

# AQUACULTURE FRONTIERS

## PART 1: CAN RAS TURBO-CHARGE AQUACULTURE?



Recirculating aquaculture technology is being used to revive species in decline and improve smolt farming. The next evolutionary step is salmon mega-farms. Learn how RAS farming is going mainstream.



ucn

# REPORT SCOPE

Matt Craze spent a year researching the current global state of the recirculating aquaculture systems (RAS) industry starting at the 2017 Aquanor show in Trondheim, Norway after getting curious about their impact on salmon industry. This research has taken him to West Virginia to learn about the work carried out by the Freshwater Institute, and the sites of the future land-based salmon farms in Maine. More recently, Matt visited Camanchaca's state-of-the-art RAS smolt facility in southern

Chile. Matt interviewed dozens of executives involved in the RAS industry and analyzed the return of investment models and operating cost structures of these systems versus traditional open pen aquaculture. Larisa Culeac studied a growing trend in Russia and neighboring countries to raise sturgeon in RAS tanks and revive the caviar industry that has been decimated from overfishing in the Black and Caspian seas.

# INTERVIEW LIST

- The Freshwater Institute
- Center for Cooperative Aquaculture, University of Maine
- Kingfish Zeeland
- Nova Austral
- Maine Aquaculture Innovation Center
- Candor Seafood LLC
- Maine & Co
- Marine Harvest ASA
- Hudson Valley Fish Farm
- Matorka
- Aqua-Spark
- Rabobank
- Pareto Securities
- Broodstock Capital Partners
- Billund Aquakulturservice
- AquaBounty
- Atlantic Sapphire
- Nordic Aquafarms
- Whole Oceans
- Nova Austral
- Pentair Aquatic Eco-Systems
- Salmenes Camanchaca
- RecircInvestBiotech
- Saudi Fisheries Company
- AquaGen
- Chilean fishing regulator Sernapesca
- Superior Fresh
- Ctrl Aqua
- Kepler Cheuvreux
- AKVA

# CHARTS + ILLUSTRATIONS

- Operating costs: RAS vs Coastal Farming
- RAS Industry Timeline
- Conversion Rates of Salmon Smolt Industry
- RAS Growth Rates
- Map of Industry Players
- Post-Smolt Strategies

# TABLE OF CONTENTS

## 1. Executive Summary

### 2. Grow out RAS – many failures, but a growing success rate

RAS has the potential to diversify seafood supply globally. But it needs to overcome a past chequered with spectacular failures. We analyze where grow-out RAS has worked, and where it has succumbed to biological and budgeting failures

**Side glance:** The United States. As Alaska's great fisheries decline and pen farming could be phased out, giant RAS salmon farms emerge on the East Coast

**Side glance:** Russia: rebuilding the caviar industry using aquaculture and RAS technology

### 3. Salmon's RAS smolt revolution: improving costs, health and reliability

Salmones Camanchaca first built a RAS farm to raise salmon from eggs to smolt back in 2001. Although slow to take off, the industry is now rapidly migrating to RAS technology to phase out out-dated 'flow-through' hatcheries.

### 4. RAS Economics: winning over skeptical bankers

Some of the biggest RAS failures have involved poor financial planning more than biological failure. RAS operating costs can often be cheaper, but the requirement of heavy start-up capital and a prolonged period between investment and first revenue requires executives who are fluent in finance. We assess the industry's ability to contend with the complex return on investment models.

### 5. RAS Technology: technological advancements that could increase predictability

We will look at the efforts being made to improve RAS operations and companies that are working on R&D efforts to make the technology more predictable and more affordable.

### 6. RAS in Asia: after a slow start, fast to scale?

We analyse why Asia has been slow to respond to the RAS boom. We look at efforts being made in China and elsewhere to adopt RAS technology and how it could scale quickly.

# Can RAS Turbocharge Aquaculture?

## EXECUTIVE SUMMARY

Recirculating aquaculture technology (RAS) is going mainstream.

During the past two years, the aquaculture industry collectively shook its head in disbelief as a group of Norwegian entrepreneurs turned a utopian vision of a giant salmon farm in tropical Miami into reality. Atlantic Sapphire is the talk of the town, and it's listed on the Oslo Bors.

With Atlantic Sapphire under construction, two other companies announced major RAS salmon farms in the state of Maine this year, starting what could be deemed as a land-based revolution in the United States. Outside of salmon, innovators are raising other species in a RAS environment. Kingfish Zeeland, a Dutch firm, is successfully farming tropical yellowtail fish at a site near the North Sea. Hudson Valley Fish Farms started a steelhead trout farm, just a short drive from New York City.

"That's the beauty of recirculating aquaculture systems (RAS)," said Steve Eddy, the director of the University of Maine's Center for Cooperative Aquaculture (CCAR). "You can grow anything, anywhere."

The US-based RAS announcements came in a year when Washington governor Jay Inslee said the state would phase out salmon farming following the pen collapse of Cooke Aquaculture last year, effectively ending the activity in the United States. Wild salmon captures from Alaska and Canada also plummeted in 2018, making the world's largest salmon importer more dependent on Chilean and Norwegian imports than ever. Meanwhile, US salmon demand is growing at double digits, and the massive Chinese market is just waking up to the taste of Atlantic salmon.

RAS is already a major business. The industry started off in the 1980s as a group of intrepid Danish innovators started eel farms using technology similar to that used

in a swimming pool, with a recirculating water system. A pivotal moment occurred when the salmon industry realized that RAS could significantly improve processes used in their smolt hatcheries. Salmenes Camanchaca became a pioneer in 2001 when it built its first ever hatchery using RAS technology in southern Chile.

Now, the conventional salmon farming industry is adopting RAS technology at a frenetic rate. Major providers of turnkey RAS systems, such as Norway's AKVA Group and Denmark's BillundAquakulturservice A/S, have sizeable project pipelines and are reporting double digit growth in the sector as they cater to the salmon industry.

Converting a salmon hatchery from a traditional flow-through system to RAS reduces variability and better prepares fish for their life at sea, said Hugo Cajas, head of freshwater for Chilean producer Salmenes Camanchaca. It can also significantly reduce the time that fish spend in coastal pens, effectively freeing up that seawater capacity for more cycles, according to Grieg Seafood ASA.

Salmenes Camanchaca's salmon hatchery has been built according to RAS, with water temperature at about 15°C, 1500 ppm.

King is building a large RAS facility in Norway. The investment is about 100 million NOK, compared to 50 million NOK for a traditional hatchery. The RAS system will produce 100 million salmon per year, compared to 50 million per year in a traditional hatchery. The RAS system will produce 100 million salmon per year, compared to 50 million per year in a traditional hatchery.

For the full capabilities of RAS, we need to expand salmon, and other species, into the open sea. This is the future of aquaculture. The RAS system will produce 100 million salmon per year, compared to 50 million per year in a traditional hatchery.

## Black and Cooper speak

Steve Kelly at the ICRAR is attempting to restore naturally low Atlantic halibut stocks through RAS farming. In Asia, Gus Werner, one of the earliest employees of Danish RAS supplier Inter Aquas, is growing sea cucumber in a multi-story RAS operation in Hainan, China. He expects the technology to explode in China as the government starts to clamp down on the country's many informal fish farms. The Middle East has been experimenting with RAS technology for many years using seawater tanks.

Summerfelt left the Freshwater Institute in June to join Superior Fresh, a massive aquaculture farm located in the Wisconsin countryside that has added its first Atlantic salmon on July 4. Water from the so-called biofilter where the Atlantic salmon are kept irrigates a 100,000 square-foot greenhouse of leafy greens before being pumped back to the fish cages. The technology could revolutionize farming and food production systems in the United States, Summerfelt said.

'We are changing the world,' Summerfelt said. 'RAS creates jobs in areas that need it and provides everyone with a healthy protein source.'

Despite these advancements, RAS technology is still under serious doubt because of a high failure rate among start-ups. The technology is still prone to biological and budgetary errors and the jury is still out whether RAS will go mainstream anytime soon, according to food industry leader Rabenhair.

Biologically, operating a RAS farm requires highly skilled staff to avoid fatal human errors, according to Steve Summerfelt. A system such as the Superior Fresh biofilter requires at least a "couple" of biology graduates to avoid failure, he said. While these systems are effective at keeping pathogens out, once in, they can quite easily wipe out the entire population of a RAS farm.

The variability is gradually decreasing, said Brian Cameron, aquaculture research center manager for

offshore technology supplier Permar. In the early days of RAS, skilled individuals would assemble different parts of equipment to make a RAS system. Now that situation has "flipped" as the systems have become generic and obscure the knowledge of any one individual, he said. This is itself a new problem because it's hard to find operators of the sophisticated equipment used in modern RAS systems, he said.

Also crucially important are service providers in the RAS space. The industry has attracted major companies such as French water company Veolia, which designs the biofilters that collect fish feces and recirculate fresh water back into the cages. There are a host of other companies that supply oxygen, transport sludge, control pressure valves and other key steps. Energy utilization rates are still high and costly, making RAS prohibitively expensive in some parts of the world.

There is still much room for improvement in the standardization of technology, said Bjørn Ruge, an investor in RAS technology for Oslo-based investment fundbook Capital Partners. The firm bought 21% of Offshore last year and plans to set up acquisitions that can further optimize RAS systems, he said.

'RAS is going to boom,' Ruge predicts.

Perhaps the biggest challenge of all to operating a RAS grow-out farm is in the financial capability required to raise the large sums of capital needed and executing the project on time, and on budget.

On paper, RAS is a no-brainer. RAS provides cheaper operating costs than coastal pen farms because transport costs are close to zero, said Erik Hagen, CEO of Nordic Aquafarms, which plans a major RAS salmon farm in Maine.

These Maine sites will pay less than 100 cents per pound fresh salmon to processing plants in the U.S. Northeast Corridor, by virtue of being close to Route 1 on the Atlantic Coast. By comparison, Oregon farmers pay more than 20

# BILLUND AQUAKULTURSERVICE: RAS 128 Projects Built Since 1984



get into the market. When you get into the Santiago market, where they are treated as sovereign rights to Chile, according to local laws, the general manager of Chilean producer SalmoMar Magallanes.

The main challenge that the industry has is to the time required to get a capital investment that exceeds \$50 million for a small project to hundreds of millions of dollars needed for a fully operational Atlantic Sapphire salmon in the three-year growth cycle takes significantly longer to harvest than other forms of protein such as chicken or pork. As such, investors face difficulties in convincing banks to lend significant sums of capital on a technology that has yet to be proven at the large farm level and therefore there is a high level of equity risk at higher volumes.

"We really need the investor to be well-informed" said Mike Helgeson, co-founder of aquaculture investment fund Super Spark. "People are getting a better understanding of RAS economics, but not happening to understand how much capital is needed over 12 months of time is really dangerous."

Investment appetite differs by region. Scandinavia and especially Denmark has attracted RAS and has had significant funding from financial institutions in the region. Other regions, notably Asia, have been much slower to respond to the opportunities that RAS presents, said Thomas Christensen.

"Denmark is very open to financing projects and the water is just to start a fish farm," he said. "In the U.S. they probably wouldn't even purchase equipment."

While financing constraints affect a large number of the successful completion of projects such as Atlantic Sapphire and Northbrook, 100% of Aquaculture Technology, which was the first land-based aquaculture company to go public globally.

"The first one is the most important" said Helgeson in reference to the Atlantic Sapphire project. "That's why we work the other projects well. If we have a successful one and learn it will save the investment community. We want them to be all successful."

# REPORT AUTHORS

## Matt Craze



Matt started Spheric Research in 2017 to provide research and consultancy services to the seafood and food industries. Matt is a regular contributor of articles on global seafood trends for Undercurrent News.

Previously, Matt was part of a team that founded Bloomberg LP's commodities news desks in Europe, the Middle East and Africa, and Latin America between 2004 and 2015. Matt also works with New York-based management consultancy firm 10EQS and holds an MBA with Cornell University.

## Larisa Culeac



Larisa has spent the past six years working for LG Corp., developing the Korean company's commodities division in South America. Larisa studied at Babson College in the United States, completed an MBA at Chile's

Universidad del Desarrollo and worked for the European Bank for Reconstruction and Development in her native Moldova.

## Spheric Research

Provides key insights into the global seafood industry, and has now provided research to numerous major companies in seafood and several of the world's largest agricultural companies. Spheric Research provides research on major global seafood topics that are sold exclusively by Undercurrent News and also offers tailor-made research and consultancy services to the seafood industry.

## Undercurrent News

Undercurrent News is the most read seafood industry news service globally. UCN was started by journalists Eva Tallaksen and Tom Seaman in 2012 and has become an authoritative voice in the industry, placing an emphasis on high quality journalism and sending reporters to key trade shows and industry seminars around the world.