment will transfer their genes to the next generation. A research group at The Marine Research Institute in Bergen published data last year that demonstrate genetic variation in tolerance of warm water in sea lice. Further studies are, however, needed to prove whether significant heritability for temperature tolerance exists.

The existing regulatory framework for non-medical sea lice treatment has not been found to be adequate to fully assure the fish's welfare during thermal treatment. According to the authors (article no.3/2018), the present documentation of "thermal sea-lice treatment on welfare is based on a weak scientific basis and not calibrated for the use in field situations."

Dr. AsbjØrn Bergheim is a senior researcher in the Dept. of Marine Environment at the International Research Institute of Stavanger. His fields of interest within aquaculture are primarily water quality vs. technology and management in tanks, cages and ponds, among others.
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Diseases of Freshwater Prawn *Macrobrachium rosenbergii* Part II:

Pathogens from Penaeid Shrimp and Other Decapods

Hui Gong Jiang, PhD

***Macrobrachium rosenbergii* (de Man) -** the giant freshwater prawn, is the largest and most popular palaemonid freshwater prawn cultured worldwide. In this discussion we will address *M. rosenbergii* pathogens that were originally isolated from Penaeid shrimp and other decapods.

Several penaeid shrimp pathogens have been found to be pathogenic to *M. rosenbergii*, as listed below.

• White spot syndrome virus (WSSV)

WSSV has been the most catastrophic shrimp disease and caused the great economic loss to the shrimp aquaculture industry. WSSV is a large, enveloped, double-stranded DNA virus, in the Whispovirus genus and the Nimaviridae family. *M. rosenbergii* is susceptible to WSSV, and WSSV can induce similar syndromes in *M. rosenbergii* as in marine shrimp. These include sudden reduction in feeding, lethargy, soft and loose shells, white spots 0.5 to 2 mm under the cuticle, and high mortality.

• Infectious hypodermal and haematopoietic necrosis virus (IHHNV)

IHHNV was responsible for the high mortalities (up to 80–100%) in postlarvae of *M. rosenbergii* in southern Taiwan between July 2004 and January 2005. It was reported that eosinophilic intranuclear inclusion bodies were found only in the hepatopancreatic tubular epithelial cells of the infected postlarvae from hatchery farms, instead of lesions usually found in the tissue of ectodermal or mesodermal origin in penaeid shrimp species. Affected sub-adults showed growth retardation and deformities of the fourth to sixth abdominal segments and tail fan, but without INI formation or the unusual mortality. These lesions were similar to those of Runt Deformity Syndrome described in *Penaeus vannamei*, *P. monodon* and *P. stylirostris* with IHHNV infection.

• Covert mortality nodovirus (CMNV)

Starting from 2002, CMNV has resulted in cumulative mortalities from 30 to 80 days post stocking with peaks around 60-80 days. High ammonia / nitrite concentrations and temperature could expedite and worsen the disease outbreak process. The clinical signs include atrophic or faded hepatopancreas, whitish abdominal muscle, empty stomach and gut, soft shell and slow growth, etc. It has been found that the existence of

co-infection of CMNV with EHP is not uncommon.

• Shrimp hemocyte iridescent virus (SHIV)

SHIV, an irdidescent virus, was first discovered and identified in samples of diseased shrimp collected from a farm in Zhejiang Province, China, in December 2014. It could cause basophilic inclusions and pyknosis in hematopoietic tissue and hemocytes in gills, hepatopancreas, periopods and muscle. In addition to being present in *P. vannamei* and *P. chinensis*, 5 out of 10 *M. rosenbergii* samples were tested as SHIV positive. There is an increasing concern that the virus may have spread to other provinces in China.

• *Enterocytozoon hepatopenaei* (EHP)

EHP was first discovered in *P. monodon* in Thailand in 2004, and named shortly after. It infects the tubule epithelial cells of the hepatopancreas to cause Hepatopancreatic Microsporidiosis and retarded growth.

Spiroplasma eriocheiris

The bacterium *S. eriocheiris*, the original cause of crab trembling disease, was responsible for epizootics in *M. rosenbergii* in Jiangsu, China in 2010. Once they were infected with *S. eriocheiris*, *M. rosenbergii* showed lethargy and aggregation along the pond edge and up to 80% massive mortality ensued. *S. eriocheiris*, a wall-less helical bacterium ranging from 2-10μm in length, possesses a unique swimming pattern by switching the cell helicity at a kink traveling from the front to the tail. The pathogenic agent is able to pass through membrane filters with pores of 220 nm in diameter, and infect hemocytes and all the connective tissues of the organs, such as the hepatopancreas, digestive tract, cardiac muscle and others. A recent study showed that a ras-related nuclear protein (Ran) obtained from *M. rosenbergii* participated in regulating the phagocytosis of *S. eriocheiris* in *M. rosenbergii*.

Cherax quadricarinatus iridovirus (CQIV)

Recently, an iridescent virus was identified from the freshwater crayfish *Cherax quadricarinatus* and thus named as CQIV. CQIV may also be pathogenic to *M. rosenbergii* since it was found causing high mortality in freshwater crayfish and *P. vannamei* shortly after these aquatic species were infected.

All infectious disease outbreaks usually occur via the interactive relationship among pathogen, host and environmental factors. Relying primarily on the innate immunity of the defense system, the immunological capability of freshwater prawns against infectious diseases is much limited in comparison with finfish. To date, there are hardly any effective treatments or cures once these infections are initiated in prawn stocks. Instead, the preventive approaches should be the key in controlling these disease problems in *M. rosenbergii*. This can be done by starting with clean stocks and implementing appropriate biosecurity practices and vigorous heath management to mitigate these disease risks.

The prawn disease list has been growing longer in the past two decades, but the pathogenicity of prawn diseases and epizootics have not been studied thoroughly. More research efforts are required to gain in-depth understanding of relevant mechanisms of disease control in *M. rosenbergii*.

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The Promises of Aquaculture and *Caveat Emptor*

*By Michael A. Rice**

Since the science-centric zeitgeist of the post-Sputnik 1960s, aquaculture has captured the imagination of much of the general public in America and elsewhere. In its origins, American President John F. Kennedy said in a letter to the President of the Senate and the Speaker of the House of Representatives, May 29, 1961, "We are just at the threshold of our knowledge of the oceans . . . [This] knowledge is more than a matter of curiosity. Our very survival may hinge upon it."

Kennedy's successor President Lyndon Johnson along with his former colleague and close friend in the U.S. Senate, Senator Warren Magnuson of Washington championed the formation of a national ocean policy commission in 1965 focusing on a host of ocean and environmental protection policies, including aquaculture. This commission soon became known as the Stratton Commission, named after its chairman Julius A. Stratton of the Ford Foundation and it had members from federal government agencies, leading universities with marine science programs, the business community, and advisors.

The Stratton Commission had a strong influence on ocean and environmental legislation in the United States, which included the National Sea Grant College Program of 1966, National Environmental Policy Act of 1969, Clean Water Act of 1972,

Figure 1. Carolina shellfishing.

Coastal Zone Management Act of 1972, and the Magnuson Fishery and Conservation Management Act of 1976. And the Commission's findings even influenced discussions about marine resource usage internationally, most notably through the highly influential Third United Nations Conference on Law of the Sea (UNCLOS III) that began in 1973.

Beyond the active legislative and policy discussions of the 1960s and 1970s, the public imagination was captured about the promises of aquaculture as a key player in feeding the world. Famed scuba pioneer, explorer, ocean conservation proponent and film maker, Jacques Y. Cousteau became a very high profile advocate for farming of the oceans:

"With Earth's burgeoning human populations to feed, we must turn to the sea with new understanding and new technology. We must farm it as we farm the land." Jacques Cousteau, 1973

"In his exploitation of the sea man is still a barbarian, a ruthless hunter slaughtering whole species of animals without heeding the consequences. With earth's burgeoning human populations to feed we must turn to the sea with new understanding and new technology. We need to farm it as we farm the land. This is called mariculture. It has just begun. … with properly managing limited bodies of water. In such controlled volumes the ideal conditions can be maintained all year and by ensuring fertilization and protecting the larvae from predators, incredibly high yields can be obtained from a number of protein-rich populations. High efficiency sea farms totaling the size of Switzerland would produce more food than all fisheries combined." Jacques Cousteau, 1973.

And, *"In the past 10,000 years we have learned to irrigate, fertilize, and develop hardy breeds of grain and stock. An acre of land, scientifically farmed, is far more useful in human terms than an agriculturally idle one. Yet thousands of years after we abandoned hunting on land as an inefficient method of obtaining food, we continue to pursue the creatures of the sea with the attitudes of cavemen. Ocean farming – mariculture – can protect the natural stock in the sea as well as vastly supplement our food supply."* Jacques Cousteau, 1979.

Figure 2. RI-Quahog Rake.

Much of this exciting marine policy and public advocacy work was going on while I was still in high school and an undergraduate student in California. At the time, there were two influential books that helped set me upon my career path, they were: *Aquaculture; the Farming and Husbandry of Fresh Water and Marine Organisms*, by Drs. John Bardach, John Ryther and William McLarney, published by Wiley and Sons in 1972; and *Underwater California* by Dr. Wheeler J. North, published by University of California Press in 1975. Dr. North, based at Cal Tech's Kerckhoff Marine Laboratory in Corona del Mar, was also a scuba pioneer and considered to be the Jacques Cousteau of Southern California, having expertise in kelp forest ecology, mariculture and economic uses for harvested kelp.

I was fortunate to meet and get to know Dr. North when I was in graduate school at nearby UC Irvine as he was a close friend in the social circles of my major professor Grover Stephens. And I was a direct beneficiary of these heady days of the Stratton Commission by being one of the first California Sea Grant Graduate Student Fellows at UCI. There was lots of economic promise for this new field of aquaculture at the time. However, for me and many of my colleagues, the attractive business aspect of private aquaculture was not the primary impetus for getting involved. Most of us entered this field with some sense of idealism, recognizing that seaweeds as well as invertebrates and fish feeding low on the food chain may have the greatest promise for providing relatively inexpensive protein and alleviating world hunger in the long term. Some of this same excitement about the promise of aquaculture has carried forward over the years inspiring new generations of aquaculture scientists and professional practitioners.

However, uncritical excitement about the promises of aquaculture

can be problematic by fostering conditions ripe for unscrupulous or under-informed individuals to exploit. For example, in the early 1990s there was a high profile legislative effort to improve the regulatory climate for commercial aquaculture in my home state of Rhode Island. At issue was the ease (or lack of it) with which privately held aquaculture leases would be granted in the state's public waters. Reform of the aquaculture laws had come to the forefront in state legislative affairs and it caught the imagination of the popular press, creating great angst among members of the state's iconic quahog or hard clam *(Mercenaria mercenara)* wild harvest fishery.

In the summer of 1997 during the height of all the legislative controversy, an aquaculture promoter stepped forward to work with the quahoggers to develop a shellfish aquaculture hatchery and nursery system to seed all the natural shellfish beds of the state. The quahog hatchery would be located at one of the marinas where many quahoggers had their boats docked, and the boat docks in turn would hold the then newly developed floating upweller shellfish nursery systems (FLUPSYs) to be managed by the shellfishers themselves (Figure 3). A certain percentage of their quahog catch revenues would be reinvested into the hatchery and quahog nursery systems. The idea was unqualifiedly popular with quahoggers, the shellfish dealers serving the existing industry, and some members of the shellfish regulatory community, including the state's Division of Fish and Wildlife and its parent agency the Rhode Island Department of Environmental Management (RIDEM) who were well vested in the procedures for managing the wild harvest fishery. Everybody seemed to love *public aquaculture*.

As part of the public aquaculture promotion effort, Warwick Marine Resources, Inc. was created as a Delaware non-profit corporation, and key stakeholders, potential investors and community opinion leaders were recruited into its board of directors. One of the first investors approached to join the board was an executive from Rhode Island based G-tech Corporation, a manufacturer of electronic gaming devices supplying the growing casino industry on Native American reservation lands in nearby Connecticut. As an electronics firm, G-tech was interested in possibly developing an electronic water monitoring apparatus for the FLUPSYs. As a gesture of goodwill, they funded helicopter overflights of Narragansett Bay for the promoter and quahoggers to locate possible areas for quahog seeding.

Other members of the board of directors included the president of the Rhode Island Shellfishermen's Association, the chief legal counsel of RIDEM, Eileen S. Naughton the member of the Rhode Island House of Representatives who was the primary author of the aquaculture reform legislation then under consideration, myself as a shellfish researcher and extension faculty member at the University of Rhode Island, and Dr. Robert Rheault, who was the proprietor of Rhode Island's only operating shellfish hatchery at the time. He is currently the executive director of the East Coast Shellfish Growers Association. Rheault was contracted by Warwick Marine Resources, Inc. to produce initial batches of quahog seed in his hatchery to supply a highly publicized "First Seeding Effort" on the shellfishing grounds in October 6, 1997 (See Figure 4).

Figure 3. FLUPSY Rheault.

Problems began to arise with the effort about the time "First Seeding" was scheduled. First, from the time I was first contacted to be on the board late in the summer 1997, I had asked to see the *pro-forma* financial plan because I could not figure out from the pretty diagrams and summaries presented at the board meeting where the money was coming from to fund the helicopters and R&D for electronic monitoring systems for the FLUPSYs. Furthermore, I could not understand how all this was going to work in the long run given the known knowledge about quahog seed mortality rates in the wild. Nothing was forthcoming from the promoter and there were indications that he was very annoyed by my questions. Then, there was an issue arising when Rheault had delivered several batches of quahog seed for the preliminary seeding ef-

Much of this exciting marine policy and public advocacy work was going on while I was still in high school and an undergraduate student in California.

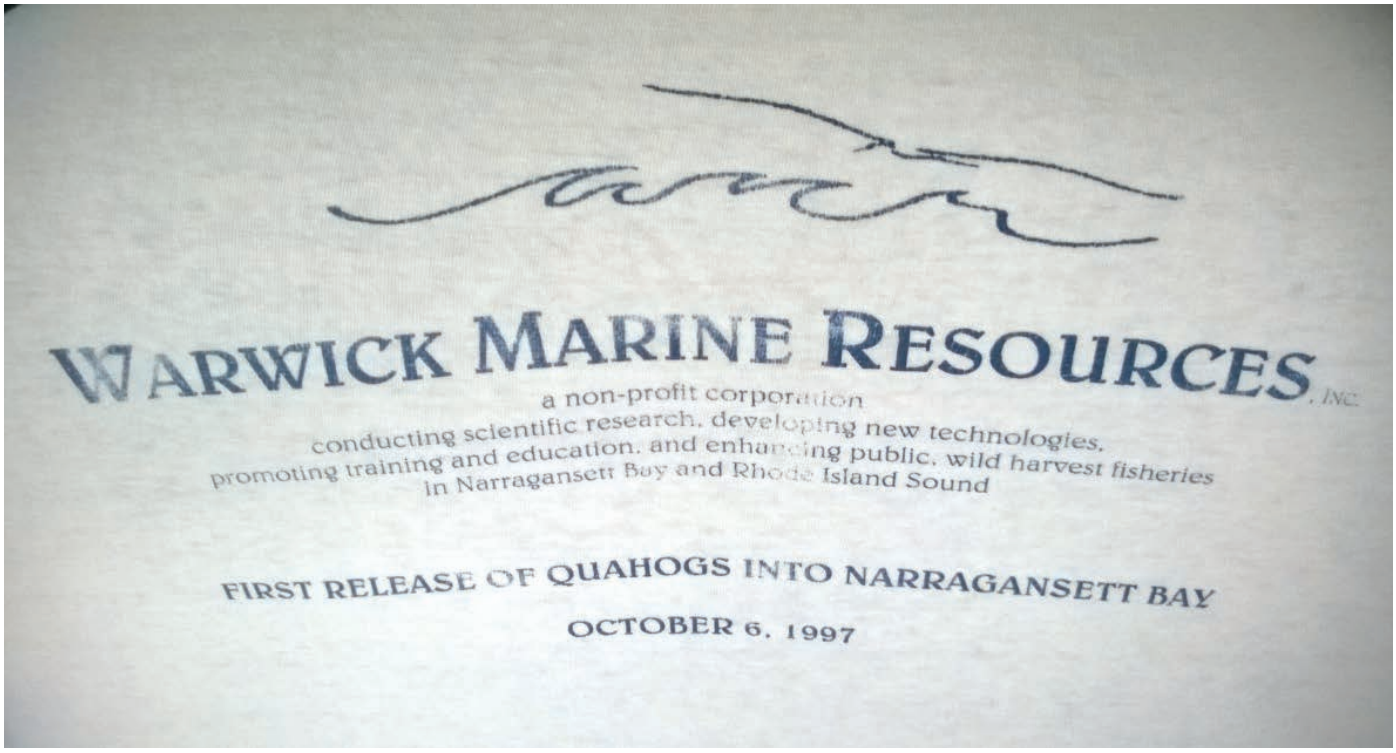

Figure 4. Warwick Marine Resources.

Reform of the aquaculture laws had come to the forefront in state legislative affairs and it caught the imagination of the popular press.

forts and had not gotten paid a dime for any of it.

But the clincher occurred when the chief legal counsel of RIDEM was contacted by a real estate broker in Arizona asking if it was true that the Board of Directors of Warwick Marine Resources, Inc. had authorized the co-signing of a real estate investment deal in metro-Phoenix. Of course there was no such authorization, and this prompted the RIDEM legal counsel to contact both the RI State Police and the local office of the FBI to begin investigations. Everybody involved was questioned. In the end it did not go so well for the promoter who was eventually convicted of financial fraud and was sent to prison. One of the final unpaid bills coming in was from a law firm in Delaware for services to incorporate Warwick Marine Resources as an IRS non-profit organization under Section 501(c), thus exempting the organization from Delaware corporate income tax.

Fortunately it is very rare to see such blatant cases of outright premeditated financial fraud associated with aquaculture, but the more common problem is in unqualified yet very enthusiastic individuals after catching the 'aquaculture bug' being overly confident and promising more than can be realistically delivered. Be sure to take a hard look at their business plan and especially the *pro-forma* financial numbers and projections, and read all that fine print. The old Romans had it right with the classic warning, *Caveat emptor*!

Michael A. Rice, PhD, is a Professor of Fisheries, Animal and Veterinary Science at the University of Rhode Island. He has published extensively in the areas of physiological ecology of mollusks, shellfishery management, molluscan aquaculture, and aquaculture in international development. He has served as Chairperson of his department at the University of Rhode Island, and as an elected member of the Rhode Island House of Representatives.
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Weighing Up
The Consequences

Before you read this take a few minutes……think about how much influences on measuring the weight of product can impact your profitability and how well you are managing this. If this issue is not top of mind, then your profit could be going down the drain!

How often do you calibrate your measuring devices? How much water/glaze is going into your product? Do you check the weights of product to ensure they are correct? How do you ensure that the consumer is getting what they pay for? Are you being ripped off or are you committing economic fraud?

We are all aware of the benefits of using frozen seafood – they include matters like the eating quality which can be excellent; freezing enables variability in the supply chain to be resolved, and frozen seafood has a longer shelf-life than fresh/chilled products. Some of these benefits can be lost if the freezing, cold storage or thawing processes are poorly managed or if the integrity of the industry is impacted.

To produce the best quality thawed product, it is important for businesses and seafood operatives to understand the thawing process and ensure their systems are as effective as possible.

Businesses typically thaw seafood in-house using a range of different methods. These vary from using low-tech approaches like water, air or steam all the way through to microwave and radio frequency systems. The type of thawing method used is dependent on many factors including cost, throughput, timescale, size, efficiency and effect on quality amongst other things.

Food safety is an imperative during any process. We are fortunate that seafood is rarely incriminated with food poisoning outbreaks (with some exceptions) because most seafood is not infected by, nor carries, food poisoning bacteria. The cold temperatures at which it is stored means that, when present, most food poisoning bacteria grow poorly, and if seafood is cooked before being eaten, any bacteria present are destroyed.

The main safety issues lie with some species and many of these issues are connected to temperature abuse. As an example, histamine issues are linked to certain Scombroid species such as mackerel and tuna. The flesh of these types of fish contains higher levels of histidine. Histidine is converted to histamine by

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bacteria and if the seafood is eaten it can cause illness. Temperature abuse is the major cause of high histamine levels; growth is more rapid at high abuse temperatures (>21C) compared to moderate abuse temperatures (e.g. 7C). In general histamine production ceases at 4C. Once produced, it is heat stable so thermal processing will not remove it from the flesh. As such it is essential to more carefully control the storage temperature of affected species.

In a scientific paper, *The Microbiological Quality of Thawed Foods (Bogh-Sorensen, 2000)* it was pointed out that the number of micro-organisms is often reduced during freezing and frozen storage. Microorganisms can also remain in their 'lag phase' for some time after thawing, before the minimum microbial growth temperatures are achieved and exponential microbial growth begins. Provided adequate temperature control, hygiene and handling are exercised, freezing provides an excellent long-term preservation method. For relatively sensitive foods like seafood, freezing may affect the structural integrity of the product, making it potentially more susceptible to microbial attack. Thawed seafood is also likely to have a moist surface, perhaps amplified by drip losses or condensation, making them a good substrate for bacterial growth. In addition, some bacteria in frozen foods may become more virulent after thawing and lag phase.

The conclusion of most studies on thawed foods is that there is very little difference in the shelf-life and microbial growth between never frozen and pre-frozen/thawed foods. In some cases, freezing may increase the storage life of the thawed product. In experiments (with frozen cod), it was demonstrated that the storage for eight weeks at –20C extended its shelf life, when thawed, by several days, i.e. longer than both fresh cod or cod stored at –30C, –60C or –80C. The reason was that the two most important spoilage bacteria in cod (*Shewanella putrefaciens* and *Photobacterium phosphoreum*) died after eight weeks at – 20C but survived eight weeks at –30C or colder.

From a microbiological view, the thawing process must be carefully controlled with respect to avoiding both contamination and poor temperature control. In catering establishments and households, air thawing is the most conventional method and thawing of foods in the refrigerator is often recommended. From a food safety perspective, this is acceptable, as it ensures that no parts of the product become warmer than the temperature of the refrigerator. However, this process is relatively slow and does not always result in the best sensory quality. In experiments with whole trout, it was shown that faster thawing (water thawing) resulted in better quality than slow thawing in a refrigerator. If more rapid thawing is necessary, then thawing at room temperature for short periods of time is acceptable, but care should be taken to avoid high surface temperatures for too long.

When I was learning the business (many years ago) I recall an overseas buyer pleading 'please do not send me any additional water with the Scallops.' I investigated and found that our scallop processor was soaking the Scallops in water enabling them to nearly double their weight. A new specification had to be agreed.

Somewhat amazingly the authorities at the time showed little interest. They treated this as a 'quality' issue which was something between buyer and seller and of no interest to them. They highlighted it did not impact on the 'food safety,' which at the time was all that concerned them.

The next weighty issue I came across was with Plaice Fillets, often labelled 'Flounder Fillets.' This is a great product (often from the Netherlands or Denmark) but it is regu-

larly abused with glazing. After thorough checking we found that cartons marked '10 Kgs net weight' weighed closer to 5 kgs after thawing. Outrageous!

Processors put the blame on others, especially buyers who promote short weights, but, at the end of the day, if you sell 10 kgs then the buyer must expect you to deliver 10 kgs.

In many factories across Asia you will see the odd poster showing a 2 kg block of shrimp on the scales but the scales only indicating 4 lbs. This highlights that short-weighting is a common place practice in the industry. Innocent buyers beware.

Weights and measures have intrigued me ever since those early days. It has continued to be an integrity nightmare for the industry – especially for those that have tried to do the right thing. Playing around with weights is a 'cowboy' activity and there is a need for leadership to get out of these bad habits. We should all be on the lookout for a global solution.

With the constant use of frozen supplies there needs to be confidence in the outcome of the product quality and the thawed weight. It is essential for everyone in the supply chain to know what is required but sadly there is much conjecture on the right formula for controlling the packing and the thawing methods of seafood.

If we do not get this under control it will be an issue that will come back to bite. Nearly every year we get 'shock – horror' articles relating to short weights.

The National Oceanic and Atmospheric Administration (NOAA), which runs a seafood inspection program, said in a Boston Globe report that it finds economic fraud in at least 40 percent of products voluntarily submitted to the agency for testing by processors and other businesses. At least eight out of 10 cases involve inaccurate weights, according to the then chief quality officer of NOAA's seafood inspection program.

The Globe, back then, hired an independent lab to weigh the fish after removing the glaze following a survey of 43 seafood samples from supermarkets across Massachusetts which showed about 1 in 5 glazed with ice weighed less than the net weight stated on the label, which is supposed to exclude packaging and glaze. Two examples promoted were scallops sold at a Walmart store which weighed roughly 13 ounces, not the 16 ounces listed and crab meat at Kyler's Catch in New Bedford, labelled as 6 ounces, weighed 5 ounces.

From that activity a Rhode Island food supplier that repeatedly sold underweight frozen fish to local supermarket chains was 'outed.'

Additionally, the newspaper made it clear that short weighting was a part of a persistent problem in the industry. While individual shoppers are short-changed in small increments, cumulatively, excess water in seafood is a serious issue.

In Hong Kong Officers of the Customs and Excise Department posed as customers and ordered seafood at various restaurants on several occasions during the year.

After the officers were informed of the purported weight of the ordered seafood, including crabs, lobsters and fish at the restaurants, they revealed their identities and checked the net weight of the seafood with electronic scales. Officers found that it was short of the purported and charged weight.

In subsequent examinations by the Hong Kong Government Laboratory, discrepancies were found between the net weight and the purported weight of the seafood ranging from 21 per cent to 60 per cent. It was highlighted that selling goods by weight which is less than their net weight is an offence under the Weights and Measures Ordinance in the country and the restaurants were subsequently fined heavily.

Recently in Australia the issue came to a head when the National Measurement Institute (NMI) -- the government regulator for weights and measures -- announced a clarification of its policy on determining the net weight of frozen seafood in retail and foodservice packaging. This was done after consultation with Seafood Importers Association of Australasia (SIAA) who had been lobbying hard for change. The new laws commenced on 1 July 2018.

It has been documented through various media that the NMI policy clarification covers all species of fish, crustaceans and molluscs normally traded, but excludes value-added variations such as marinades and coated seafood products. The "frozen fish method", which is sometimes known as the partial thaw method, or test procedure 7.9, will now be the only method applied to determining the net weight of non-value-added seafood.

This method does not allow for the product's ice glaze to be included in the weight statement regardless of being listed in the contents or ingredients. Thus, a package of shrimp labelled 1 kilogram for instance should contain 1kg of shrimp once partially thawed following the NMI's described procedure, it said.

For a long time, the policy applied to the calculation of net weight in packaged seafood, including wholesale and retail sold in Australia, allowed some manufacturers to include the weight of water and ice-glaze in the so-called net weight.

Maybe this puts us on the right track to solve this integrity situation once and for all …and by the way, make sure you get all your scales calibrated as soon as you can…

Happy Fishmongering!

The Fishmonger

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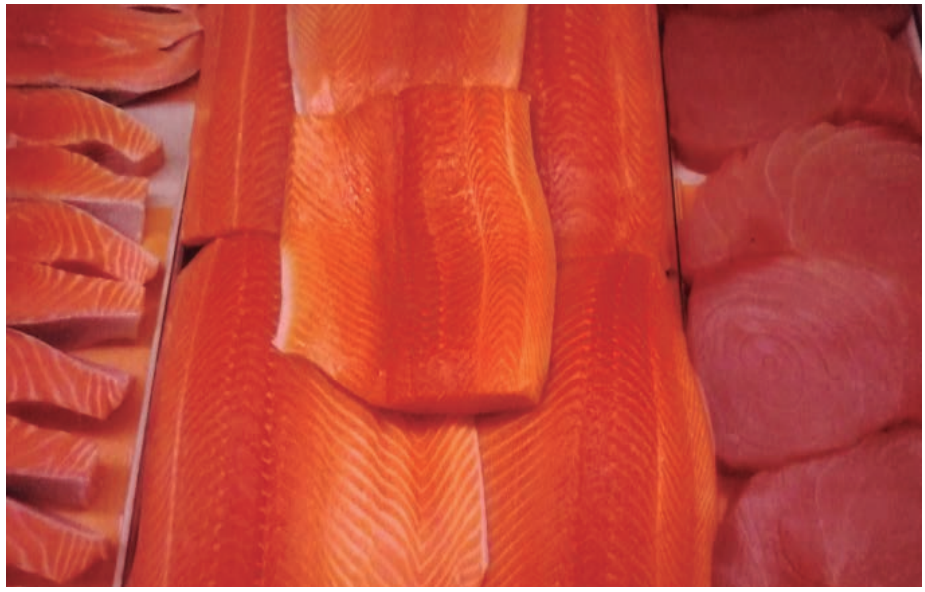
SALMON
UPDATES FROM URNER BARRY

*By: Paul B. Brown Jr.**



Overall March 2018 salmon imports were 13.14 percent higher on a year-to-date basis. On a month-to-month basis total imports were up 12 percent compared to the previous month. European whole fish numbers were trending with even lower offers noted heading into the last week of May. The Northeast and West Coast Canadian whole fish markets have seen downward pricing pressure on bigger fish; supplies are fully adequate for a dull demand.

Imports of Fresh Whole Fish Atlantic Salmon

YTD imports were up again in March, 7.4 percent from 2017, and the themes seen last year in regard to country of origin breakdown and market share have continued into 2018. Canada is now seeing a 3.8 percent increase in YTD levels, Norway is up 16.9 percent while Scotland is down 16.9 percent. But the overall loss of Canada's total market share continues, and is down to 53 percent compared to last year's 55 percent – all of which are significant drops from 2016. Overall monthly imports for March 2018 were up 12.9 percent compared to February 2018. Individually, Canada saw an 18.2 percent monthly increase while Norway saw a 3.4 percent decrease.

Imports of Fresh Atlantic Fillets

Imports in March 2018 were 14.4 percent higher than the previous month, and total YTD imports were 12.9 percent higher. Chile, the main driver in this category, did see an increase; imports up 25.5 percent YTD. Additionally, on a month-to-month basis, imports out of Chile increased 15.2 percent. Overall, comparing March 2018 to March 2017 there was a 15.9 percent increase. Fresh fillet imports out of Norway saw an 8.4 percent increase in month-to-month imports; while experiencing a 16.8 percent decrease in YTD imports.

Frozen Atlantic Salmon Fillets & Portions, Imports and Price

Imports of frozen Atlantic fillets increased 3.6 percent in February compared to the previous month. Additionally, on a YTD basis imports were 31.1 percent higher. Imports from Chile increased 3.6 percent from the previous month and were 32.5 percent higher on a YTD basis. Imports from Norway increased 16.9 percent compared to the previous month and were 45.6 percent higher on a YTD basis. We must mention that we assume this HS code includes frozen portions.

InfoTrade, Chilean Exports of Salmonids and Atlantic Salmon to the U.S. (in MT)

According to Chilean data, exports of Chilean salmon to the world increased by 23.3 percent through March 2018 compared to the same period last year. Shipments of fresh Atlantic fillets to the U.S. were 20.8 percent higher on a YTD basis.

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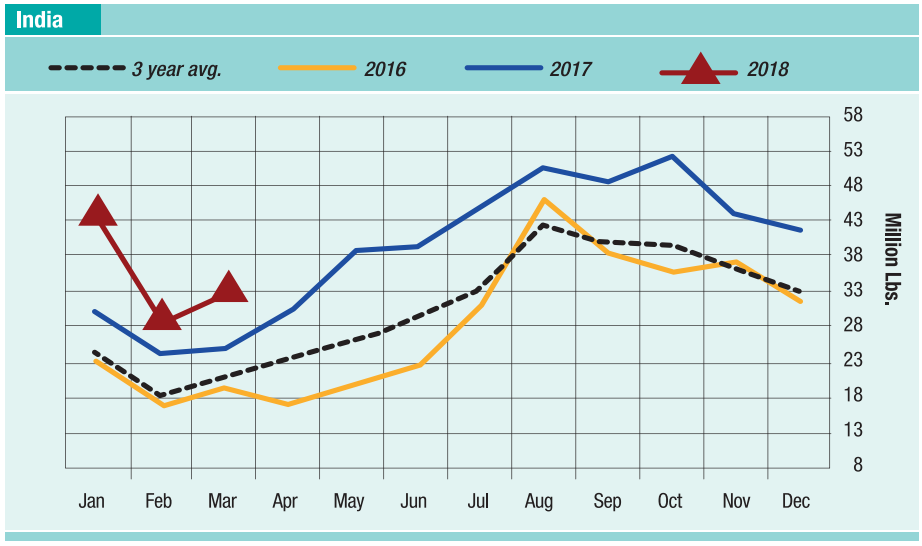
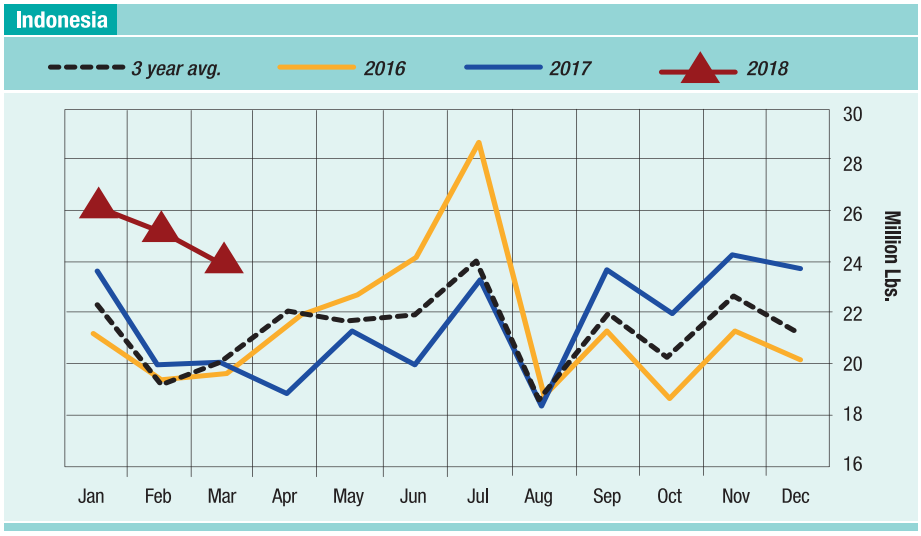
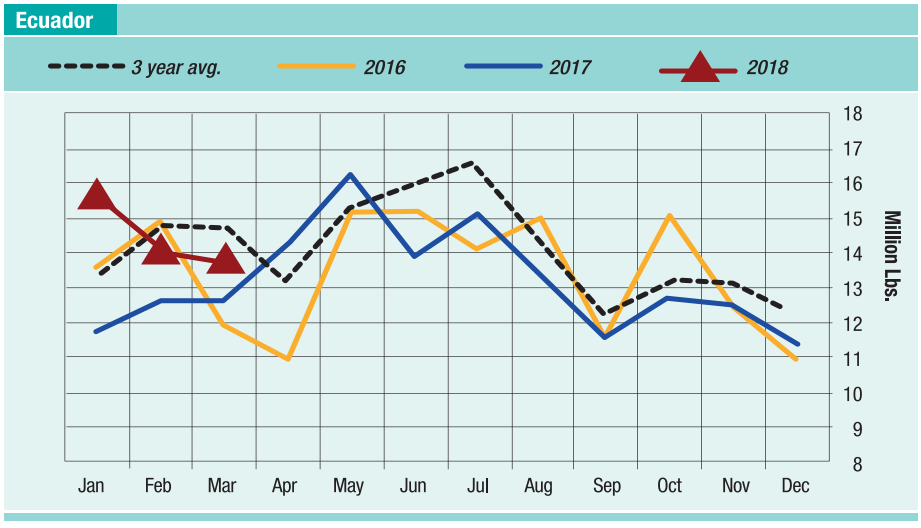
SHRIMP

UPDATES FROM URNER BARRY

*By: Paul B. Brown Jr.**







Farmed White

The entire complex has been under significant pressure, largely due to the widespread availability of Indian shrimp, and to a somewhat lesser extent, Indonesian and Ecuadorian shrimp. The market for shrimp from both Latin American and Asian origins, in all product forms, has been eroding and maintains a weak bias.

Farmed Black Tiger

The bulk of this category also sits at 52-week lows, pressured by the widespread availability of white shrimp. The exceptions continue to be the largest count sizes of headless shell-on shrimp.

U.S. Imports All Types

March 2018 U.S. Census figures were released, and the trend continues with imports higher year-over-year. Imports were 12.5 percent higher in March, sending the first quarter total 16.3% above a year ago. Shipments increased from most major shrimp supplying countries, led by India, where imports were up 29.9%. In addition to India, an increase in shipments was noted from Indonesia (+19.5%), Ecuador (+8.7%) and China (+38.1%). Shipments from Thailand declined 42.9% and Vietnam 1.7% in March.

Monthly Import Cycles By Country (All Types)

India: India continues to be the dominant supplier to the U.S. market, accounting for roughly 31 percent of Q1 imports. Shipments were up 29.9 percent for the month of March and are 34.2% higher year-to-date. This is a continuation of a trend that's been in motion for a decade. Year-over-year growth from India, on an annual basis, has ranged between 13 and 60 percent during this time. The growth is also widespread; noted in the HLSO, P&D and cooked categories.

Indonesia: Indonesia is the second largest supplier to the U.S. market, making up roughly 22 percent of Q1 imports. Shipments were up 19.5 percent in March and are 18.4% higher in the first three months combined. Like In-

dia, increases from Indonesia are noted in all forms. Indonesian shipments of shrimp to the U.S. have increased for seven straight years.

Ecuador: Unlike India and Indonesia, shipments from Ecuador to the U.S. have been on the decline. However, shipments in the month of March were up 8.7 percent and stand 17.5% higher for the year. The increase may have in part been the result of a redirection of exports due to the Chinese crackdown on smuggled imports through Vietnam that began earlier in the year. Ecuador has significantly increased shipments of P&D shrimp to the U.S.

Thailand and Vietnam: Shipments from Thailand were down 42.9 percent for the month and 25.1% year-to-date. Vietnam shipped 1.7 percent less in March and 1.3% fewer this year.

Shell-On Shrimp Imports, Cyclical & by Count Size

Headless shell-on imports, including easy peel, were up both in March and YTD led by large increases from Ecuador, Indonesia, India and Mexico. In terms of count size, imports of 16-20 through 41-50 were noticeably higher.

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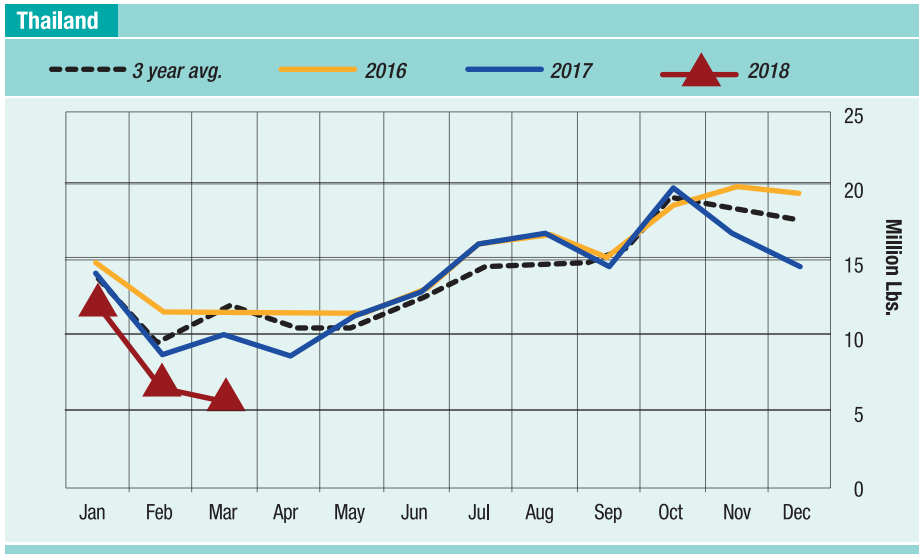

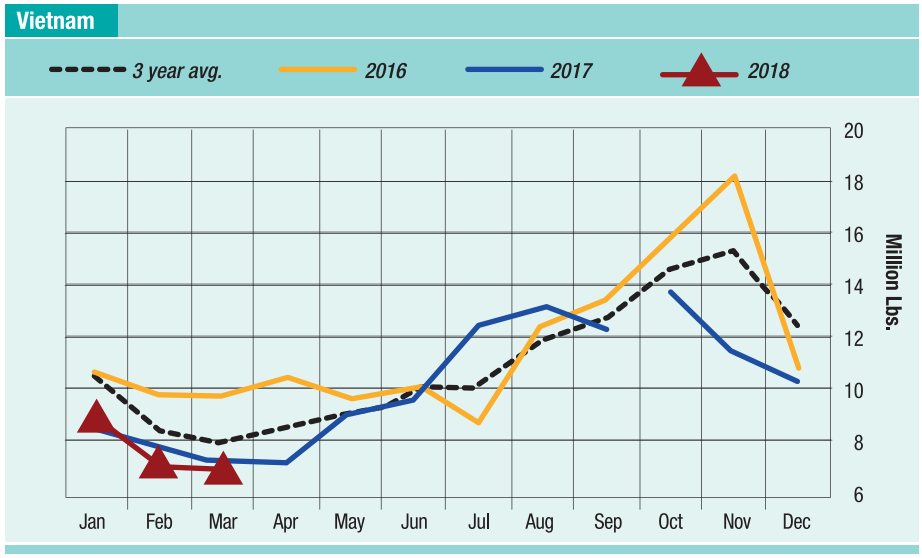

TILAPIA, *PANGASIUS* AND CATFISH

UPDATES FROM URNER BARRY

*By: Paul B. Brown Jr.**

Tilapia imports at the start of Q2 retreated, continuing their declining trend with total volumes falling 40 percent across all categories compared to the previous month. The most notable decline was for frozen fillets, down over 50 percent from March 2018. This is a significant decline as this time last year imports were up 27 percent compared to the previous month. On a year-to-date basis, however, total imports are down 5 percent compared to the same time a year ago, with frozen whole tilapia reversing the trend, up 12 percent compared to YTD 2017 figures.

Imports of Fresh Tilapia Fillets

Imports in April contracted 11 percent from the previous month, totaling 3.9 million pounds, the lowest April on record since 2011. Imports from Ecuador (-28.1%) and Mexico (-34.9%) saw the largest decline from the previous month, while imports from Brazil (18.2) and Colombia (6.7%) increased on a YTD basis compared to last year. YTD imports from Colombia have increased year-over-year since 2014.

Fresh Tilapia Fillet Pricing & Imports

From a replacement cost basis, as well as the adjustments made to weighted import price per pound (which includes only the top five suppliers), we found that the April figure of $2.83 remained steady from the previous month. Market demand has been steady with skin-packs slightly driving demand.

Imports of Frozen Tilapia Fillets

Imports dropped significantly, down 51.1 percent from the previous month and 48 percent from last year, totaling

8.7 million pounds for April 2018. This is the lowest monthly total on record since April 2008. This figure is down 32 percent compared to the 3-year average for the month. YTD imports total 78.6 million pounds, this is the lowest YTD average since 2009, falling 8.7 percent below figures from last year.

Domestic Channel Catfish, Urner Barry Prices

A stable backdrop for pond and feed prices have resulted in a steady domestic catfish market. Feed prices have been on the relatively lower side for some time. Supplies are fully adequate. The combination of the USDA food nutrition assistance program that encourages domestic consumption of catfish and the return to domestic catfish after Swai hit above $3.00 have resulted in a pick-up in sales for the 7-9 and 9-11 oz frozen fillets. Lower offerings helped reduce inventories and move prices back inline.

Pangasius and Channel Catfish

Pangasius imports for April have increased from the previous month, albeit only 1.17 percent compared to last month, but this is the second month in a row we are seeing imports in the green. Imports are still down nearly 24 percent compared to April 2017 and down 25 percent compared to YTD figures from last year. The same holds true for channel catfish as imports are up 3 percent compared to the previous month, but have declined 24 percent from April 2017. On a YTD basis, imports are down 25 percent compared to last year YTD figures.

Even though Imports of *pangasius* have experienced their second month-to-month increase for 2018, as back orders from Vietnam are starting to be filled, there is still much uncertainty surrounding the market and how long this activity will last. Total *pangasius* imports continue to suffer a significant drop in 2018 compared to previous years and continue to experience record high prices due to supply issues abroad, added demand from China and longer delays caused by USDA regulation. We have yet to see demand divert from to tilapia or channel catfish yet.

Imported Channel Catfish

Imports of frozen channel catfish fillets increased significantly in April, up 61.1 percent compared to the previous month following a seasonal trend. This number is slightly higher than the previous 3-year average for that month. On a YTD basis, imports are below figures recorded last year by 29 percent.

Shipments in April entered the U.S. with a declared value of $2.53 cents per pound, dropping $0.10 from the previous month. This is the lowest recorded value since the December 2014 figure of $2.48. The wholesale market remains steady to about steady with demand reportedly fair at best. Key industry players are not seeing a shift in demand from *pangasius* to channel catfish.

Imports of Frozen *Pangasius* (Swai) Fillets

April imports have increased for the second month in a row, but just barely, registering 12.9 million pounds. This figure falls 32 percent below the 3-year average for April imports. On a YTD basis, imports are down 25 percent compared to last year. European data goes through April 2018. Both U.S. (-25%) and European (-23%) imports are significantly down compared to last year.

According to data from the USDOC, replacement prices have surpassed the record-setting level reached in November 2017, setting a new record high for replacement prices. Increasing $0.10 from the previous month, the April 2018 figure of $1.82 per pound is the highest price on record. According to most in the industry, this upward trend was expected and could continue. Some traders have reported they are just beginning to see backorders being filled. Raw materials continue to be an issue due to a strong demand from China.

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W: www.offshoremariculture.com/europe

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W: www.gafconference.org/home.htm

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W: www.was.org

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W: www.sealice2018.cl/

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E: simposio.int.maricultura.fcm@uabc.edu.mx

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W: www.fenacam.com.br/

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