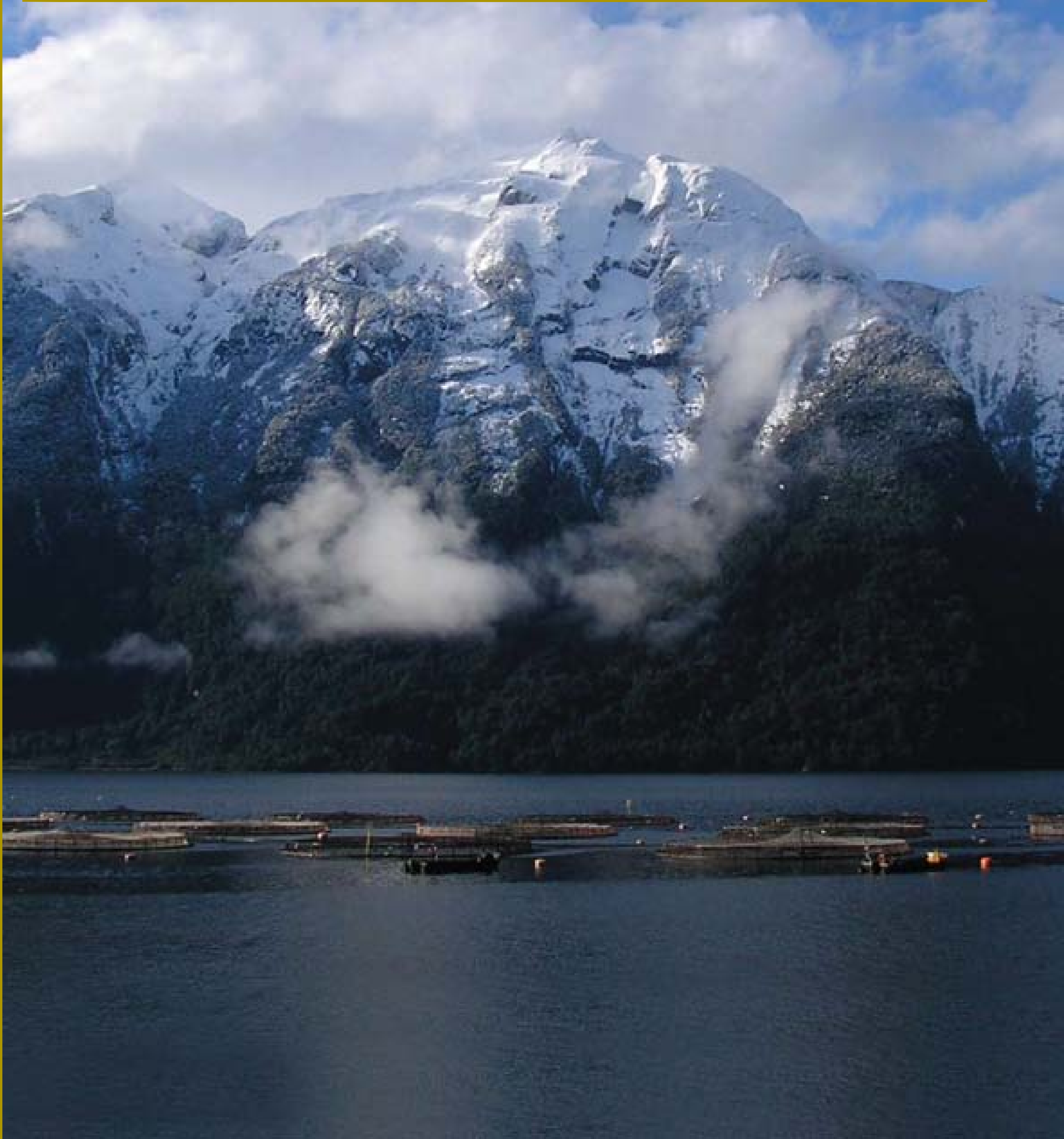
global aquaculture

# the advocate

The Global Magazine for Farmed Seafood
September/October 2011

GOAL 2011 ISSUE
GLOBAL AQUACULTURE ADVOCATE
Volume 14, Issue 5
September/October 2011



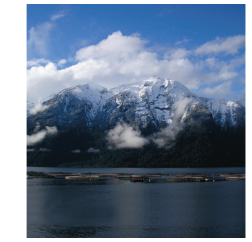
# september/october 2011

## production



## marketplace





**On the cover:**
Host country for GOAL 2011, Chile is a major base for salmonid aquaculture. Its products ship worldwide. Photo courtesy of Armin Ramirez.

## DEPARTMENTS



**Page 58**
***Streptococcus* Vaccine**
A vaccine for tilapia was found safe and effective against *S. agalactiae* biotype II in lab testing and field trials. Studies have shown it protects for at least 30 weeks.

**Page 88**
**Floating Closed Containment**
Floating, solid-wall culture systems with low-pressure pumping, oxygenation, waste separation and efficient feed management offer benefits over traditional net pens.



## innovation

**GLOBAL AQUACULTURE ALLIANCE**

The Global Aquaculture Alliance is an international non-profit, non-governmental association whose mission is to further environmentally responsible aquaculture to meet world food needs. Our members are producers, processors, marketers and retailers of seafood products worldwide. All aquaculturists in all sectors are welcome in the organization.

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*Global Aquaculture Advocate*
is printed in the USA.
ISSN 1540-8906

# Shaping The Future Together

**George W. Chamberlain, Ph.D.**
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Global Aquaculture Alliance
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Peter Drucker, an influential management expert, once said, "The best way to predict the future is to create it." This captures the spirit of GAA's annual GOAL meeting: to go beyond projecting trends by working together to address the issues.

At GOAL 2010 in Kuala Lumpur, GAA identified a surge in seafood demand due to the global shift in economic power that is giving rise to a new middle class in Asia. This long-term trend is already causing shortages of seafood supply, rising prices and major shifts in buying, selling and production.

At GOAL 2011 in Santiago, industry leaders will explore how to meet this surging demand. The first step will be to define the demand in greater detail through a new World Bank study, "Fish to 2030." This is a dynamic simulation model that will project future seafood demand based on various regional and global scenarios.

Next, economists will present the current and projected global production of major species of shrimp, fish and bivalves. Comparisons of these production projections with corresponding seafood demand expectations will identify the gaps in projected supply and demand.

The next aspect of GOAL 2011 will consider the obstacles that are likely to hinder the growth of aquaculture and their potential solutions. Consensus views will be assessed through use of individual audience response indicators that allow each participant to anonymously vote on options and immediately see the compiled views of the group.

The first potential obstacle to be considered will be disease. A common scenario in aquaculture development begins with successful pioneering farms in a given region, progresses to rapid development of neighboring farms and culminates in a catastrophic disease outbreak. It is difficult to determine when increasing development begins to predispose the region to disease risk. Improved policies are needed to stay ahead of the curve at the regional and national levels.

At GOAL 2011, experts will present a case study on the outbreak of infectious salmon anemia virus in Chile. They will review the causes, recovery measures and lessons learned – lessons that may be applicable to other regions and species. This and other planned case studies are part of a new GAA-led World Bank study on "Lesson Sharing for Aquaculture Disease Control" to help improve aquaculture policies in countries at risk of new or recurring disease outbreaks.

Expansion to meet increasing demand will require substantial investment capital. How can we overcome this hurdle? For the first time, a full session at GOAL will be devoted to understanding the perspectives of banks, private equity groups and financial analysts toward aquaculture. GAA will also present an online mechanism to facilitate interactions between aquaculture projects and the investment community.

As production of seafood and other animal proteins increases, so too do feed requirements. Experts will discuss the future availability of fishmeal, grains and oil seeds, as well as the ethical issue of whether aquaculture growth will cause grains to be priced out of reach of the world's poor. Representatives of NGOs and foundations will also identify other critical environmental and social issues likely to emerge with industry growth.

The final day of GOAL will be devoted to seafood markets and the question of how seafood buyers can influence growth and sustainability through well-reasoned purchasing policies.

We have much to discuss, but this much is clear. Aquaculture is entering a period of great potential for long-term growth, but also one of unprecedented challenges. If we work together, we can indeed shape a better future.

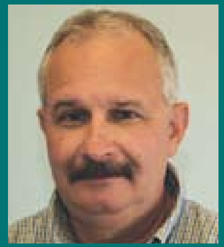
Sincerely,

George W. Chamberlain





# Are We Ready For 7 Billion?



**Darryl E. Jory, Ph.D.**
Editor, Development Manager
*Global Aquaculture Advocate*
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In a comprehensive 2009 report by the Food and Agriculture Organization (FAO) of the United Nations, a key point was that over 500 million people are directly or indirectly dependent on the seafood industry. We will soon be 7 billion, and the number will inexorably continue to increase. Already about 15% of the world population goes to bed hungry every night. With our population projected to grow by 37% over the next 40 years, and with global food needs expected to grow even faster because of the higher living standards in developing countries, global food production must increase fast.

Aquatic products already contribute significantly to food security around the world, and many developing nations depend on seafood as a major source of protein. However, over half of the world's marine fisheries are fully exploited or fished at the maximum allowable level, while an additional 28% is "overfished," depleted or recovering from depletion. If overall production is to keep pace with an expanding world population, and given the likelihood that capture fisheries will remain stagnant, future growth will have to come from aquaculture.

Not only do we have to expand aquaculture production to new areas, but we also have to become even more efficient producers, following the path of terrestrial agriculture. Our industry today faces numerous challenges that were not around a few years ago. I have discussed these before; the list is long, and the task at hand is challenging.

We have two critical areas to consider. One is that only with new technologies to improve efficiency and sustainability can we properly address industry challenges. We must, for example, develop management practices that increase control over our production systems, incorporating selective-breeding programs, lines resistant to specific pathogens, improved disease detection and better health management.

We need better understanding of the nutritional requirements of cultured species, more renewable ingredients, improved manufacturing processes, reduced use of water. Other aspects include industry integration and consolidation, and increased adoption of certification to ensure product safety and wholesomeness.

The other critical area is financing. To significantly increase aquaculture production in a few years will require huge investments, and from where will this funding come? Management expert Peter Drucker once said, "Aquaculture, not the Internet, represents the most promising investment opportunity of the 21st century." How are we going to help not just private investors but also Wall Street and other investment centers discover our industry?

The success of major aquaculture industries like shrimp, salmon and tilapia – which are significantly more productive, responsible and sustainable than even a few years ago – shows what can be accomplished with dedication, ingenuity, vision … and financing. There is much to consider as the future happens; how it happens is up to us.

Finally, I would like to welcome our two newest columnists, each of whom brings a lifetime of distinguished and unique experiences to help us analyze and chart the future of our industry. Dr. Thomas R. Zeigler, senior technical advisor, past president and chairman of Zeigler Bros., Inc., will discuss paths to profitability in "The Bottom Line." Roy Palmer will provide his unique insight into current topics that shape our industry in his column, "Fishy Business." A hearty welcome to you both, and thanks for your support!

To our readers we also extend a big thank you. Please let us know how we can best continue to serve you and the rest of our industry.

Sincerely,

Darryl E. Jory

# Study To Report Lessons Of Chile's ISA Recovery At GOAL 2011

A new production model is helping Chile's aquaculture industry recover from disease issues. Photo courtesy of Undersecretariat for Fisheries, Chilean Government.

The Responsible Aquaculture Foundation is working with the Subsecretariat of Fisheries of Chile and SalmonChile, Chile's salmon industry association, on a case study directed to share lessons that can contribute to prevent and mitigate disease crises in aquaculture. As the initial effort of a major project promoted by the World Bank, the study will be initially reported at the GOAL 2011 conference in Chile in November.

The study will analyze the evolution of the infectious salmon anemia (ISA) crisis in the Chilean salmon industry and evaluate the recovery process from various perspectives. This information should be beneficial to the Chilean salmon industry and other countries involved in aquaculture – especially those that are just beginning commercial aquaculture development.

The study is being developed by an international team of experts that includes Dr. Fred Kibenge of the University of Prince Edward Island in Canada, United States-based aquaculture consultant Dr. John Forster, José Burgos of the Undersecretariat for Fisheries of Chile and Jeroen Wijsman of Wageningen University in Denmark. Adolfo Alvial of Adolfo Alvial Consultancies in Chile will coordinate the team.

The Chilean salmon-farming industry is in the process of recovering from a severe outbreak of ISA that began in 2007. This outbreak caused severe impacts on Atlantic salmon production, which formerly represented two-thirds of Chile's salmonid production. It has also caused secondary impacts on employment, social welfare and international market presence.

For different sectors and experts in Chile, the ISA epidemic marked the end of a period when priorities were focused on production and sales, with lesser emphasis on local research, regulations and enforcement. Now the majority of actors have agreed to measures that are giving form to a new regulatory system. In essence, a new production model has been rapidly put in place – allowing the recovery of this important sector under new rules and practices.

# GAA Offers New Traceability Option For BAP Certification

The Global Aquaculture Alliance is introducing a new option for achieving the traceability required for Best Aquaculture Practices (BAP) certification.

Later this year, facilities that apply for or renew their BAP certifications can opt to use either the current online verification or a chain-of-custody verification. Either approach to meeting the traceability required in the BAP standards will be verified during the third-party audits of the facilities.

Currently, all BAP-certified hatcheries, farms, feed mills and processing plants are required to maintain specified traceability data for at least one step forward and one back. Farms, for example, must identify inputs such as sources of juveniles and feed, production data such as use of therapeutants and buyers of harvested products.

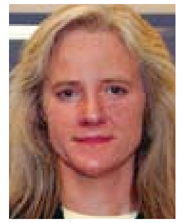
During BAP site audits, facilities must demonstrate that effective internal traceability systems are in use. In addition to the internal traceability, BAP certification has required that participants enter or upload key portions of the specified data to the BAP online traceability database. This assists in the verification of the chain of custody of multiple BAP-certified inputs, which is depicted within the BAP retail packaging mark as stars for processing plant, farm, hatchery and feed mill.

With the new option, facilities that select chain of custody for traceability verification will have records reviewed by third-party auditors as part of their initial or renewal certification audits. The adoption of chain-of-custody verification as an alternative to participation in online traceability will provide a more achievable option for small farms and will not result in any changes in program fees.

The Global Aquaculture Alliance recognizes that various companies in the international marketplace prefer their suppliers to employ electronic traceability. The BAP program will therefore continue to provide that capability through the production chain for aquaculture facilities and retail and foodservice businesses that require it.

**During BAP site audits, facilities must demonstrate that effective internal traceability systems are in use.**

# Lisa Goché To Join BAP Management Team



Lisa Goché

The Global Aquaculture Alliance has selected certification management specialist Lisa Goché as vice president of the Best Aquaculture Practices division of GAA.

"Lisa Goché's extensive experience and leadership in managing food safety, environmental and social auditing systems will be great assets for the BAP program," BAP Executive Director Jim Heerin said.

Goché has nearly 30 years of experience in the seafood industry. Her most recent position was president of Surefish Seafood Quality Specialists headquartered in Seattle, Washington, USA, where she managed seven global locations conducting a variety of third-party seafood industry services, such as quality inspections, testing and auditing. Goché also previously directed quality assurance programs at Trident Seafoods Corp. and Emerald Resource Management.

Goché holds a wide range of credentials related to food safety and quality, including HACCP, ISO 22000, ISO 9001-2000, S.A. 8000, SQF and BRC. Surefish has provided auditing services for the BAP program for several years.

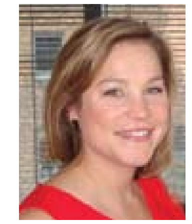
"I have an extremely strong belief in the standards," Goché said. "I have developed relationships with many companies that support the BAP program. I hope to expand upon those relationships as I manage the activities of the premier global aquaculture certification program."

When Goché takes her new position in late September, she will coordinate with ISO 65 auditing firms to provide timely implementation of BAP standards. She will also assist GAA's Technical and Standards Oversight Committees, and work closely with William More, who directs the BAP certification program.

In addition, Goché will manage BAP benchmarking and coordinate with the Responsible Aquaculture Foundation in its work to improve aquaculture processes and facilities.



# Molly Metcalf To Represent BAP In North America



Molly Metcalf

Best Aquaculture Practices has expanded its international marketing team with the addition of Molly Metcalf as BAP's new business development manager for North America.

Metcalf will help manage relationships with seafood suppliers, buyers, retailers and foodservice outlets in the United States and Canada to share the benefits of the world's leading certification program.

BAP Vice President of Development Peter Redmond said Metcalf's appointment demonstrates ongoing commitment to assist companies in the marketplace, as well as a commitment to advance the principles of BAP within the overall seafood community.

"The Global Aquaculture Alliance is delighted that Molly Metcalf has decided to join our BAP team," Redmond said. "Her addition will allow us to give more attention to existing retailers in the BAP network and focus on getting additional retailers on board, as well."

Metcalf is a seafood industry professional who has worked for Slade Gorton & Co. since 2002 in various buying and sales positions. Previously she taught Spanish at the high school level.

Metcalf is a graduate of the National Fisheries Institute Future Leaders program. Her class raised over $300,000 for SeaShare, a non-profit hunger relief organization. A graduate of Bates College in Lewiston, Maine, USA, she has a degree in Spanish, which will allow her to apply bilingual skills in the marketplace.

# BAP At *Pangasius* Workshop, Vietfish Expo

The Best Aquaculture Practices booth welcomed visitors at Vietfish.

Best Aquaculture Practices Director of Quality Jeffrey Peterson and Asia-Pacific Coordinator Ken Corpron carried the BAP story to Vietnam at a June workshop on sustainable *Pangasius* development held in Ho Chi Minh City.

Organized by the Directorate of Fisheries, Vietnam Fisheries Society and Vietnam Association of Seafood Exporters and Producers in cooperation with the World Wide Fund, the workshop was held to introduce international standards for *Pangasius* production and determine how willing producers will be to adopt such standards.

Peterson gave a 30-minute presentation on BAP's *Pangasius* farm standards. Other presenters spoke on standards from GlobalGAP and the Aquaculture Stewardship Council (ASC). The agenda also included market updates on Vietnamese *Pangasius* and U.S. catfish, and strategies and policies of Vietnam's government for sustainable *Pangasius* development.

In the discussion panel that followed the presentations, Peterson reinforced the strengths of the BAP program, which include its full coverage of environmental, social and food safety issues, and its comprehensive nature in addressing aquaculture from the hatchery to the processing plant.

Peterson said compliance with the BAP certification standards is more difficult than GlobalGAP certification, but BAP has more depth. ASC standards for *Pangasius* have not been finalized.

### Vietfish Expo

Following the workshop, Peterson and Corpron attended Vietfish, a major Vietnamese seafood exposition and trade show held every year in Ho Chi Minh City. At the BAP booth, they were kept busy answering questions about BAP for shrimp and *Pangasius* farms, processing plants and feed mills, as well.

The two were assisted by Nguyen Ngoc Son, a BAP auditor based in Ho Chi Minh City who works for NSF-Surefish. He was indispensable as a translator and also as a person familiar with the major seafood players in Vietnam.

# GAA Seeks ISO Accreditation For BAP Salmon Standards

Following the release of its new Best Aquaculture Practices (BAP) standards for salmon farms, the Global Aquaculture Alliance has begun the process of accreditation against ISO/IEC Guide 65:1996. The process involves several formal steps, including application, standard review, audit witness assessment and head office assessment.

The first certification body to seek accreditation to the BAP salmon farm standards is Global Trust Certification Ltd. Global Trust's Bill Paterson said that his organization's extensive experience with salmon standards certification will prove beneficial in obtaining a successful outcome to the accreditation process.

Dan Lee, standards coordinator for the BAP program, said that following the successful accreditation of the BAP seafood processing standards last year, the accreditation of BAP farm standards was the next logical step. Among other things, it will satisfy key requirements of the Food and Agriculture Organization of the United Nations' Technical Guidelines for Aquaculture Certification.


The BAP mark means that seafood was raised and processed according to international best practices for responsible aquaculture.

# Best Aquaculture Practices Basics

## *Voluntary Facility Certification Affirms Responsible Production*

Best Aquaculture Practices (BAP) is an international certification system that verifies environmentally and socially responsible processes under which fish, shrimp and other seafood are produced. The "Best Aquaculture Practices Certified" mark on seafood packaging means the facilities that raised and/or processed the seafood adhere to the Best Aquaculture Practices standards in minimizing environmental impacts, respecting workers' rights and producing wholesome products.

BAP certification is currently available for salmon, tilapia, channel catfish and *Pangasius* farms; shrimp hatcheries and farms; feed mills and seafood processing plants. Over 400 BAP-certified facilities can be found in Asia, Latin America and other parts of the world. Additional certifications for facilities raising other aquatic species are also under development.

Seafood with the "Best Aquaculture Practices Certified" logo is stocked at hundreds of major retail and supermarket outlets. For example, in the United States, buy BAP-marked seafood at Kroger, Giant Eagle, Aldi, Walmart, Sam's Club and Target locations. In Canada and Europe, shop IGA, Sobeys, COOP, Morrisons and other retailers for BAP seafood.

### Comprehensive Standards

BAP certification defines the most important elements of responsible aquaculture and provides quantitative guidelines by which to evaluate adherence to those practices. The comprehensive Best Aquaculture Practices standards developed by the Global Aquaculture Alliance form the basis for BAP certification. The standards include specific criteria that define responsible practices and food safety controls at aquaculture facilities around the world.

The program promotes environmentally responsible use of land, water, nutrients and other resources for aquaculture production. Participants in the BAP program must be good neighbors within local communities and cooperate with other rightful users of land and water to minimize conflicts. Further, BAP assures that aquaculture products are safe for human consumption and that culture animals are treated humanely.

### Certification Process

To be certified, aquaculture facilities must initially provide administrative and operational data, then undergo a site audit by a representative of an independent ISO-accredited certification body. The audit process includes a physical inspection, documentation reviews, personnel interviews, results from laboratory analyses and accompanying fees. Any non-compliance identified during an audit must be corrected before BAP-certified status is given.

The BAP program strives to set standards at an achievable level to encourage a broad cross section of producers to participate. Over time, however, the BAP standards are regularly improved. Since facilities must undergo audits and renew their BAP certifications annually, they constitute part of a continuum along which the aquaculture industry as a whole can advance.



# GOAL 2011 PROGRAM

## *Double In A Decade – Responsibly*

PROGRAM

### NOVEMBER 1-5

Tours available: Colchagua Wine District (2 days), Torres del Paine (5 days)

### NOVEMBER 6

| | |
|---|---|
| Noon-5:00 p.m. | Registration: Grand Hyatt Hotel, Mezzanine Level |
| 2:00-4:00 p.m. | GAA Membership Meeting: Grand Hyatt Hotel, Aysen Room |
| 6:30-8:30 p.m. | Welcome Reception, "A Taste of Chile": Grand Hyatt Hotel, Poolside |
| Social Event | Tours available: Portillo (8 hours), Viña del Mar/Valparaiso (8 hours) Santiago, Concha y Toro Winery and La Cachimba Bike Tour (3.5-4 hours each) See www.gaalliance.org/GOAL2011/goal-tours.php for tour details and registration. |

### NOVEMBER 7

| | |
|---|---|
| 7:30-8:00 a.m. | Coffee in Foyer |
| 8:00-8:15 a.m. | Opening Remarks: Wally Stevens, Global Aquaculture Alliance – USA |
| 8:15-8:30 a.m. | Formal Welcome |

#### PRODUCTION SESSIONS

| | |
|---|---|
| 8:30-9:00 a.m. | Keynote: Ricardo Garcia, Camanchaca – Chile |
| 9:00-9:20 a.m. | Fish 2030: World Bank |
| 9:20-9:40 a.m. | Shrimp Production Review: James Anderson, World Bank<br>Diego Valderrama, University of Florida – USA |
| 9:40-10:00 a.m. | Fish Production Review: Ragnar Tveteras, University of Stavanger – Norway |
| 10:00-10:20 a.m. | Salmon Production Review: Ragnar Nystoyl, Kontali Analyse – Norway |
| 10:20-10:50 a.m. | Coffee Break |

#### HEALTH MANAGEMENT PANEL

| | |
|---|---|
| 10:50-11:00 a.m. | Introduction: George Chamberlain, Global Aquaculture Alliance – USA |
| 11:00-11:15 a.m. | Modeling Ecosystem Carrying Capacity to Avoid Epidemics |
| 11:15-11:30 a.m. | Learning Lessons From Terrestrial Animal Health Management |
| 11:30 a.m.-Noon | Chile's Recovery From ISA: Adolfo Alvial, Adolfo Alvial Consultancies – Chile |
| Noon-2:00 p.m. | Lunch and Learn Session: Chilean Experience/Double In A Decade – Responsibly |
| 2:30-4:30 p.m. | Business Innovation Meetings |
| 2:30-5:00 p.m. | Best Aquaculture Practices Meetings |
| | Tours available: Santiago, Concha y Toro Winery and La Cachimba Bike Tour (3.5-4 hours each) See www.gaalliance.org/GOAL2011/goal-tours.php for tour details. |

### NOVEMBER 8

| | |
|---|---|
| 7:30-8:00 a.m. | Coffee in Foyer |

#### GLOBAL AQUACULTURE INVESTMENT

| | |
|---|---|
| 8:00-8:15 a.m. | Introduction: Jeff Fort, Global Aquaculture Alliance – USA |
| 8:15-8:45 a.m. | Keynote: Can Aquaculture Find the Capital to Double in a Decade?<br>Gorjan Nikolik, Rabobank International – The Netherlands |
| 8:45-9:00 a.m. | Private Equity View |
| 9:00-9:15 a.m. | Banking View: Jose Mujica, Claro and Associates |
| 9:15-9:30 a.m. | Financial Analyst View: Colin Guheen, Cowen Group – USA |
| 9:30-9:45 a.m. | Investment Experience: Victor Hugo Puchi, AquaChile – Chile |
| 9:45-10:00 a.m. | Online Tool: Linking Investors to Aquaculture: Jeff Fort, Global Aquaculture Alliance – USA |
| 10:00-10:30 a.m. | Coffee Break |

#### ENVIRONMENTAL ISSUES PANEL

| | |
|---|---|
| 10:30-10:45 a.m. | Introduction: Dan Lee, Global Aquaculture Alliance – USA |
| 10:45-11:00 a.m. | Foundation View |
| 11:00-11:15 a.m. | NGO View |

## Key Conference, Key Questions

The GOAL 2011 conference in Santiago, Chile, will bring together hundreds of seafood and aquaculture leaders in a forum that examines emerging issues and seeks collaborative solutions. In GOAL's first visit to the Southern Hemisphere, the event will also encourage key business connections.

Expect expert interpretations of global supply data for farmed fish and shrimp, as well as concise reviews of leading international markets. Under the theme of "Double in a Decade – Responsibly," the GOAL program will revolve around how the aquaculture community will gear up to meet the world's soaring demand for seafood.

**GOAL 2011 Registration Still Available**

See www.gaalliance.org/GOAL2011/ for registration and other conference information.

**Early Bird Discount Deadline: September 15!**

### NOVEMBER 8 (CONT.)

#### FEED REQUIREMENTS PANEL

| | |
|---|---|
| 11:15-11:25 a.m. | Introduction: Hugo Contreras, Cargill Animal Nutrition |
| 11:25-11:45 a.m. | Projected Supply of Grains, Oilseeds for Aquafeeds |
| 11:45-12:05 p.m. | Sustainability of Fishmeal, Fish Oil: Jonathan Shepherd, International Fishmeal and Fish Oil Organisation – United Kingdom |
| 12:05-2:00 p.m. | Lunch and Learn Session: Soy Meal In Aquaculture Feed<br>Dr. Michael Cremer, U.S. Soy Export Council – USA |
| 2:30-4:30 p.m. | Business Innovation Meetings |
| 2:30-5:00 p.m. | Best Aquaculture Practices Meetings |
| 7:00-11:00 p.m.<br>Social Event | Gala Reception and Dinner: Castillo Hidalgo (Buses depart at 7:00 p.m. from Grand Hyatt Hotel) |

### NOVEMBER 9

| | |
|---|---|
| 7:30-8:00 a.m. | Coffee in Foyer |

#### MARKETING SESSIONS

| | |
|---|---|
| 8:00-8:15 a.m. | Introduction: Peter Redmond, Global Aquaculture Alliance – USA |
| 8:15-8:45 a.m. | Keynote: "The Role of Seafood Buyers in Ensuring Sustainable Development of Aquaculture": Albert Zeufack, World Bank, Khazanah Nasional Bhd. |

#### RETAIL SEAFOOD BUYERS PANEL

| | |
|---|---|
| 8:45-10:00 a.m. | Chris Brown, Asda – United Kingdom<br>Robert Fields, Sam's Club – USA<br>Mike Loftus, Raley's – USA<br>George Parmenter, Hannaford Bros. – USA<br>Other Panelists TBA |
| 10:00-10:30 a.m. | Coffee Break |
| 10:30-11:00 a.m. | Retailer Dashboard: Howard Johnson, Sustainable Fisheries Partnership – USA |

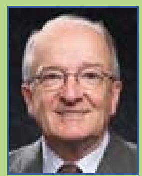
#### FOODSERVICE BUYERS, DISTRIBUTORS PANEL

| | |
|---|---|
| 10:30-11:30 a.m. | Roger Bing, Darden – USA<br>Jorge Hernandez, U.S. Foodservice – USA<br>Other Panelists TBA |
| 11:30-11:50 a.m. | China's Domestic Seafood Market: John Galiher, Preferred Freezer Services – USA |
| 11:50-12:10 p.m. | Closing Comments |
| | Tours available: Santiago, Concha y Toro Winery or La Cachimba Bike Tour (3.5-4 hrs) Aquaculture in Pacific Patagonia (4 days), Emerging Aquaculture (4 days) See www.gaalliance.org/GOAL2011/goal-tours.php for tour details and registration. |

# FEATURED GOAL 2011 PRESENTERS

## *Double In A Decade – Responsibly*

SPEAKERS



**Wally Stevens**

Global Aquaculture Alliance, United States

Stevens is executive director of GAA, where the 35-year seafood veteran helped expand Best Aquaculture Practices certification. Stevens formerly led Slade Gorton & Co. and helped establish the NFI Future Leaders program.

**Ricardo Garcia**

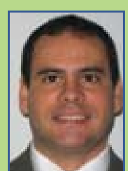
Camanchaca, Chile

As CEO of Camanchaca Fishing Co., Garcia manages Chile's leading seafood company's operations in fishing, fishmeal and aquaculture. He is also president of the Chilean North American Chamber of Commerce.

**James Anderson**

World Bank – University of Rhode Island, United States

Dr. Anderson is a senior economist in the World Bank's Europe and Central Asia region. He is also a professor of environmental and natural resource economics at the University of Rhode Island.



**Diego Valderrama**

University of Florida, United States

Dr. Valderrama is an economist with expertise in aquaculture and marine resources. He conducts research and teaches economic development at the University of Florida and was an aquaculture economist for the FAO.

**Ragnar Tveteras**

University of Stavanger, Norway

Prof. Tveteras is a business economist in the Department for Industrial Economics, Risk Management and Planning at the University of Stavanger, where his research focuses on aquaculture and seafood markets.

**Ragnar Nystoyl**

Kontali Analyse, Norway

Nystoyl is a managing director at Kontali Analyse, an independent worldwide analysis company focused on fisheries and aquaculture. Nystoyl works primarily in the areas of industry and market analysis.

**George Chamberlain**

Global Aquaculture Alliance, United States

Dr. Chamberlain has served as president of GAA since its inception in 1997. An aquaculture consultant with varied interests, Chamberlain has broad experience in all aspects of aquaculture production and marketing.

**Adolfo Alvial**

Adolfo Alvial Consultancies, Chile

Alvial is a former technical director for Marine Harvest Chile and founder of Adolfo Alvial Consultancies. His Chilean company provides services in technical development for aquaculture, environmental management and ecotourism.

**John Forster**

Aquaculture Consultant

Dr. Forster has worked as an aquaculture scientist, manager, fish farm owner and consultant since 1965. He moved to the United States to start Stolt Sea Farm before later founding his consulting practice.

**Fred Kibenge**

University of Prince Edward, Canada

Dr. Kibenge is chairman of the Department of Pathology and Microbiology at the University of Prince Edward. The expert on salmon disease and his laboratory confirmed the first occurrence of ISA in Chile in 2007.

**Jeff Fort**

Delta Blue Aquaculture, United States

Now on the GAA board, Fort formerly served as treasurer of the Aquaculture Certification Council. Fort is president of Delta Blue Aquaculture and a partner in a leading online wildflower retailer.

**Gorjan Nikolik**

Rabobank International, The Netherlands

Nikolik is a senior associate and industry analyst at Rabobank International, where he focuses on the global seafood sector, including farmed and wild-caught seafood, and seafood trade and processing.

**Jose Mujica**

Claro and Associates, United States, Chile

Mujica is part of Claro & Associates, which provides specialized consulting services to international organizations, governments and companies. Mujica was formerly a research analyst for corporate banks in Spanish-speaking countries.

**Colin Guheen**

Cowen Group, United States

Guheen is a vice president and research analyst covering food industries at the Cowen Group, a diversified financial services firm that provides alternative investment management, banking, research and sales services.

## Meeting Demand

More middle-class consumers – especially in Asia – are eating more seafood and driving demand exponentially higher. GOAL 2011 will consider new outlooks, new practices and new technology to answer the industry's unfolding challenges and opportunities.

How will existing seafood facilities generate more product? Will new culture areas be developed? Will advances in technology once again come to our rescue? How will this major growth be financed? And how can all of this be accomplished responsibly?

Attend GOAL 2011 to consider the solutions. **See www.gaalliance.org/GOAL2011/ for registration and other conference information.**

**Victor Hugo Puchi**

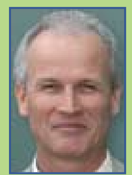
AquaChile, Chile

Hugo is chairman of AquaChile, parent of Empresas AquaChile S.A. As Chile's leading salmon and trout producer, its vertically integrated companies are involved primarily in farming and exporting salmon and salmon-derived products.

**Robert Fields**

Sam's Club, United States

Fields is senior director for fresh meat, seafood and gourmet deli at Sam's Club, a division of Walmart. Sam's is a leading membership club with locations in the U.S., Brazil, China and Mexico.



**Dan Lee**

Best Aquaculture Practices, United Kingdom

Lee is an aquaculture specialist with expertise in design, implementation and project management. He is GAA's Best Aquaculture Practices standards coordinator and manages research for the Centre for Applied Marine Sciences.

**Mike Loftus**

Raley's, United States

Loftus is director of meat and seafood at Raley's, whose 133 U.S. supermarkets are in California and Nevada. Loftus has 25 years in grocery with experience in meat, seafood, operations and merchandising.

**Hugo Contreras**

Cargill Animal Nutrition

Contreras is global general manager for Cargill Animal Nutrition's aquaculture feed business. He oversees feed operations in China and leads initiatives regarding capital expansions and protein supply chains across Cargill's portfolio.

**George Parmenter**

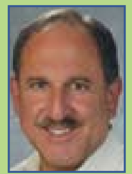
Hannaford Bros., United States

Parmenter is director of corporate responsibility for Hannaford Supermarkets, a 170-store chain in the northeastern United States. Hannaford is known as a responsible corporate citizen and leader in green practices.

**Jonathan Shepherd**

International Fishmeal and Fish Oil Organisation, United Kingdom

Shepherd is director general of IFFO. He has extensive management experience in industrial marketing and business development, and has run businesses connected with fish farming, pharmaceuticals and feed manufacturing.



**Roger Bing**

Darden Restaurants, United States

Bing is vice president of purchasing for Darden, the world's largest full-service dining restaurant company. Formerly senior director of seafood purchasing, he worked with producers to improve practices and living standards.

**Peter Redmond**

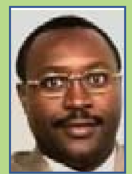
Global Aquaculture Alliance, United States

Redmond is vice president of Best Aquaculture Practices development for GAA. He is a former senior director of Walmart Stores' sustainability department and a previous vice president of deli/seafood.

**Jorge Hernandez**

U.S. Foodservice, United States

As senior vice president for food safety and quality assurance, Hernandez is responsible for food standards for U.S. Foodservice distribution centers, food-processing facilities and private-label products. He advocates global food safety harmonization.



**Albert Zeufack**

Khazanah Research and Investment Strategy, Malaysia

Dr. Zeufack is director of research and investment strategy for Khazanah Nasional Berhad, a Malaysian fund associated with the World Bank. Prior to joining Khazanah, Zeufack was the World Bank's acting lead economist.

**John Galiher**

Preferred Freezer Services, United States

Galiher is founder and CEO of Preferred Freezer Services, the world's fifth-largest cold storage operation. With varied engineering, construction and management experience, he has been featured in several articles on state-of-the-art technology.

**Chris Brown**

Asda, United Kingdom

Brown is head of ethical and sustainable sourcing for Asda Stores, Ltd., a top U.K. retailer and Walmart subsidiary. In addition to ensuring responsible sourcing, Brown responds to the wider green-living debate.

2011 PLATINUM SPONSOR

# Camanchaca

## Unusual Name, Extraordinary Seafood Products

Camanchaca is one of the world´s leading fishing and seafood companies, a leader in both the aquaculture and wild fishery sectors, with production facilities in Chile and Ecuador, and customers in more than 50 countries.

Aquaculture operations include: Atlantic salmon, steelhead trout, mussels, scallops and abalone.

Camanchaca built the first Chilean state-of-the-art "recirculating fresh well-water" salmon hatchery at Petrohue in Patagonia over 10 years ago. Today, it is still one of the largest of its type in the world – a reflection of leadership, vision, a commitment to environmental sustainability, efficiency of resources and biosecurity.

This strong commitment to high biosecurity standards, along with a completely integrated value chain in its different products, allows Camanchaca to provide superior and consistent product quality. This is reflected in the reputation of the "Camanchaca" and "Pier 33 Gourmet" brands of consumer products, as well as Camanchaca's industrial fishmeal and fish oil products, which are marketed globally.

Wild fishery operations consist of a fleet of modern ocean-fishing vessels and state-of-the-art processing plants for canned and frozen jack mackerel, Langostino lobsters, fishmeal and fish oil.

In the wild fish sector, Camanchaca plays a leadership role in management and adherence to all government regulations pertaining to wild fish stocks and capture in Chilean waters.

Camanchaca operates with an overarching philosophy of sustainability, with continuous programs to integrate and develop the local communities where it operates, neutralize environmental harm and improve process quality standards in all aspects of operation.

From the pure, cold Pacific waters along the 6,640-km (4,126-mile) coast of Chile, Camanchaca is proud to supply the world with its gourmet seafood products.

Grateful for its past successes, proud of its present bounty and committed to protect the future.

**Camanchaca**
Global Sales – Corporate Office: Santiago, Chile
http://www.camanchaca.cl

2011 PLATINUM SPONSOR

# Marine Harvest Chile

## Thinking In A Sustainable Way

At Marine Harvest Chile, our core ambition is to provide tasty, healthy and safe seafood to consumers throughout the world. Aware of our responsibility, we constantly innovate in our processes to guarantee the quality of our food products, as well as the sustainability of our production.

We believe that in order to be profitable over the long term, we must provide customer value from healthy, tasty and nutritious seafood, farmed both cost-effectively and in an environmentally responsible way that maintains a good aquatic environment and respects the needs of the wider society.

For that reason, day by day we work, thinking of future generations and guided by our corporate vision of “Seafood for a Better Life” and our four closely interrelated principles: People, Planet, Product and Profit.

We work very closely with our customers to ensure that our salmon meets their strictest requirements. Our objective is to meet them with high technical and nutritional quality. All aspects of quality are covered by our total quality management system, Qmarine, and its standard operating procedures (SOPs). This system allows us to control our production practices and processes, and to ensure we meet our customers’ specifications and comply with regulatory requirements.

Marine Harvest develops all is activities harmoniously with the environment, always innovating through initiatives that reduce the impact of its operations to a minimum. Our production model is based on fish welfare farming practices and has already shown very good results. This sustainable approach means our fish are kept under conditions that, as much as possible, naturally satisfy their needs for food, clean water, space and habitat. By providing good conditions, we aim to minimize distress, injury and disease, and decrease the need to intervene.

Marine Harvest Chile has understood that its success is very much dependent on having an open and transparent dialogue with neighboring communities. This has been the hallmark we have promoted in order to establish solid relationships with the groups who live where our operations take place.

We are committed to respect the rights, interests, cultures and customs of the members of local communities, paying special attention to having constant and fluent communication, and maintaining good relationships in the areas where we operate, with the purpose of supporting development within the sustainability framework.

We work thinking toward the future. Marine Harvest’s ambition is to enable our industry to increase the supply of nutritious seafood to the world’s population, while improving our technology and reducing our environmental footprint.

**Marine Harvest Chile**
Units Worldwide – Corporate Office: Oslo, Norway
http://www.marineharvest.com

2011 PLATINUM SPONSOR

# Mazzetta Company

## Oceans of Flavor, Abundant Variety, Unsurpassed Quality

Mazzetta Company literally goes to the ends of the earth for its customers. It seeks out the highest-quality fisheries. It partners with the best local suppliers and resources to responsibly harvest and meticulously process the freshest-tasting seafood available in the world today.

By extending its reach around the globe for well-managed, environmentally sound aquaculture and wild-caught fisheries, Mazzetta is able to meet the ever-increasing demand for premium-quality fish and shellfish. The company works around the clock providing a constant supply and wide variety of delicious and nutritious seafood to today's consumers. It has made a deep commitment to business practices that ensure healthy, sustainable marine resources for tomorrow.

The pure quality of Mazzetta Company frozen premium seafood always earns applause. Fish and shellfish marketed under the SEAMAZZ brand are widely recognized for consistently excellent flavor and texture. Each step in the supply chain has been carefully designed and consistently executed to deliver Mazzetta Company premium products efficiently and safely from points of origin to our customers across North America.

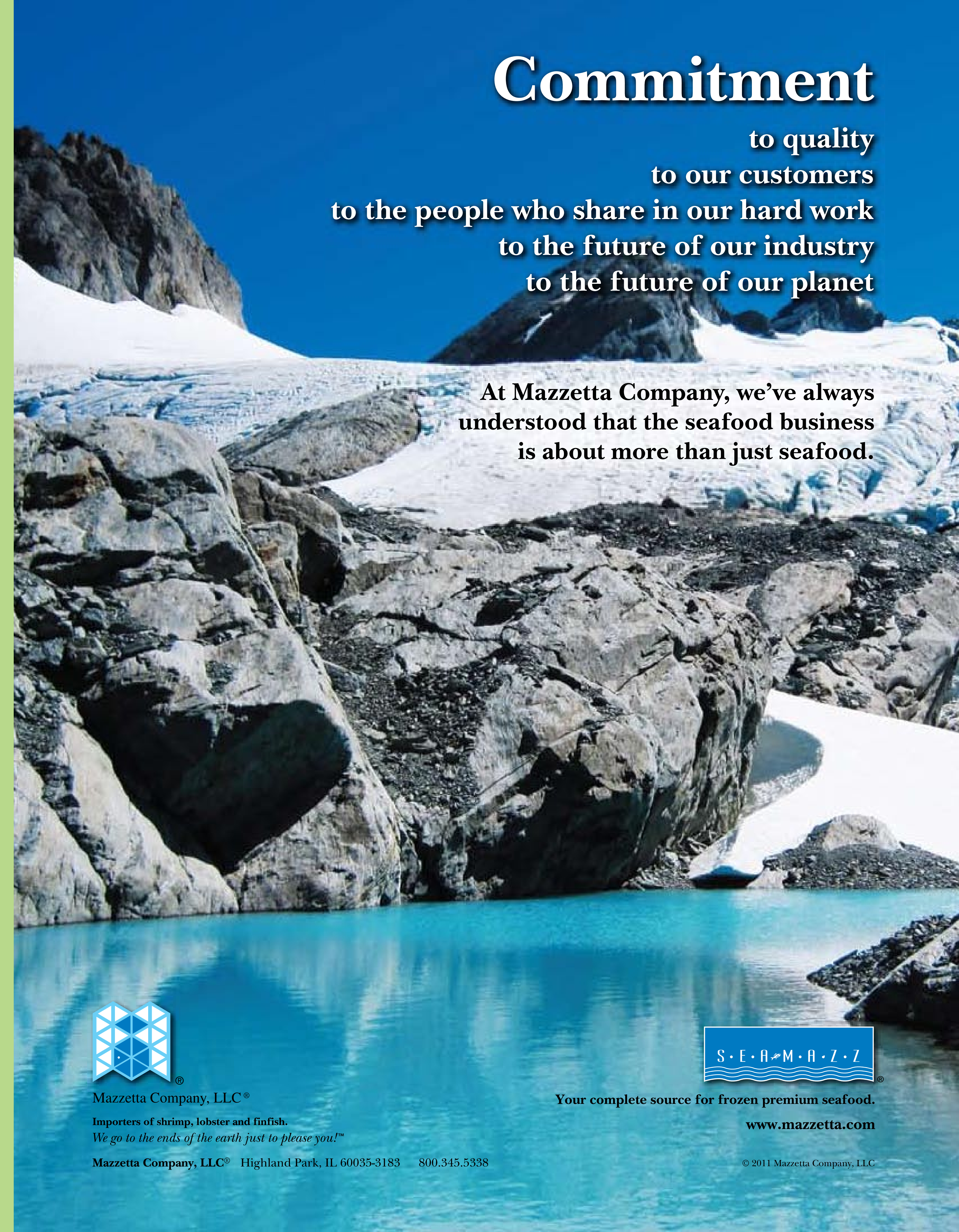
At the source, Mazzetta seafood is skillfully processed and quickly frozen to capture the peak of flavor and freshness. Mazzetta's stringent inspection, monitoring and traceability processes are second to none. Its proficient management of state-of-the-art warehousing and high-tech packaging facilities preserve the just-caught quality of premium seafood. Every day Mazzettta seafood products are delivered across North America, arriving as flavorful, pure and nutritious as the moment they were harvested.

Now is a great time to serve seafood. Consumers are continuously demanding healthier eating options. Fish and shellfish are high in protein, low in fat and contain significant amounts of heart-healthy omega-3 fatty acids. The growing popularity of ethnic and international cuisines is ensuring seafood's position as one of the most desired foods on American menus.

Mazzetta Company makes it easy for leading foodservice organizations, retailers, distributors and restaurateurs to meet their consumers' growing appetites for fresh-tasting, nutritious and sustainable seafood. A wide selection of frozen seafood is available in standard and custom portion sizes. Simply thaw and cook.

Mazzetta's customers are able to count on uninterrupted supplies of premium seafood year round. The net result? Across North America, Mazzetta Company customers enjoy generous servings of business success.

**Mazzetta Company**
Corporate Office: Highland Park, Illinois, USA
http:.//www.mazzetta.com



2011 PLATINUM SPONSOR

# National Fish & Seafood Inc.

## A Leader In Sustainable Seafood

National Fish & Seafood, Inc. was founded in 1979 as a value-added processor of seafood. Over the years, National has expanded its capabilities to include bagged fillets, imitation crab, stuffed clams and shrimp, both IQF and value-added. Along with being HACCP certified, in 2008, National Fish was the first seafood processor in the USA to obtain Level 3 SQF 2000 status. This ensures that National Fish will only produce, import and distribute products that meet SQF, BRC, Dutch HACCP and International Food Standard certifications. With the addition of Best Aquaculture Practices certification, National Fish & Seafood has shown a determination to be the leader in providing safe seafood products that meet strict quality standards and are, most importantly, sustainable.

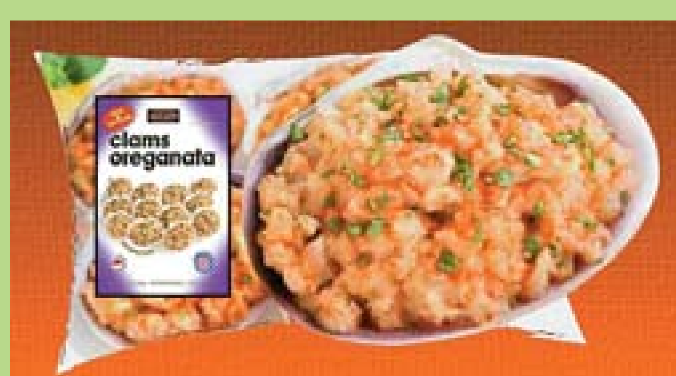
National Fish & Seafood has partnered with Pacific Andes Resources Development Ltd. of China, one of the largest seafood companies in China and the world.

Through numerous relationships with suppliers all over the world, National has recognized the importance of being a global seafood company. Today, more than ever, these relationships with suppliers are vital in creating a sustainable, quality seafood program. Being able to work with the same suppliers year after year allows for a consistent, high-quality sustainable seafood program.

Initially as Lu-Mar Lobster & Shrimp and now as National Fish & Seafood, the company is both a Founding Member and Governing Member of the Global Aquaculture Alliance. National Fish is at the forefront of GAA's Best Aquaculture Practices (BAP) sustainability initiatives.

National Fish & Seafood, in partnership with its contract processors and raw material suppliers, has helped develop the cluster program for grouping farms into units for BAP auditing and certification purposes. National has sponsored seminars attended by independent farmers on behalf of the BAP program to bring the GAA sustainability message to producers. National Fish & Seafood and its partners are one of the largest single "holders" of shrimp produced at BAP-certified farms in Thailand. National Fish & Seafood and its partners have committed more than $100,000 over several years to sponsoring seminars, enlisting participants and organizing clusters for certification.

National Fish & Seafood, Inc. will continue its GOAL of being a leader with the Global Aquaculture Alliance by striving to develop more sustainable farms, continue the education process of the independent farmers and create more awareness for sustainable seafood.




**National Fish & Seafood, Inc.**
Corporate Office: Gloucester, Maine, USA
www.nationalfish.com

2011 PLATINUM SPONSOR

# Preferred Freezer Services

## Superior State-Of-The-Art Cold Storage Technology

Headquartered in Chatham, New Jersey, USA, Preferred Freezer Services (PFS) is dedicated to designing, constructing and operating state-of-the-art, temperature-controlled warehouses throughout North America, Asia and the world. The company has expanded from a single facility in 1989 to become the fourth-largest cold store operator globally.

As part of its global expansion, Preferred Freezer Services completed construction on its inaugural warehouse in Shanghai, China, during the third quarter of 2011. The approximately 280,000-square-foot (26,000 $m^2$) temperature-controlled warehouse is one of the largest energy-efficient and advanced single-story cold storage facilities in China, according to the Shanghai Institute of Mechanical & Electrical Engineering Co., Ltd. An additional PFS facility is set to open the first quarter of 2012 in Wai Gao Qiao, Shanghai, while two additional warehouses are currently under development. The company's first international fully automated warehouse was completed in 2010 in Ho Chi Minh City, Vietnam.

Tim McLellan, Managing Director of International Business Development, states: "Preferred Freezer Services is very proud to set a higher standard for temperature-controlled warehouses in China and to be able to participate in the development of China's cold chain supply and logistics industry. Current PFS customers in the U.S. who value our business model are delighted to know they can expand into China and receive the same dedicated first-class service and premium-quality cold chain solutions to fulfill their China business needs. Even more important are the domestic Chinese companies that understand Preferred Freezer Services' commitment to building and managing state-of-the-art, temperature-controlled warehouses and how valuable our model will be to helping China meet its demands for properly handled food products."

In addition, PFS has recently completed construction of a fully automated warehouse in Elizabeth, New Jersey. This location is the second PFS facility in Elizabeth. All facilities are strategically and conveniently located in port locations, as well as strategic intermodal hubs or highly traveled distribution lanes throughout New Jersey/New York, California, Georgia, Florida, Illinois, Massachusetts, Pennsylvania, Texas, Virginia, Vietnam and China.

Preferred Freezer Services continues to follow the vision of John J. Galiher, President/CEO, to be a multinational gateway service provider through the use of state-of-the-art, ecologically sensitive facilities in every country. The company continues to aggressively pursue markets where there is need to service the international import/export of frozen proteins, including frozen seafood and aquaculture products.

The company's growth is based on a foundation of constructing superior facilities, utilizing leading-edge technologies, incorporating the finest MIS systems available and hiring dedicated people with the talent and drive to perform. Preferred Freezer Services' main goal is to be rated "The Best" by every customer, employee and vendor with whom it engages with all facilities.

As a developer and operator of state-of-the-art, full-service refrigerated warehouses, Preferred Freezer Services has a vested interest in helping to create a cleaner, more energy-efficient environment now and in the future. PFS will continue to shape the future of temperature-controlled warehouse facilities by developing LEED®-certified buildings. The company is investing in sustainable buildings and practices to save energy and encourage environmentally friendly design and construction techniques in its facilities.

**Preferred Freezer Services**
United States, China, Vietnam – Corporate Office: Chatham, New Jersey, USA
http://www.preferredfreezer.com

# Association of the Salmon Industry in Chile

SalmonChile

Created to represent and unite the efforts of the producers of salmon and trout in Chile through guidance on legal, technical, research, environmental issues and through development of markets, both internal and external, SalmonChile celebrates its twentieth fifth anniversary in 2011.

Its main mission is to ensure the appropriate development of the industry through consolidation of advances in health policy and regulations, oversight of fundamental aspects of responsible production, and through guidance of industry relations with and integration into the local community.

SalmonChile's objectives also emphasize the promotion and marketing of salmon internationally, to maintain Chile's strong reputation abroad. In addition, SalmonChile represents its members before public and private agencies on matters related to the industry, and liaises with similar institutions and scientists, both at home and abroad, that might contribute to the development of the salmon industry.

In its twenty-five years, the Chilean salmon industry has undergone significant development. This has meant the incorporation of 70 national and international companies in SalmonChile, such that our association represents 63% of total exports of salmon and trout in Chile. SalmonChile associates are also important suppliers of goods and services for industry, including such items such as fish (eggs, fry and / or smolt), salmon feed, technology and equipment service and support, packaging, laboratory, veterinary and transportation services.

SalmonChile works for the industry to produce a superior quality product, in a sustainable way, in harmony with the environment and sociably responsible.

## Salmon Technical Institute (INTESAL)

The Salmon Technical Institute (INTESAL) is the technical arm of SalmonChile. Its goal is to become a platform for technical coordination of the trade at national and international levels. INTESAL's current scope is the provision of technical support to companies associated with SalmonChile, through decision-making in the areas of fish health, environmental responsibility, and food safety.

INTESAL coordinates the development and implementation of various programs of research, the monitoring and tracking of salmon, as well as ongoing monitoring of needs and technological developments within the industry.

### a) Health Management Program :

- Auditing: Since June 2008, INTESAL has been identifying opportunities for improvements to the production model through a systematic field audit program. This program measure the levels of compliance and implementation of health guidelines established by SalmonChile.
- Production Information: INTESAL manages production data generated from all farms of associated companies. A significant portion of this data is generated by information gathered during the on-growing stage of the salmon production cycle. This data enables the preparation of reports and multivariate analyses. These analyses include the description of epidemiological trends in order to identify significant factors to improve fish health, and the health status of the industry as a whole, and are an important part of decision-making in the industry.

### b) Sea Lice Monitoring Programme

Weekly monitoring of this ectoparasite is a fundamental tool for the control of the caligidosis, as it allows companies to take remedial measures at appropriate times in order to exercise effective control of the parasite.The Sea Lice Monitoring Program generates online reports of parasite loads by grouping of management areas, treatments and outcomes. These reports enable companies to conduct coordinated, appropriate actions for the control of Caligus.

### c) Phytoplankton Monitoring Program

The Phytoplankton Monitoring Program is a support tool that detects the presence and geographical distribution of harmful algal blooms, and provides companies with the information they need in order to take appropriate measures to mitigate and avoid significant losses in production. Currently, the program has 43 monitoring stations distributed in the regions of southern Chile. One of the oldest of its kind in the world, the Phytoplankton Monitoring Program has been gathering data for more than two decades. It is one of the most valuable databases in this field in Latin America, and has made it possible for Intesal to provide substantial support to national and international scientific endeavors in Chile.

# UNDERSECRETARIAT FOR FISHERIES

## Ministry of Economy, Development and Tourism Chilean Government

Global Outlook for Aquaculture Leadership SANTIAGO 2011 ™

### Aquaculture in Chile

Aquaculture has become a major global solution for problems related to food security, as well as an alternative to increase the income and well-being of countries that have the human capacities and environmental conditions required to develop this activity.

Chile has an extensive coastline, favorable geographic and oceanographic conditions, technical knowledge and an economic policy that facilitates the development of aquaculture.

To date, the Chilean aquaculture industry has operated on the basis of over 3,500 authorized farming centers. Seventeen species, both native and exotic, are farmed at a commercial level, and more than 30 species are farmed at an experi-mental level. Almost 600,000 mt were harvested in 2010, and over 400,000 mt were exported to the most important markets worldwide – particularly countries of the Asia-Pacific, North America and the European Union – yielding about U.S. $2.3 billion.

Salmonid species register the highest production and exportation (93%), followed by mussels (4%, showing significant growth over the last years), seaweed (mainly gracilaria), scallops and others.

Aquaculture in Chile is mainly developed in marine environments and freshwater environments such as rivers and lakes. The activity is geographically concentrated in the northern zone in the regions of Atacama and Coquimbo, with culture of scallops, abalone and seaweed; and in the southernmost regions of Los Lagos, Aysén and Magallanes, with the culture of salmonid species, mussels and seaweed. The southernmost zone concentrates the highest production levels and number of farming centers.

These figures and their evolution reflect how aquaculture has become one of the economic sectors with the highest growth over the last decade in Chile, representing 5% of the national exports and generating a wide range of opportunities for rural areas of the country.

In Chile, the administration and regulation of aquaculture are responsibilities of the Undersecretariat for Fisheries, which operates under the Ministry of Economy, Development and Tourism. This agency promotes the sustainable development of aquaculture, devising and proposing policies and regulations to help increase the social and economic benefits derived from this activity, thus ensuring the well-being of present and future generations in the country.

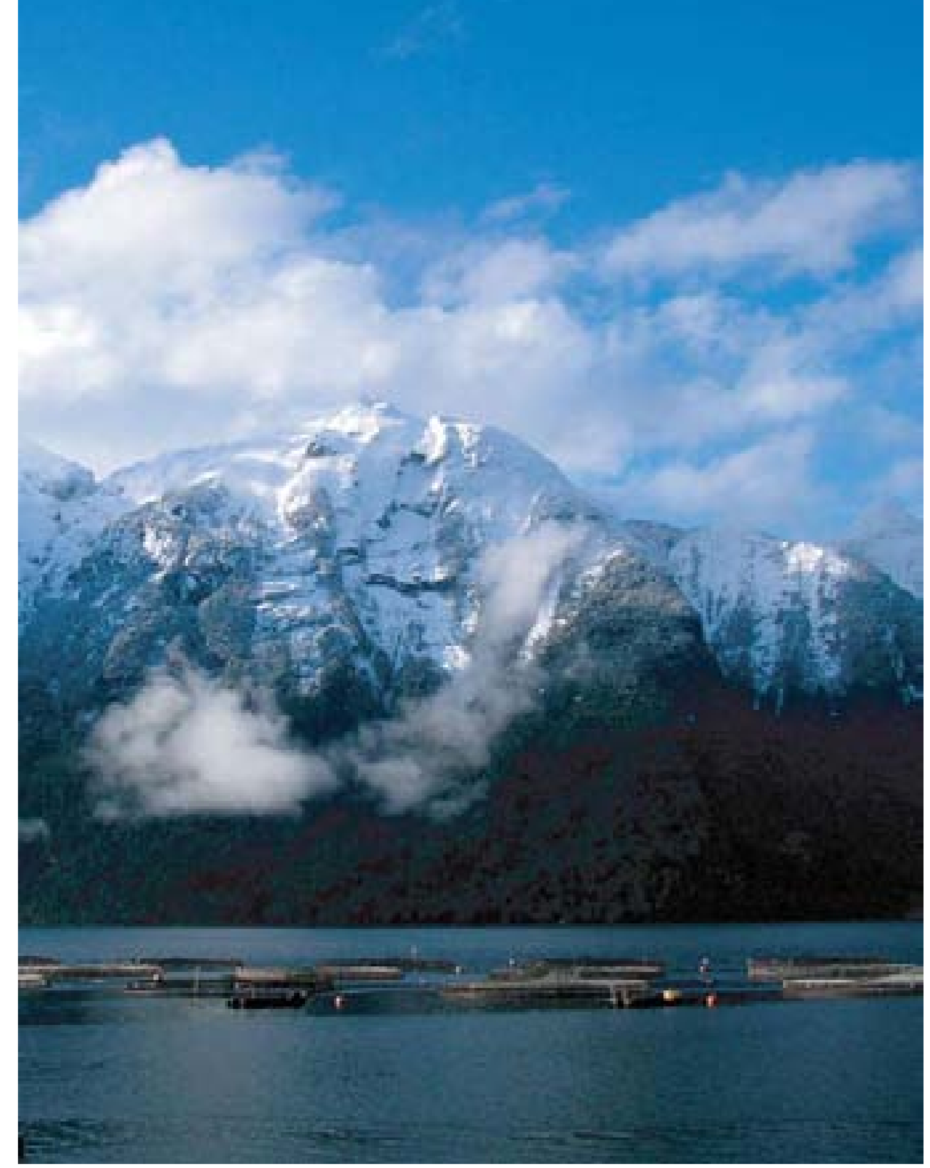
Chilean aquaculture is governed by a sound regulatory framework. The most important instrument is the 1991 General Law on Fisheries and Aquaculture and its complementary regulations, which cover environmental and sanitary issues, as well as matters relating to pest control, territorial planning, information, species importation and granting of permits, among others.

Additionally, the National Aquaculture Policy was created in 2003. This instrument sets as a national objective the promotion of aquaculture's maximum level of economic growth over time, within a framework of environmental sustainability and equitable access. In order to fulfill this objective, it is important to prioritize areas related to protecting the sanitary and environmental patrimony, economic stability, equitable access, competent public apparatus, pertinence and timeliness of research, partici-pation, partnership and co-responsibility of public and private agencies.

Undersecretariat for Fisheries
Chilean Government

**Undersecretariat For Fisheries**
**Chilean Government**
Valparaíso, Chile
http//www.subpesca.cl


Global Outlook for Aquaculture Leadership SANTIAGO 2011
Chile
Seafood from Chile's Deep Blue Sea:
A powerhouse for foods
Chile´s extensive 4,300 km coastline, its ocean depth, the temperate waters of northern Chile and the cold seas of the south provide unparalleled wealth of resources, and favors unique conditions for large-scale aquaculture.
International Standards
ISO 9000:2000 and ISO 14000
Certification programs
HACCP based quality assurance
CHILEAN PROMOTION BUREAU
pro|CHILE



# Politics And Understanding

**Roy D. Palmer, FAICD**
FishyBusiness
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Australia
email@fishybiz.com.au

At a recent seafood conference, I joined the group in the hall to wait, as the politician who was to open the conference had failed to arrive on time. The organizers were in panic mode, of course, but eventually the politician and accompanying entourage and media appeared, 45 minutes late. Additionally, their process took longer than was planned, which added to the organizational problems.

Other speakers, some of whom had traveled a long way, had to cut their presentations short. Many of the roundtable discussions were also shortened, as the meeting had a finite ending time.

Since the government was helping to finance the conference, it was clearly appropriate to schedule the politician's appearance. But the late arrival created issues for the organizers for the rest of the day. Then the speaker failed to stay for the rest of the conference.

Although situations like this immediately impact both the speakers and participants, does it not also affect the visiting politicians? Wouldn't they be better off staying a while?

## Opportunity Lost

Here we had a minister whose main portfolio was being discussed by specialists. An event that attracted all the main local players and many international experts was here in his own back yard. The government had contributed to the finances for the event, as well.

What an excellent opportunity for the minister, his political team and the invited media to absorb information, discuss current and future issues, and get local and international views on many things. But alas, the minister came late, gave a presentation and quickly departed. With the minister went the majority of the staff and the media. Opportunity lost!

## Limited Attendance

I wonder why officials rarely stay for the day at conferences. Are their knowledge and the knowledge of their staff so in depth and current that they do not see any learning potential? As heads of aquaculture or fisheries departments, would it not be good for them to learn more about their portfolios by hearing the experiences of others and networking with the industry they represent? What on earth could be more important "at the office"? The apparent lack of engagement is surprising.

Thank goodness it's not always like this. The last fisheries conference I attended managed to attract the prime minister, the fisheries and aquaculture minister and the attorney general. I had the impression that there was a good, clear working relationship between the government and the industry.

But the only politician attracted to another event was the state minister responsible for aquaculture, who attended the gala dinner. A third conference – in which the state government had invested – failed to get one state politician. On the other hand, a federal minister did come and open the event, and the federal opposition shadow minister, who came to the conference for two days, said he learned much from his time at the conference.

## Much To Learn

The latter minister learned much. We should applaud his efforts to learn, for they don't seem to happen often enough.

Those of us on the industry side of aquaculture can also certainly learn much from those in government and regulatory circles. Let us spend more time with each other at these conferences and related events, so that all the good ideas that flow through to and from government don't have to pass through closed doors.

Ministers, please join us. I firmly believe that your time – and ours, as well – will be well spent.

**Let us spend more time with each other so that good ideas don't have to pass through closed doors.**







# History Of Shrimp Farming

## *Summarized From* The Shrimp Book

**George W. Chamberlain, Ph.D.**
President
Global Aquaculture Alliance
5661 Telegraph Road, Suite 3A
St. Louis, Missouri 63129 USA
george.chamberlain@gaalliance.org

Aerial view of intensive shrimp ponds in Taiwan. Photo courtesy of Dr. I. Chiu Liao.

*The Shrimp Book,* published in 2010 by Nottingham University Press (ISBN 978-1-904761-59-4), brings together experts from around the world to fill the critical need for a central reference source on the state of shrimp production practices.

With chapters by 67 authors representing the spectrum of shrimp biology and aquaculture – many of whom have contributed to this magazine – the book is addressed to a diverse readership at every step of the shrimp-farming value chain. The editor is well-known shrimp pathologist Victoria Alday-Sanz, DVM, M.S., Ph.D.

Overall, the comprehensive book represents an extraordinary effort by many of the most prominent researchers involved in penaeid shrimp studies.

With the permission of the publisher, the *Global Aquaculture Advocate* will present a series of summary articles that highlight chapters from *The Shrimp Book.* These summaries are meant to provide a glimpse into the vast knowledge available in the book, and by no means can replace actual reading of this excellent publication.

Shrimp farming is a young and dynamic business with a history of rapid change in response to technological advances. The first breakthroughs in shrimp-farming technology occurred in Japan during the late 1930s, but Japan's climate and species were not suitable for large-scale production. During the 1970s, Japan's technology was transferred to other countries in Asia and the Americas. The top shrimp-producing countries are listed in Table 1.

The history of shrimp farming is analogous to that of terrestrial animal husbandry, where traditional culture of wild animals at low density in a natural setting progressed to intensive culture of domesticated animals in a controlled setting. The difference is that domestication of terrestrial animals began thousands of years ago, but that of penaeid shrimp began in the last few decades.

Shrimp farming in its earliest form began centuries ago in Asia, where wild shrimp fry migrated into tidal impoundments intended primarily for milkfish, mullet and other coastal finfish. This resulted in incidental crops of 100-200 kg/ha/year of shrimp with no additional input aside from trapping/harvesting.

Little advancement in technology occurred until the 20th century. The primary obstacle to development was the poorly understood life cycle of penaeid shrimp, which involves an oceanic reproductive phase, a complex series of larval stages and an estuarine juvenile phase.

## Breakthroughs By Fujinaga

The first advancements toward completing the life cycle of penaeid shrimp in captivity occurred in 1934, when Dr. Motosaku Fujinaga (also referred to as Dr. Hudinaga) of the Yamaguchi Prefecture of Japan induced spawning of *Penaeus japonicus,* hatched the eggs and reared the nauplii to mysis stage using diatoms.

In the two decades following World War II, Fujinaga developed the seminal techniques for shrimp spawning, larval rearing and growout that remain the basis of today's shrimp-farming technology. Thus, Fujinaga is considered the "Father of Shrimp Farming," and Japan became the springboard for development of the industry.

Dr. I Chiu Liao, renowned former director general of the Taiwan Fisheries Research Institute, who studied under Fujinaga as a postdoctoral fellow in 1968, offered the following comments about Fujinaga:

"Dr. Hudinaga wrote his landmark doctorate thesis, entitled 'Reproduction, Development and Rearing of *Penaeus japonicus* Bate,' in English, rather than Japanese, which was very unusual and showed his international awareness. He also made a special effort to train dozens of students, technicians and researchers, who built upon his foundation and ultimately extended it around the world. His dream was to make shrimp an affordable food."

Dr. I Chiu Liao (left), former director general of the Taiwan Fisheries Research Institute, studied under Dr. Motosaku Fujinaga as a postdoctoral fellow in 1968.

**Table 1. Top global shrimp-producing countries.**

| Rank | Country | Metric Tons (1,000) |
|---|---|---|
| 1 | China | 1,000 |
| 2 | Thailand | 525 |
| 3 | Vietnam | 410 |
| 4 | Indonesia | 350 |
| 5 | Ecuador | 145 |
| 6 | Mexico | 120 |
| 7 | India | 100 |
| 8 | Bangladesh | 100 |
| 9 | Brazil | 80 |
| 10 | Malaysia | 60 |

The accomplishments of Fujinaga and his colleagues were broad in scope and enduring in relevance. Their many advances allowed production of postlarval shrimp on a commercial scale for farming and restocking programs. With an available supply of postlarvae, Japanese researchers began to study growout technology, as well.

Despite the remarkable research achievements in Japan, commercial shrimp farming was destined to shift to areas with more favorable climates, greater availability of land and more suitable species. During the 1960s, the second wave of development occurred, in which researchers attempted to transfer and adapt Fujinaga's methods to other locations and species. The focal points of this initial transfer were the United States and Taiwan.

## Rapid Growth Of Black Tiger Shrimp

Early comparisons among several penaeid species showed that black tiger shrimp, *Penaeus monodon*, had the fastest growth and best adaptability to farming conditions. Techniques for the intensive culture of *P. monodon* quickly spread throughout Asia, and black tigers became the dominant species of farmed shrimp.

During the 1980s, it was not uncommon for intensive ponds to yield over 10 mt/ha of 30-g *P. monodon* using postlarvae produced from wild spawners. However, increasing disease incidence in wild populations began to cause progressive declines in performance.

## Importance Of SPF Populations

During the 1990s, a global epidemic of white spot syndrome caused a rethinking of health and biosecurity practices. During this period, specific pathogen-free (SPF) Pacific white shrimp, *Litopenaeus vannamei*, developed by the U.S. Marine Shrimp Farming Consortium were introduced to Asia.

By stocking SPF shrimp in ponds with disinfected water, consistently high yields could be achieved. Farmers quickly shifted from wild *P. monodon*, which carried diseases, to SPF *L. vannamei*. They also changed their production practices to reduce disease risk by reducing water exchange, disinfecting raw water and eliminating the use of natural food organisms.

## Genetics Drive Performance Improvement

Genetic selection programs were a natural outcome of the evolution from wild to domesticated and SPF stocks. Typical selection traits were growth rate and disease resistance. Genetic selection has the potential to consistently deliver growth improvement of 5-15%/generation. No other discipline (health, nutrition, management, etc.) can match these gains. As growth rates have increased, the length of production cycles has declined, with corresponding decreases in costs of feed, energy and labor.

Selective breeding can also yield genetic resistance to disease, which has enabled consistent production in areas previously crippled by viruses. Genetics is becoming the primary driver of performance improvements and cost reduction. To maximize the performance of genetically improved shrimp, the larval rearing, growout and nutrition components of production must also be upgraded in step.

Selective breeding programs have greatly improved shrimp performance. Fluorescent elastomer tags (green bands in shrimp tails) identify shrimp families reared together. Photo courtesy of Kona Bay Marine Resources.

**Genetics is becoming the primary driver of performance improvements and cost reduction.**

## Renewed Interest In Black Tiger Shrimp

The success of *L. vannamei* production has led to an oversupply, commoditization and declines in prices of small to medium-sized shrimp. The market is segmenting with premiums for large sizes, which is leading to renewed interest in *P. monodon*. Results have indicated that declines in *P. monodon* production due to accumulating diseases can be regained using SPF genetically improved stocks.

## Comprehensive Solutions

The shrimp-farming industry is faced with challenges from diseases, tightening resources and increasing costs. Shrimp markets are also evolving toward greater insistence on quality, certified sustainability and full traceability.

The history of shrimp farming shows that to remain competitive, producers must continuously improve productivity and efficiency in every aspect of the supply chain, including health, breeding, hatchery and pond management, feed formulation, information systems, processing and certification of practices for marketing to premium buyers.

Shrimp farming is a late-comer to the field of animal husbandry. After Fujinaga's pioneering work with *P. japonicus* during the 1930s to 1960s, Japan's technology was adapted to more suitable climates and species. Ecuador and Taiwan were the early production leaders that served as technology role models for the Americas and Asia, but China later emerged as the dominant producer.

Viral disease epidemics plagued the industry from the 1980s through the turn of the century, but these ultimately led to more disciplined management that has improved efficiency and reduced dependence on natural resources. One of the most rapid adjustments was the switch in Asia from wild *P. monodon* to specific-pathogen-free, genetically improved *L. vannamei.*

The technology of shrimp farming has evolved quickly by capitalizing on advances from other fields. Viral diseases are now detected using DNA tools developed by the biomedical field. Shrimp are bred using genetic strategies and fed using nutritional disciplines applied by the poultry and swine sectors. Farm management, traceability and supply chain logistics have benefited from innovations in information technology. The industry is consolidating and integrating to improve efficiency and control.

## Emerging Issues

As shrimp farming has grown, so too have concerns about associated environmental, social, food safety and international trade issues. Sweeping changes in regulatory and management practices have improved sustainability by reducing habitat destruction, effluent discharge and antibiotic use. Bodies like the Global Aquaculture Alliance are developing certification standards to assure retailers and consumers of wholesome and sustainable practices.

In short, the history of shrimp farming has been characterized by major setbacks, rapid technological advances and global scrutiny from environmentalists and regulators. It has overcome these daunting challenges and emerged in a strong position to face the future.

The next step is to improve communication and coordination among the entire network of global stakeholders, including governments of exporting and importing countries; importers, retailers and their organizations; financial and lending institutions; conservation and social justice organizations; foundations and donor organizations; and many others.

While each of these organizations plays an important individual role, their fragmented structure can lead to conflicts, confusion, duplication and needless cost. This phase of the evolution has the potential to stimulate further efficiency and growth through a new level of transparency, accountability and trust.

In shrimp aquaculture's early days, wild shrimp postlarvae were collected from estuaries to stock ponds.

# Strategies For Managing Large Integrated Shrimp Farms

The most challenging element of integrated aquaculture is the farm. Successful farm operations rest on factors that include farm location and layout, biosecurity and technical management.

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**Summary:**
Integrated shrimp farming is desirable due to its ability to provide food safety and traceability. Companies within the integrated structure must produce the high-quality, competitive products required by their sister companies. Each unit must be sustainable as a profit center by itself and, at the same time, coordinate with and fulfill the requirements of other units. Production planning is the most essential exercise in integrated systems.

Integrated shrimp farming is at present the most desirable system due to its ability to provide the food safety and traceability required by many shrimp-importing countries. Integrated seafood companies have hatchery, farm, feed and processing plant facilities that work together with complete traceability.

The most challenging element of integrated aquaculture businesses is the farm. There have been several cases in Indonesia where integrated shrimp companies collapsed due to their farms' failure to produce. The successful operation of a large integrated shrimp farm rests on a number of factors, including farm location, layout and pond construction; biosecurity; technology and technical management.

## Advancing Technology

Most shrimp farms built during the mid-1980s were located within a feasible range for operation with present technology. However, the major challenges are in farm construction layout and technology.

At many large shrimp farms constructed in the 1980s, the ponds were lined with high-density polyethylene and set up in rows with inlet and outlet canals at opposite sides. Water was pumped directly into the ponds. During this period, antibiotic residues became an issue in some farmed shrimp.

From the early 1990s, reservoirs in which to promote phytoplankton were introduced to reduce stress due to sudden environmental changes and control vibrio issues in shrimp without the use of antibiotics. Some farms were designed with water recirculation systems.

With the appearance of white spot syndrome (WSS) in Asia in late 1994, concepts changed further, and the major focus became how to prevent or control viral problems. The 2002 introduction of specific pathogen-free *Litopenaeus vannamei* to Asia again changed culture technology.

Intensive culture with high stocking densities has become very popular among shrimp farmers. Minimal water exchange and biosecure technology appear to prevent or control the WSS. Treated water is used as much as possible.

Recently, biofloc technology has also become popular. The systems have a stable culture environment and better biosecurity, and reduce feed-conversion rations – all of which lead to greater economic returns.

## Integrated Farming

There are many large integrated shrimp farms in Asia, especially in Indonesia. Although challenging, integration is a very good concept in which different major production facilities meet the needs of other companies. However, each company must not take it for granted that whatever it produces will be absorbed by the sister companies. This attitude has led to the failure of more than one integrated business.

Companies within the integrated structure must produce the high-quality, competitive products required by their sister companies. And all facilities within the integrated system must have the right to refuse products from their partners if quality slips. Each unit must be sustainable as a profit center by itself and, at the same time, coordinate with and fulfill the requirements of other units.

Several large 1980s-era shrimp farms in Indonesia and Malaysia have been successfully redesigned as biosecure, modular systems with reservoirs for water treatment.

## Production Planning

Production planning is the most essential exercise in integrated systems. Effective coordination among the hatchery, farm, feed mill, processing plant and marketing becomes very important.

Before a production cycle begins, a complete culture operation schedule from stocking to harvest needs to be established based on market demand from the processing plant. The requirements for postlarvae, feed and other inputs need to be worked out within a budget to enable the respective units to prepare. Estimated requirements will need to be updated monthly and later weekly for smooth operations.

The major understandings that need to be established among hatchery, farm, feed mill and processing are on quantity and quality. The parties need to agree on standard operating procedures approved by the units involved before the transfer of postlarvae, feed or shrimp at harvest. The size and quality of shrimp required for the market need to be known before the farm starts stocking for production, and there should be no compromise on quality throughout the production process.

## Farm Biosecurity

Farm biosecurity starts with farm layout and construction. Most large farms – some with up to 200 ponds – built in the 1980s did not have reservoirs or sedimentation ponds to treat waste water. Some had large reservoirs, but only one or two to supply the whole farm. Most of the supply and discharge water gates were adapted from agriculture irrigation systems.

In many cases, important elements of different farm systems were mixed, which led to biosecurity breaches and resulting production failures. However, large 1980s-era shrimp farms in Indonesia and Malaysia have been redesigned successfully into biosecure, modular systems with reservoirs for treatment.

Farm biosecurity is challenging due to the large area farms occupy and the large number of workers involved. All personnel

Intensive culture systems with minimal water exchange and biosecure technology are producing increasingly large volumes of high-quality shrimp.

within the company need to be educated on biosecurity, including senior management, since all are potential disease carriers. Invited guests need to go through biosecurity protocols before entering farm facilities.

In the case of a biosecurity breach or suspected disease outbreak, swift action needs to be taken with established protocols. Do not wait for confirmations such as polymerase chain reaction reports.

## Technical, Lab Support

Technicians come from different backgrounds and have varied experience and mindsets. For a large farm to effectively control the many technical aspects of operation, training and workshops are required to come up with the best possible technology for a production cycle. Short and informative guidelines are very important information for technicians down to pond operators.

Senior technical staff need to provide a clear outline for operation before a cycle begins. Once decisions are made on systems and technology for a cycle, no one person should be allowed to change them. If change is indicated, the issues need to be discussed at a technical meeting.

Laboratory services are essential to support culture operations with good data on postlarvae quality, pond and water conditions, feed and chemical use, and shrimp quality at harvest. Shrimp health monitoring is another area laboratory technicians need to address.

Laboratory technicians need to be independent, should there be any confusing issues or incidents during production. In addition to testing, laboratory technicians should provide regular technology updates to farm technicians.

## Incentives

Farm success or failure depends on farm technicians from production managers and supervisors down to the pond operators who are directly responsible for day-to-day culture activities. Their motivation is crucial for the success of farm operations. A simple incentive system based on results for targeted production and quality can help provide such motivation.

A number of incentive systems are used in Indonesia, Malaysia and Asia. The best are based on only two or three factors. At large farms, incentives often consider production volume, shrimp size and feed conversion. Others examine only production and feed-conversion ratios, the main economic factors at farms. Incentives at small farms are usually based only on production.

Normally, pond operators earn the most when targets are met. Due to their higher salaries, managers and supervisors see lesser incentives. Support personnel actively involved in production, such as engineers and laboratory technicians, should also get incentives based on production, but in lesser amounts.

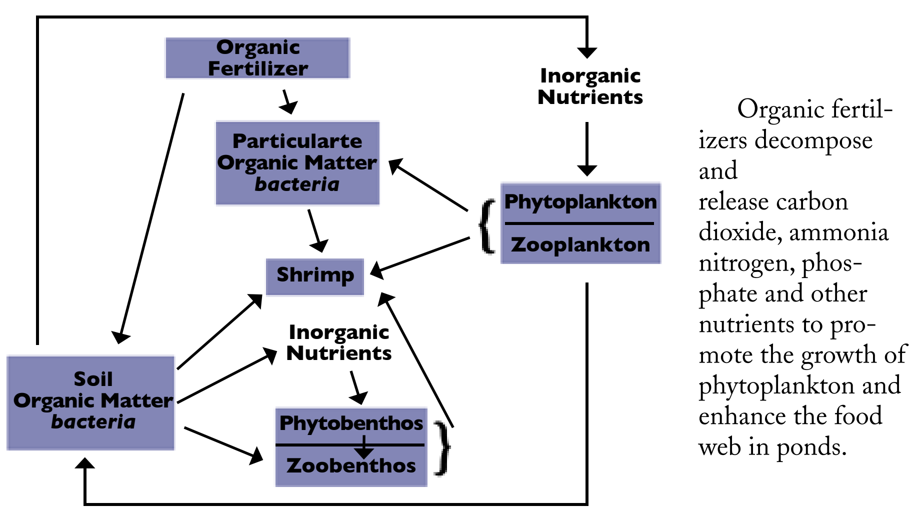
Another motivation for senior technical staff is attendance at national and international aquaculture seminars and meetings. Participation in these meetings widens their outlook on advancing technology and makes them greater assets to the company.

## Effective Management

Managing a large shrimp farm in an integrated concept is very challenging. Senior management personnel are typically non-technicians. Failures at large shrimp farms are often due to misunderstandings between senior managers, who define policies and hold authority, and the technicians who are responsible for production.

Senior managers need to clearly understand the realities of raising shrimp and fish in water, for unlike terrestrial farming of chickens or cattle, the stock can not be so easily observed. For aquaculture animals, management can only estimate how they are doing. Good support and understanding of technology are essential for successful production at shrimp farms.

# Organic Matter For Pond Fertilizer




Organic fertilizers decompose and release carbon dioxide, ammonia nitrogen, phosphate and other nutrients to promote the growth of phytoplankton and enhance the food web in ponds.

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**Summary:**

Animal manures, grasses and other organic matter have been widely used as fertilizers in aquaculture ponds. The fertilizers decompose and release nutrients that promote the growth of phytoplankton and enhance the base of the food web. Inexpensive organic fertilizers provide food for both zooplankton and zoobenthos, eliminating the lag between primary and secondary production. The disadvantages of organic pond fertilizers include high application rates, elevated oxygen demand, soil quality impacts and potential off-flavors in fish.

Animal manures, grasses, agricultural by-products and other types of organic matter have been widely used in many countries as fish pond fertilizers and, to a lesser extent, to fertilize shrimp ponds. Plant and animal meals are sometimes applied to nursery ponds and production ponds for high-valued species during the first weeks of culture. Some shrimp farmers also apply molasses, an immediately available carbon source that can rapidly increase bacterial activity. This practice is especially common in heterotro-phic floc systems.

## Major Role

The primary role attributed to organic fertilizers is that of decomposing and releasing carbon dioxide, ammonia nitrogen, phosphate and other nutrients to promote the growth of phytoplankton and enhance the base of the food web – the same role of chemical fertilizers such as urea, triple superphosphate, ammonium phosphate, etc. However, particles of organic matter serve as surfaces for growth of microorganisms.

This phenomenon enhances the protein content of particles, and zooplankton and other aquatic animals, including some aquaculture species, consume the nutritionally enriched particulate matter directly. Plant and animal meals can serve directly as food for postlarval or juvenile stages of some culture species.

## Composition

The typical range in composition of major types of organic fertilizers (Table 1) reveals that these materials have much lower concentrations of nitrogen, phosphorus and potassium than those found in chemical fertilizers. Moreover, manures are not constant in composition like commercial chemical fertilizers.

They vary in composition with the composition of the diets provided to the land animals from which they came, as well as with the length of time and conditions under which they were stored. Grasses and agricultural by-products also vary greatly in composition depending upon their origins. Plant and animal meals and molasses have relatively constant compositions.

## Application Rates

A large amount of organic matter must be applied to achieve the same nutrient input possible with a much smaller amount of chemical fertilizer. For example, 1 kg of triple superphosphate is equal in phosphorus content to 230 kg of fresh dairy cattle manure. Just 1 kg of urea is equal in nitrogen to 90 kg of this manure.

This leads to two problems. High application rates of organic fertilizers are required to provide desired nutrient inputs, and an elevated demand for dissolved oxygen occurs when organic fertilizers decompose. The total oxygen demand of organic matter is roughly 2.7 times its organic carbon content, but the rate that organic matter decomposes – and removes dissolved oxygen from water – is related to the carbon:nitrogen (C:N) ratio of the material. The lower this ratio, the more intense the oxygen demand.

The C:N ratios of plant and animal meals, which decompose quickly, are typically 5-20:1. Application rates greater than 25 kg/ha/day could lead to dissolved-oxygen depletion in non-aerated ponds.

Manures, grasses and agricultural by-products usually have greater C:N ratios and decompose more slowly. Nevertheless, because high application rates are typically used, materials with a high C:N ratio can also cause a high oxygen demand. Because animal manures, grasses and agricultural by-products vary greatly in composition, it is not possible to recommend a safe, maximum daily application rate. However, daily application rates reported in the literature seldom exceed 50-60 kg/ha dry weight. Of course, for a manure with 80% moisture content, 250 kg/ha would be necessary to provide 50 kg/ha dry weight.

Results from the literature for four typical studies of fertilization with animal manures in non-aerated shrimp and tilapia ponds (Table 2) showed that manures can lead to comparable or greater shrimp and fish production than that achieved with chemical fertilizers. However, the use of feed can increase production far beyond that possible with manures.

**Table 1. Nutrient composition of organic fertilizers for aquaculture ponds.**

| | Nitrogen (%) | Phosphorus (%) | Potassium (%) |
|---|---|---|---|
| Animal manure | 0.50-1.40 | 0.20-1.30 | 0.50-1.20 |
| Agricultural by-products (rice hulls, grass) | 0.25-2.50 | 0.03-0.70 | 0.40-2.60 |
| Black-strap molasses | 0.50 | 0.20 | 3.50 |
| Plant meals (soybean, cottonseed, corn) | 1.50-7.00 | 0.50-2.50 | 0.30-2.30 |
| Animal meals (fish, bone, blood, meat scraps) | 2.10-12.00 | 0.60-28.00 | 0.10-1.00 |
| Chemical fertilizers | 15-45 | 20-48 | 44-60 |

## Advantages

There are several advantages of organic fertilizers. They can serve directly as food for both zooplankton and zoo-benthos, eliminating the lag period between primary and secondary production that occurs in chemically fertilized ponds. Bacteria growing on organic particles not only increase the nutritional value of the particles, but also remove potentially toxic ammonia from water for use in synthesizing bacterial protein.

Organic fertilizers often are available from other agricultural activities on family farms in developing countries, but if they must be purchased, they usually are cheap in comparison to chemical fertilizers. Moreover, utilization of organic fertilizers in aquaculture is ecologically desirable, because it results in waste recycling.

## Disadvantages

The disadvantages of organic matter as pond fertilizer sometimes outweigh the advantages. The problems of low nutrient content, high application rate and elevated oxygen demand have already been mentioned, but there are several other issues.

Organic fertilizers may not be available nearby, and transport of the large amounts of organic material needed to fertilize ponds is expensive. Soil quality may be impaired by organic matter that settles to pond bottoms. Fibrous, organic particles can be sites for growth of macrophytic algae that compete with phytoplankton for nutrients. Humic compounds in manures, especially grasses and other plant residues, can inhibit phytoplankton growth through direct toxicity, and discoloration of the water by these compounds can interfere with light penetration and photosynthesis.

Off-flavor in fish and shrimp may result from odorous compounds in manure or produced by actinomycetes, a filamentous bacteria, growing on it. Manures often have a high trace metal content that possibly could lead to increased trace metal concentrations in the culture species.

**Table 2. Results reported in studies of pond fertilization with organic matter or chemical fertilizers.**

| Fertilizer (Amount) | Production (kg/ha) |
|---|---|
| **Shrimp – Study 1** | |
| Chicken manure (4,500 kg/ha/crop) | 262 |
| Cow manure (4,500 kg/ha/crop) | 218 |
| Control (no manure) | 160 |
| **Shrimp – Study 2** | |
| Fresh cow manure (1,800 kg/ha/week) | 950 |
| 5 postlarvae/m$^2$ | 1,700 |
| 10 postlarvae/m$^2$ | 1,860 |
| 15 postlarvae/m$^2$ | 1,750 |
| 20 postlarvae/m$^2$ | |
| **Tilapia – Study 3** | |
| Dairy cow manure (1,020 kg dry matter/ha/week) | 1,626 |
| Chicken litter (500 kg dry matter/ha/week) | 2,075 |
| Inorganic fertilizer (10-20-0 – 140 kg/ha/week) | 1,513 |
| **Tilapia – Study 4** | |
| Inorganic fertilizer (108 kg nitrogen and phosphorus/ha/crop) | 1,109 |
| Fresh cow manure (19% dry matter at 28,380 kg/ha/crop) | 1,646 |
| Fish feed (3,520 kg/ha/crop) | 2,660 |

Antibiotics used in land animal production have occasionally been passed from manure to fish or shrimp. It also is likely that many consumers would not like to know that their aquaculture products were produced in ponds treated with animal waste. This fear is compounded by the idea that human wastes may be used to fertilize fish ponds in a few countries.

## Safety Precaution

As a food safety precaution and to avoid possible consumer dissatisfaction, the use of animal manures as organic fertilizers should be discouraged when resulting aquaculture products are intended for export. Of course, animal manures that have been composted for several months before application to ponds would be more acceptable than fresh manures for production of export products. Nevertheless, manures, grasses and agricultural by-products are extremely important for use in ponds to produce fish for family use and domestic markets by small-scale farmers in developing countries – especially in Asia and Africa.

**Article Submissions**

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# Sludge Management At BAP *Pangasius* Farm Cuts TAN, $BOD_5$, TSS In Discharges


The QVD Aquaculture farm is located on an island in the Mekong River. Google Earth Photo

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**Summary:**
In modifying its infrastructure and related pond management, QVD Aquaculture has achieved Best Aquaculture Practices certification for a portion of its pond-based *Pangasius* farm in Vietnam. Expansion of a discharge canal allowed sedimentation of suspended particles before discharge into the river. The farm also uses floating water plants to remove nitrogen and phosphorus from the discharge water. Sludge pens capture sludge at ponds for later reuse.

Compliance with Best Aquaculture Practices (BAP) certification standards typically involves modifications of production practices, but the effluent standards and restrictions on sediment disposal also often require modifications of farm infrastructure.

A case study is following changes in infrastructure at the QVD Aquaculture *Pangasius* farm near Tan Hoa, Dong Thap Province, Vietnam, in its efforts to achieve compliance with the BAP effluent and sediment standards.

## Farm Infrastructure, Operation

The farm is situated on a small island in the Mekong River. The land on which the farm is sited was formerly in rice cultivation. The original layout of the farm consisted of 16 production ponds ranging from 0.56 to 0.95 ha in water surface area for a total area of 12 ha. Average pond depths vary from 3.0 to 3.8 m, and the total volume of the production ponds is about 400,000 $m^3$.

A pumping station on the eastern side of the island discharges into a central water supply reservoir from which all ponds are supplied. Ponds on the eastern side of the farm discharge into a canal along the eastern border of the farm. This canal conveys water from ponds around the northern and southern perimeters of the farm, allowing all effluent to be discharged on the western side of the farm and thereby preventing contamination of river water near the pumping station.

Ponds are stocked at high density with a maximum standing crop of about 40 $kg/m^2$. The fish are fed twice daily with a commercial pelleted feed that contains 26% crude protein. Daily water exchange in ponds ranges from 20% pond volume at the beginning of a crop cycle up to 30% pond volume at maximum fish density.

Dissolved-oxygen concentrations in intake water are increased as a result of the turbulence introduced when water is pumped at high velocity up to 3 m above the river level into the inlet aqueduct. Pond waters always have dissolved-oxygen concentrations of 4-7 mg/L, and mechanical aeration in ponds is not required.

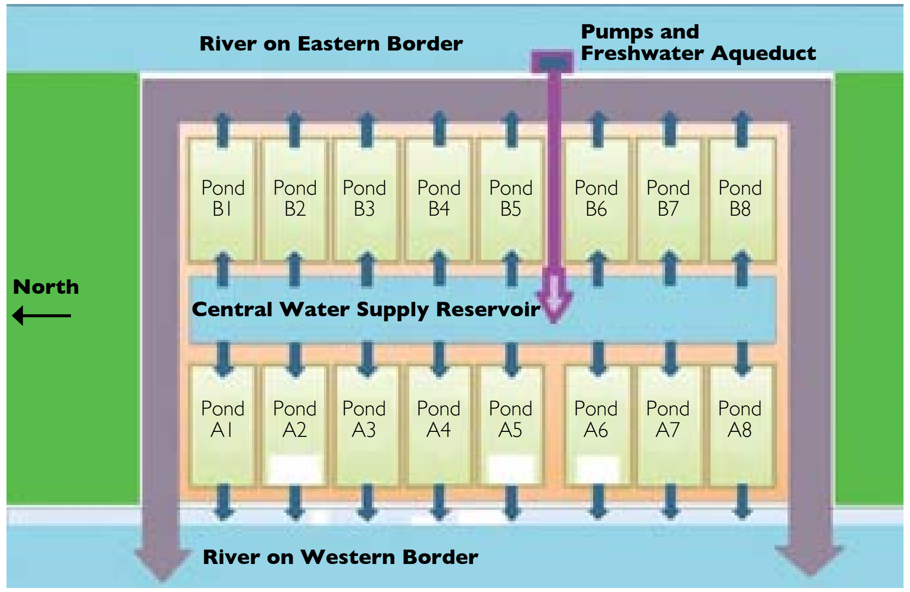
Because of the intensive nature of the culture operation, sludge accumulates on pond bottoms and must be removed periodically. Sludge removal in each pond is accomplished at approximately three-week intervals using a small, boat-mounted dredge. The total amount of sludge and water removed each time is roughly 700 $m^3$/pond. The water and sludge from the dredge formerly were discharged into the river on the western side of the island.

By use of the procedures described above, the farm's output of *Pangasius* in 2010 was approximately 10,000 mt or about 833 mt/ha in 1.3 production batches. The feed-conversion ratio was about 1.7. Thus, in 2010, about 17,000 mt of feed containing around 707 mt of nitrogen and 170 mt of phosphorus were applied to the ponds. About 35 to 40% of the nitrogen and phosphorus applied in feed was recovered in the fish, while the remainder entered the water of the ponds or was contained in sludge that accumulated on pond bottoms.

The high density of fish favors resuspension of solids, which elevates concentrations of total suspended solids (TSS) and five-day biochemical oxygen demand ($BOD_5$) in pond water. Thus, particular attention to the BAP concentration limits for nitrogen, phosphorus, TSS and $BOD_5$ was necessary.

## Modifications

The original farm infrastructure was compatible with BAP certification



Before implementation of the BAP standards, pond water was returned to the river untreated.

requirements on the eastern side of the farm. However, in preparing this part of the farm for BAP certification, the depth and width of the discharge canal were increased so that water flow is slow enough to allow sedimentation of suspended particles to occur before discharge back into the river. Weirs installed in the ends of the discharge canal to raise the water level cause the effluent to fall about 1 m to the level of the river. Gravity aeration at the weirs improves dissolved-oxygen concentrations in the effluent.

After the modifications described above, the discharge canal has a total water surface area of 1 ha and an average depth of 2 m. At the maximum water exchange rate of 40% pond volume/day, the eight BAP-certified ponds (representing 5.5 ha surface area) release about 75,000 $m^3$/day into the discharge canal. Thus, the canal has a hydraulic retention time of 6.4 hours. This is adequate time for coarse solids to settle from the effluent. Of course, in the future, sediment removal from canals will probably be required to maintain adequate hydraulic retention for solids removal.

## Beneficial Aquatic Plants

Floating, environmentally beneficial aquatic plants – mainly Chinese water spinach, *Ipomoea* aquatic; and water hyacinths, *Eichhornia crassipes* – grow profusely in the discharge canal. These plants remove considerable nitrogen and phosphorus from the water in their growth. Moreover, their roots extend into the water column, filtering out suspended particles and providing a substrate for growth of nitrifying bacteria. The plant roots serve both as mechanical and biological filters.

The farm should harvest these plants on a regular basis to encourage new growth and assure continued nutrient removal. Water spinach is an edible species in demand in Vietnam and other Southeast Asian countries, and it likely could be sold in local vegetable markets. Water hyacinth blossoms are edible, and the plants have been used as a source of fiber for making baskets and other handicrafts. Water hyacinths have been fed to cattle and hogs, but they have low nutritive value due to high moisture content.

## Sludge Disposal

To comply with BAP standards for sludge disposal, the dredge output had to be subjected to solids removal before entering the river. Direct discharge into the effluent canal was possible, but this would greatly accelerate the rate at which the canal filled with solids and possibly cause trouble in meeting the BAP standard for TSS concentrations. Thus, a structure for removing solids from dredge discharge was constructed on top of the pond embankments.

This structure – called a sludge pen here – is lined with a fine-mesh, geotextile material. The bottom is covered with a layer of sand. A second liner of fine mesh netting material covers the sand and the geotextile liner. The sludge pen filters nearly all of the coarse suspended solids from the dredge effluent, and the filtrate enters the discharge canals. It should be noted that the sludge pens in current use are temporary, and based on experience in operation of the prototype sludge pens, some improvements in design and efficiency for more permanent sludge pens are expected.

Solids retained in the sludge pens are allowed to dry. The fertilizer nutrient composition of the dry product compares quite favorably with that of traditional, organic manure (Table 1). It contains more nitrogen and phosphorus than dairy cattle manure does, and more phosphorus than found in steer and horse manure. Its potassium concentration is greater than that of traditional manures.

Although the organic matter content of the *Pangasius* pond sludge was not measured, it undoubtedly has a higher organic matter concentration than that found in the highly leached, tropical soils of the Mekong Delta region. Thus, the sludge has value as an organic manure and soil amendment for use on agronomic or horticultural crops. The nutrient and organic matter content of the dry sludge probably could be increased by modifying the dredge to minimize intake of bottom soil underneath the layer of sediment.


Sludge pens remove solids from dredge discharges before their release to the effluent canal.

**Table 1. Comparison of the plant nutrient content of *Pangasius* farm sludge with common organic manures.**

| Material | Nitrogen (%) | Phosphorus (%) | Potassium (%) |
|---|---|---|---|
| *Pangasius* farm sludge | 0.49 | 0.45 | 1.25 |
| Chicken manure | 1.10 | 0.80 | 0.50 |
| Dairy cattle manure | 0.25 | 0.15 | 0.25 |
| Steer manure | 0.70 | 0.30 | 0.40 |
| Horse manure | 0.70 | 0.30 | 0.60 |

**Table 2. Water quality variable concentrations before and after modification of the discharge canal.**

| Variable | Before | | After | | BAP |
|---|---|---|---|---|---|
| | Average | Range | Average | Range | Criteria |
| pH | 6.97 | 6.75-7.00 | 7.40 | 7.00-7.60 | 6.00-9.50 |
| Dissolved oxygen (mg/L) | 6.17 | 5.50-6.00 | 5.54 | 5.00-7.00 | > 4.00 |
| Soluble phosphorus (mg/L) | 0.16 | 0-0.43 | 0.47 | 0.25-1.00 | < 0.50 |
| Total ammonia nitrogen (mg/L) | 1.13 | 0.10-2.88 | 0.22 | 0.09-0.51 | < 5.00 |
| 5-day biochemical oxygen (mg/L) | 14.8 | 6.00-21.80 | 5.90 | 2.60-7.00 | < 50.00 |
| Total suspended solids (mg/L) | 89.2 | 40.00-137.00 | 25.60 | 17.00-33.20 | < 50.00 |

The water spinach and water hyacinths that grow profusely in the discharge canal serve as both mechanical and biological filters.

## Water Quality

Water quality data from the BAP effluent-monitoring station are available for nine dates before modifications were made in the canal and for four dates after completion of the changes.

The modifications had little effect on pH and dissolved-oxygen concentrations (Table 2). However, there were large reductions in total ammonia nitrogen, $BOD_5$ and TSS concentrations as a result of the modifications. The increase in soluble phosphorus concentration after the modifications does not seem logical and was likely the result of a single, exceptionally high and possibly erroneous measurement. It should be noted that the modifications used to achieve compliance with the BAP standards did not require reduction of fish production.

## Current Activities

The QVD farm is currently modifying infrastructure to achieve BAP certification for the ponds on the western side of the island. A canal being constructed to receive the effluent from these ponds will join the existing canal to form a single canal that will traverse the perimeter of the farm and enter a 5,000-$m^2$ settling basin.

Final discharge from the settling basin will enter the river from a single outfall on the eastern side of the farm. Additional sludge pens will be constructed to accommodate the sludge from the ponds on the western side of the farm. The pumping station will be moved to the western side, where water quality is better because of greater river flow.

# China's Tilapia Germplasm: Chance And Challenge

Thousands of tilapia fingerlings are raised in cage cultivation. Technical advances are expected to lead to improvements in China's germplasm.

**Summary:**
China's expansive tilapia culture industry is based on exotic species introduced continuously since 1956. Now, the new GIFT and *O. niloticus* x *O. aurea* hybrid tilapia are commonly used. China's tilapia germplasm is totally from international introductions with low genetic variation and inbreeding, however, and capacities for genetic breeding are still somewhat limited. Technical advances for improving the limited tilapia germplasm are expected to aid the Chinese tilapia industry.

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Through 50 years of experimentation and exploration, China has become the biggest tilapia producer in the world. Its success has been based on the introduction of nine tilapia species from Africa, including *Oreochromis mossambicus, O. niloticus* and *O. aurea*, since 1956. These introductions formed the founding germplasm of the Chinese tilapia industry (Table 1). Some minor additional indirect private introductions are not recorded.

## GIFT Strain

The Genetically Improved Farmed Tilapia (GIFT) strain, selected from the combined base populations of four African strains and four Asian strains in the Philippines, was introduced to China in 1994. It showed growth rate and recapture rate superior to those of all extant strains in China and thus became a superior introduced variety.

New GIFT fish were developed from the introduced GIFT strain by Shanghai Ocean University through eight generations of mass selection for growth rate and morphology. The new GIFT and *O. niloticus* x *O. aurea* hybrid are two commonly cultured species in inland fisheries.

The *O. niloticus* x *O. aurea* hybrid can produce a higher percentage of males. Other species or strains are not extensively used due to their performance. Red tilapia (*O. niloticus* x *O. mossambicus*), GILI tilapia (*O. niloticus* x *S. melanotheron*) and MOHO tilapia (*O. mossambicus* x *O. hornorum*) are applied in some brackish water areas.

## Issues With Introduced Germplasm

Although essential, the multiple introductions of new and different tilapia strains over time came with a number of issues.

### *Disorganized Introduction*

Since the tilapia introductions were made for research or commercial use, they were never organized by any single government or organization. The introduced tilapia were kept in separate institutes or at private fish farms, and sometimes poorly managed. Because records of tilapia sources, quantities and characteristics were not consistently kept, their value as resources may not be fully utilized now.

### *Small Populations*

Population sizes are determined by the actual mating parents' numbers rather than the total parental numbers. Because of long-distance transporting, only a few individuals could survive long-term. Therefore, the small effective population resulted in lower genetic variation.

### *Loss Of Genetic Variation*

With small population sizes, genetic drift often occurred and severely changed their genetic variation by generations. Low genetic diversity is the ultimate limitation for future genetic improving.

### *Inbreeding*

Inbreeding also easily happened because of the small populations (Table 2). Further, unjusted mating schemes were another source of inbreeding during generational transitions.

### *Hybridization*

Because of easy interspecific hybridization among the tilapia species, more than two kinds of species kept in the same fish farms could produce additional interspecific hybrids. These hybrids were often mixed with the broodstock, and genetic introgression has been found in some tilapia fish farms.

**Table 1. Introductions of tilapia to China.**

| Species | Year | Source | Introducing Institute |
|---|---|---|---|
| *O. mossambicus* | 1956 | Vietnam | Guangdong Fisheries Institute |
| *O. niloticus* | 1978 | Sudan | Yangtze Fisheries Institute |
| | 1978 | Thailand | Zhujiang Fisheries Institute |
| | 1988 | Egypt | Hunan Fisheries Institute |
| | 1992 | United States | Freshwater Fisheries Research Center |
| | 1994 | Philippines | Shanghai Fisheries University |
| | 1998 | Egypt | Shanghai Fisheries University |
| | 2005 | Malaysia | Freshwater Fisheries Research Center |
| *O. aurea* | 1981 | Taiwan | Guangzhou Fisheries Institute |
| | 1983 | United States | Freshwater Fisheries Research Center |
| | 1998 | Egypt | Shanghai Fisheries University |
| *O. hornorum* | 2000 | United States | Zhujiang Fisheries Institute |
| *S. melanotheron* | 2002 | United States | Shanghai Fisheries University |

**Table 2. Estimated inbreeding coefficient for introduced tilapia in China.**

| Population/ Stains | Survival No. | Effective Size | Coefficient Index |
|---|---|---|---|
| N78-1 | 10 females,12 males | 21.8 | 0.00965 |
| N78-2 | 30 | 30.0 | 0.03333 |
| N85 | 9 females, 1 male | 3.6 | 0.01389 |
| N95 | 24 females, 29 males | 52.0 | 0.00952 |
| N98 | 3,000 | 3,000.0 | 0.00017 |

Regarding the germplasm, low genetic variation and inbreeding of these introduced populations further constrained their long-term utilization.

## Genetic Improvements Of Tilapia

China's ongoing development of tilapia genetics has produced advances in several areas.

### *Growth Rate*

Excellent growth rate is the first demand for a good variety of tilapia. The initial GIFT strain exhibited excellent growth rates, and with growth rates up to 30% higher than the control group, the "new" GIFT tilapia have become the most popular cultured species in China.

Although there have been many introductions of different tilapia species, their small effective population sizes resulted in genetic drift or genetic bottlenecks. The loss of genetic variation made their selection ineffective for most strains.

### *Male Percentage*

Sexual maturation that occurs before tilapia reach commercial size always perplexes tilapia farmers. Although the administration of hormones at the fingerling stage to increase male percentage is relatively easy, its food safety is debated.

Another practical method for producing male-only offspring is interspecific hybridization. The best hybridization combination for high male percentage is *O. niloticus* x *O. aurea*, which claims to produce more than 95% males. In fact, genetic and environment factors also affect the practical male percentage.

Male Nile tilapia have XY chromosomes, and females have XX chromosomes. Using sex-reversal techniques, a male XY can be changed into a female XY, then YY males can be identified among XY x XY progenies. Mating of a YY male with a normal XX female would produce all XY male progeny.

### *Salt Tolerance*

*O. niloticus* grow fast with salt tolerance up to 15 ppt, while

*S. melanotheron* grow slowly and with high salinity tolerance up to 100 ppt. Although it is easy for interspecific hybridization among some tilapia species, hybridization of *O. niloticus* and *S. melanotheron* is less successful, probably due to their different genera. The mouth-hatching parent is female in *O. niloticus*, while the mouth-hatching parent is male in *S. melanotheron*.

The growth and salinity tolerance of *O. niloticus* x *S. melanotheron* were better than that of the reciprocal hybrid, *S. melanotheron* x *O. niloticus*. Difficulties in getting enough first-generation ($F_1$) fish greatly confined their application.

In contrast, the $F_2$ generation could easily be obtained by natural mating among $F_1$ individuals. They kept salinity tolerance and growth rates similar to those of their parents. They could be widely propagated and cultured in brackish water ponds or in polyculture with shrimp. Their meat quality also improves under culture with higher-salinity water.

### *Disease Resistance*

Disease is another problem perplexing the tilapia industry. An epidemic that has affected some main producing areas since 2009 mainly attacked tilapia at about 200-g weight and resulted in 20 to 30% morbidity and 95% mortality, thus greatly decreasing the total production.

Recently, *Streptococcicosis agalactiae* was identified as the main pathogen in Guangdong and Hainan Provinces. A new program has been initiated to prevent and control this disease during the whole production process. Also, the development of a disease-resistant strain is expected, as well as adjustments to the present high-density aquaculture mode.

Development of disease-resistant tilapia strains is under way.

### *Cold Tolerance*

Usually, temperate tilapia species can't survive the winter in most parts of China. The lethal temperature for *O. niloticus* is 10° C and 8° C for *O. aurea*. In northern China, tilapia were kept in warm, circulated water supplied by an electric power plant. In southern China, the fish can survive the winter in simple plastic-roof rooms. The warm climate also provides a long growth period for tilapia. Therefore, the major production area is southern China.

Since 2008, cold weather has often intruded on southern China. The low temperatures killed adult fish and decreased the total production. It also killed tilapia breeders and caused a supply shortage for the next year's seed.

The best solution for safe overwintering is providing some apparatus for keeping the tilapia warm, but this adds costs for farmers. Improving their cold tolerance has been put forward in recent years, but this may be a long reach to counter the biological characteristics of the fish and climate change.

# Genetics Key To Understanding Shrimp Growth Rates

Selective-breeding programs can lead to growth performance gains as high as 10%/generation.

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**Summary:**
Achieving higher growth rates in shrimp can reduce risks, cut costs and increase economic opportunities. The amount of additional growth that is achievable is related primarily to shrimp genetics. Shrimp generally reflect the growth rates of their parents. As a result of selective-breeding programs, however, increases of up to 10%/generation are possible. Weekly growth of 7 to 10 g has been reported during the lineal growth phase.

Under normal production conditions, growth rate is considered the primary factor in affecting pond profitability. In spite of its importance, few people actually know the maximum growth rate potential of their shrimp.

## Why Is Growth Rate Important?

Faster growth rate contributes in many ways to the profit equation. When shrimp grow faster, they are in the ponds for a shorter period of time, which significantly reduces the risk factor. There may be opportunities to grow the shrimp to a bigger size or increase the number of crops per year.

Less time in the pond can result in higher survival and lower feed-conversion ratios. In addition, total operating costs are reduced. All of these factors contribute to higher profits.

## Understanding Growth Rate

In order to manage growth rate effectively, it is first important to understand how shrimp grow. There are three main phases in shrimp growth. A hypothetical example is presented in Figure 1.

First, from approximately 1-day-old postlarvae to 3 or 4 g, the animals grow exponentially and gain weight at an increasing rate. During the second phase, up to approximately 25 g, the growth rate of shrimp is lineal and fairly constant per unit of time. At about 25 g or when the animals start reaching sexual maturity, females continue to grow at the same lineal rate, but the growth of males declines. Most of the increase in animal weight takes place during the lineal phase.

## Genetic Potential For Growth

All animals are products of their genetics and their environments. To determine the maximum growth rate of shrimp as determined by their genetics, we must allow them to grow under optimum conditions that are not limiting in any way. Figure 2 presents the data where a line of fast-growing shrimp was stocked at very low densities and fed a very high-quality feed in a very favorable greenwater environment.

Sample counts were taken approximately every seven days. In a regression analysis, the average weekly growth rate was calculated as 2.59 g – a very good estimate of the maximum growth rate, as determined by the animals' genetics.

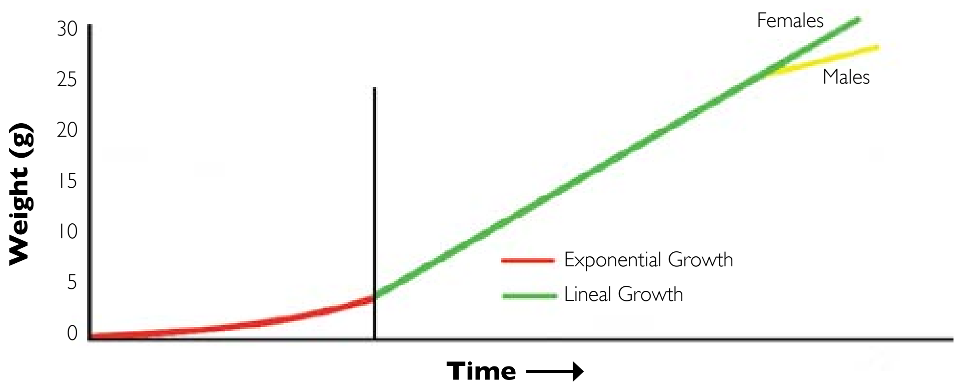


**Figure 1.** Hypothetical growth curve of shrimp. Male growth diminishes at about 25 g.

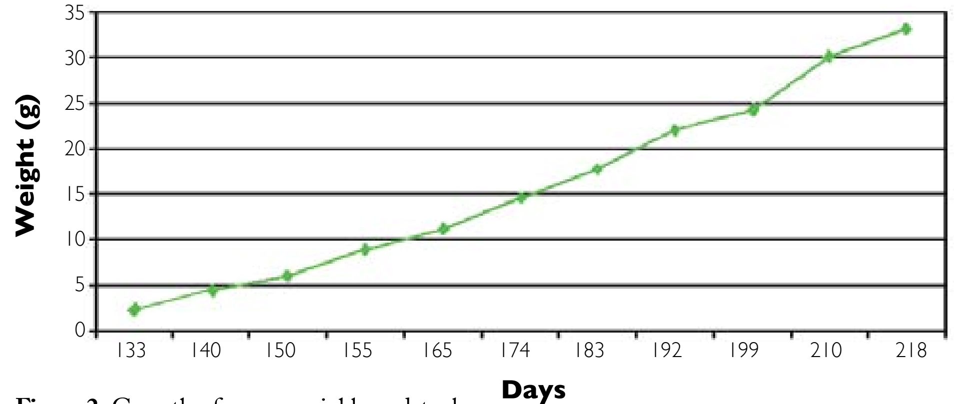


**Figure 2.** Growth of commercial broodstock.

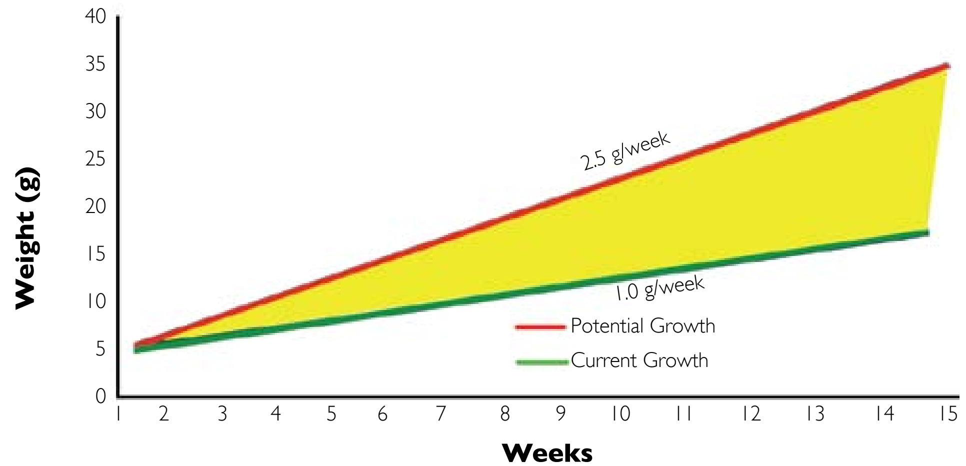


**Figure 3.** Potential growth opportunity of shrimp.

## Seeing Opportunity

A visual illustration of the opportunity from faster-growing animals is shown in Figure 3. If the normal expected growth on a farm is 1.0 g/week, as represented by the bottom line, and the maximum growth rate from the animal's genetics is 2.5 g/week, as shown by the top line representing the potential, then the opportunity is represented by the yellow area.

Within this area, we may safely conclude that one or more environmental factors are limiting. It could be nutrition, feeding technique, any of the many water quality parameters, temperature, disease, etc. If we can learn what these limiting factors are and manage them more effectively, profits will improve.

## Rising Goals

Fundamental to understanding the maximum amount of additional growth that is achievable is understanding the maximum growth potential determined by the genetics of shrimp. Selective-breeding programs are being rapidly employed by progressive shrimp hatcheries. One of their selection criteria is faster growth, which can be increased up to 10%/generation. Goals for maximum growth can therefore constantly increase, and managers will be accordingly required to continually make improvements in their production and management techniques.

Commercial breeders and suppliers of poultry, swine and row crops all provide performance statistics based on genetically selected strains. For broilers and turkeys, statistics are available for growth rate, feed conversion and survivability. These examples could be used as models within the shrimp industry. Shrimp hatcheries should develop these relative types of performance profiles and supply them to the industry for each of their genetic lines.

After years of using wild-caught postlarvae for stocking at farms, the aquaculture industry has moved almost exclusively to hatchery-reared animals. As a result of selective-breeding programs, significant increases have been made in rates of growth. There have been reports of shrimp growing 7-10 g/week during the lineal growth phase.

**Bottom Line: Know the genetic potential for maximum growth rate.**

The mussel aquaculture concentrated in northern Chile incorporates over 1,200 growout locations.

# Mussel Culture In Chile

## *Improvements In Production Chain Could Boost Output, Increase Exports*


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**Summary:**
While Chile's mussel-farming industry has entered a growth phase, challenges remain, especially in the seed production and growout components. This contrasts with the well-developed nature of the country's processing plants and marketing outlets. To improve the competitiveness of the industry and reduce the risks associated with fluctuations in current markets, efforts have been focused on establishing new markets in Latin America and Asia, as well as a "national brand" for Chilean mussels.


Mussel culture in Chile is based on the production of three main species: the chorito or Chilean mussel, *Mytilus chilensis*; the cholga mussel, *Aulacomya ater;* and the giant or choro mussel, *Choromytilus chorus*. Mussel aquaculture has developed locally since the 1960s, with production increasing substantially in the last decade. By 2000, production was around 12,000 mt, and by 2009 about 168,000 mt were harvested. Much of the production of Chilean mussels is exported to the European market. The production of cholga and giant mussels is consumed locally.

Because of the geographical conditions and water quality, the activity is concentrated in the Lakes area in Region X. According to data from Sernapesca (Servicio Nacional de Pesca, National Fisheries Services), the areas of Calbuco and Chiloé contribute 99.8% of the total landings of farmed mussels. In 2010, processed mussels reached sixth place in the region's exports, contributing a value of U.S. $39 million.

## Production Processes

This industry currently has four distinct production processes: the production of seed, which currently comes from the capture of wild seed, for production technologies are not yet economically viable; growout to market size using suspended systems; transformation of the meat products to frozen and canned products; and marketing to mostly foreign export markets (Figure 1).

The Integrated Territorial Program for Mussels reported that the industry is a productive conglomerate composed of 63 seed producers, 1,120 growout centers, 40 processing plants and approximately 60 exporting agents.

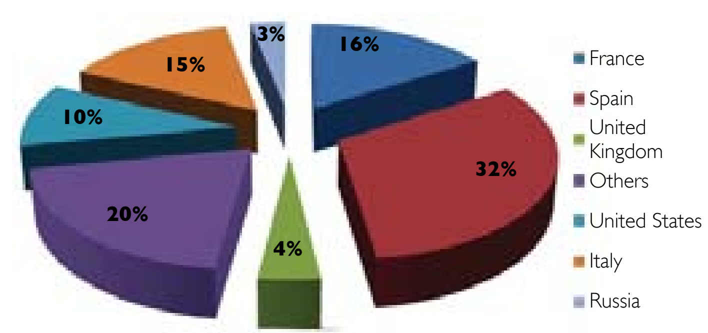


**Figure 1.** Export markets for Chilean mussels in 2010. Source: Webcomex – ProChile.

While several mussel species are raised primarily for local consumption, efforts are under way to boost the culture of Chilean mussels for additional exports.

## Standardization Needed

While Chile's mussel culture industry has entered a very important phase of growth, challenges remain, especially in the seed production and growout components. This contrasts sharply with the level of the processing plants and marketing, which have production technologies and expertise to satisfy the requirements of each market.

This results in ineffective coupling and standardization of all the production links, increasing production costs. In turn, the small and medium producers of mussels do not have management systems to respond adequately to the requirements of processing plants. Therefore, their production suffers from low prices, generating narrow profit margins that prevent scaling up and additional quality improvements.

Because of this, the Chilean or chorito mussel has been positioned as a product mainly for bulk unprocessed exports at medium to low prices. The mussels have had to face the foreign market preferences for domestic products and for value-added and certified products like those from New Zealand and Ireland.

## National Brand

To improve the competitiveness of the industry and reduce the risks associated with fluctuations in current markets, efforts have been focused on diversification into new markets in Latin America and Asia, and establishing a "national brand" for Chilean mussels that clearly represents the quality of their origin.

At Cultivos Marinos San Agustín Ltda., the company's value proposition is to raise the standards of Chilean farmed mussels through various certifications that would demonstrate environmental stewardship, as well as quality and social responsibility. This differentiation will lead to better prices – estimated at up to 40% higher for value-added products – in organic markets that are currently small but growing 20% annually, mainly in the United States and European Union.

To accomplish these goals, the company is working on several fronts, including certifying its growout phase processes as organic, and obtaining a major contract with an international company for processing to organic standards. Cultivos Marinos San Agustín Ltda. is currently awaiting a final audit to begin harvesting in the third quarter of 2011. By 2014, it expects to reach 1,000 mt of annual mussel production.

# Disease And Shrimp Farming

## *Pseudoscience, Non-Standard Practices Breed Problems*

Failure to proactively address disease issues usually leads to significant decreases in production performance.

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**Summary:**
The slipping shrimp production in Southeast Asia due to disease has a number of causes. Emerging viral diseases take a toll, as well as bacterial diseases caused by vibrios and other pathogens. Management issues from improper quarantine procedures and high stocking density to limited respect for complete disinfection may push small regional problems across borders to become systemic problems. Some suppliers will likely fail over time, but third-party technical operational audits can help foresee concerns.

For those who make their living buying and selling shrimp, the whims and vagaries of the marketplace at times are far from clear. Many factors affect the price of shrimp, and while common sense dictates that supply-side economics would be a large factor, things are unfortunately not always so evident.

Even though the actual production of shrimp is fairly straightforward, as with many endeavors of this nature, the outcome is not always clear cut. For new farms established in pristine areas, there is often a time period that many jokingly refer to as the honeymoon. Production is good, no matter what one does wrong, and as long as prices are solid, it seems as if many of these farmers have licenses to print money. Yet within these operations, the seeds of failure are often being sown.

### Disease Is Natural

Too many farmers fail to appreciate that the absence of disease is unnatural. Disease is a natural process, and the traditional high-stress monoculture rearing environments are typically not conducive to the sustained absence of profit-limiting disease.

In a production paradigm where science is marginalized and pseudoscience is the norm, the risks are even greater. Many farms that I have visited over the years are accidents waiting to happen. Managers perceive that they are taking appropriate steps to minimize the impacts of preventable problems, when in reality, this is often far from the case. In many cases, the underlying potential causes of future problems are clear, and in others, while not as clear, are no less real.

### Production And Disease

Right now we are seeing a gradual erosion of production in a number of countries in Southeast Asia. In some, the underlying cause of specific patterns of mortality has been identified. An example of this is the infectious myonecrosis virus that is currently seriously impacting production in Indonesia. There is a very strong probability this virus originated in Brazil. It is spreading, and many shrimp health experts fear it is only a matter of time until it is confirmed elsewhere.

In many other countries, problems seem to be much more generic in nature. The leading cause of mortality in farmed shrimp is bacterial disease, with vibrios typically being the primary pathogens. However, they often are secondary and non-obligate pathogens.

The serious stress shrimp experience as a result of culture practices, combined with a lack of understanding about the true nature of biosecurity and proactive health-monitoring programs, and reliance on pseudoscience ensures that problems will occur. Sloppy culture practices ignoring tried and tested science invariably lead to problems.

**Too many farmers fail to appreciate that the absence of disease is unnatural.**

### Standard Practices Not Routine

Do not expect this to change any time soon. While some efforts are being made to standardize culture practices to ensure that preventable problems are avoided, the reality is that standard practices are not yet routine.

Factors such as failure to quarantine animals that might be carrying potential pathogens, production at super-high densities without stress mitigation and failure to ensure that effluents are not components of influents can lead to significant problems. Failure to truly understand disinfection and know-it-all managers who have produced successfully despite lacking an appreciation for the many different factors in the disease process will continue to ensure that small regional problems will cross borders and become systemic problems. Disease will continue to periodically ravage the industry.

### Perspectives

Of course this does not mean the situation is hopeless or even close to it. As with many things in life, when one area suffers, another benefits. If Southeast Asian production fails, and demand remains, operations that are successfully producing in other parts of the world will reap the benefits.

This has happened many times in the last three decades and is part of the reason growth will continue despite regional problems. Unfortunately, all too often, those who fail move on and perpetuate culture practices that lead to failure again.

What you can count on is that some of the companies that currently supply you with farmed shrimp and fish will not always be there for you. As someone who relies on these companies to be consistent, you can increase the chances that they are by utilizing the services of third parties to routinely perform technical operational audits. These are not certifications. Sustainability is multifaceted, and the implementation of site-specific strategies often requires experts who see beyond what are perceived to be the traditional boundaries.

**Failure to truly understand disinfection will continue to ensure that small problems will become systemic problems.**

# *Streptococcus* In Tilapia

## *Vaccine Development, Field Experiences In Asia*

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Combining vaccination with good management, biosecurity, water quality and nutrition can help improve disease control.

**Summary:**
*Streptococcus* species account for over half of all bacterial diseases in tilapia. The authors conducted a laboratory challenge to determine the ability of biotype-specific vaccines to protect against lethal challenge with *S. agalactiae*. A vaccine was effective in the lab, and in field trials, it proved safe for fish and effective against *S. agalactiae* biotype II. Laboratory studies have shown it protects for at least 30 weeks and can improve survival and feed conversion.

Global production of tilapia has nearly tripled since the beginning of the decade. No other fish species has displayed such aggressive and sustainable growth, year after year.

However, the cost of raw materials is increasing, which is increasing the cost of production and reducing profit margins. Further advancements in production efficiency are required to improve profitability. This trend is driving the aquaculture industry toward consolidation and intensification – a situation that fosters the emergence of production diseases, including several that affect tilapia.

### Tilapia Diseases

Experience has shown that intensive fish-farming operations can suffer from six to eight major production diseases that must be prevented or controlled. Four major bacterial disease pathogens have been identified in tilapia: *Streptococcus agalactiae, S. iniae, Flavobacterium columnare* and *Francisella species*. One viral disease, iridovirus; and two major groups of parasites, Monogenean species such as *Gyrodactylus* and Protozoan species such as *Trichodina*, have also been found.

Their prevalence and severity depend on many environmental factors, such as geographical location, culture system, farming intensity, water salinity and temperature. Biological factors such as age, genetics, nutrition and stress also play roles in diseases.

### *Streptococcus*: Established Pathogen

By far the most important diseases economically are those due to *Streptococcus* species. In many instances, streptococcosis does not contribute the highest mortality, but it kills large fish and, as a consequence, heavily affects feed-conversion ratios, reduces marketable product and decreases production and processing efficiency.

In 2000, MSD Animal Health initiated extensive epidemiological surveys in the major tilapia-producing regions of Asia and Latin America. It identified over 1,000 bacterial isolates from tilapia reared at 74 sites in 14 countries to better understand the relative importance of streptococcal pathogens to the industry.

As other investigations have found, these streptococcal species were the dominant bacterial pathogens, accounting for more than half of all bacteria identified. However, it is interesting that while *S. iniae* was the most commonly reported pathogen of fish, the data showed that *S. agalactiae* was more prevalent in tilapia.

### Biotype Prevalence

Detailed analysis of the isolates revealed two distinct clusters that differed in a variety of biochemical and phenotypic characteristics. These clusters or biotypes typically differentiate between beta-haemolytical "classical" *S. agalactiae* (biotype I) and non-beta-haemolytical *S. agalactiae* (biotype II).

*S. agalactiae* biotype II was considered the more globally significant of the biotypes, with chronic mortality in many Asian and Latin American countries, whereas *S. agalactiae* biotype I was limited to Asia and displayed acute mortality peaks, often associated with higher temperatures.

In the authors' epidemiological surveys to date, 26% of all streptococcal isolates of tilapia were found to be *S. agalactiae* biotype I, and 56% were identified as *S. agalactiae* biotype II. *S. iniae* made up 18%.

### Vaccine Development

Vaccines to protect against *S. agalactiae* have been described by various authors, but it is difficult to conclude from these studies if the vaccine and challenge strains were from the same or different biotypes.

To determine if *S. agalactiae* has consequences for the development of vaccines to control strep diseases, the authors conducted a laboratory challenge to determine the ability of biotype-



Clinical signs of streptococcal diseases in farmed tilapia include pin-point petecchial hemorrhaging (left), bilateral exophthalmia (center) and late-stage bilateral exophthalmia and corneal opacity (right).

specific vaccines to protect against lethal challenge with *S. agalactiae* biotype I or biotype II strains.

Tilapia vaccinated with experimental *S. agalactiae* biotype I vaccines were protected against *S. agalactiae* biotype I strains. However, no protection was observed in tilapia that received the biotype I vaccine when they were challenged with virulent biotype II strains. Similarly, fish vaccinated with *S. agalactiae* biotype II vaccines were protected against lethal challenge with biotype II, but not biotype I strains. Thus, vaccination with biotype-specific bacterin vaccines induces biotype-specific protection against mortality caused by *S. agalactiae*.

Laboratory studies also demonstrated that AquaVac® Strep *Sa*, a biotype II vaccine ultimately developed for commercial use, protected against *S. agalactiae* biotype II for at least 30 weeks (Figure 1).

### Field Assessment

Carefully controlled field registration trials were conducted to determine if the results found in the lab for the prototype biotype II vaccine would be the same in the field.

The field trials were conducted in a lake environment using square cages housing about 10,000 fish at a large Asian tilapia farm. The trial was run in triplicate with three test cohorts including the biotype II vaccine, a placebo oil group and a negative, unvaccinated control. When the fish reached about 15 g in weight, they were vaccinated after transfer to growout cages from the nursery ponds.

Extensive bacteriological and virological samplings were conducted before, during and every month after vaccination and at specific time points during the trial when mortality was recorded above "normal." As per the routine growout strategy, the trial was terminated and fish were processed after about 200 days, when they reached

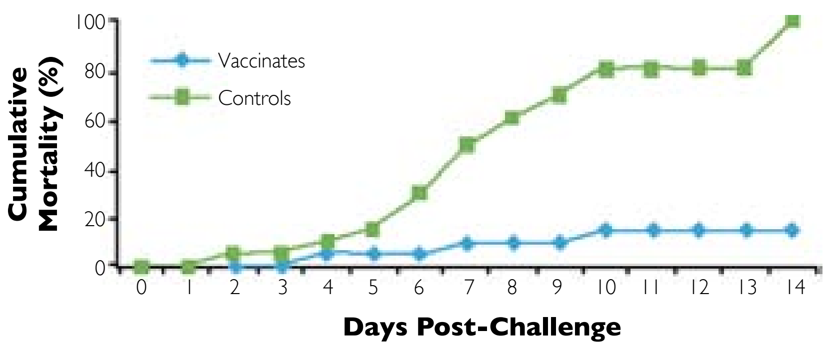


**Figure 1.** Laboratory efficacy 30 weeks after vaccination against challenge by a virulent *S. agalactiae* biotype II isolate.

approxmately 1.2 kg. Mortality, feed and water quality parameters were recorded daily along with the final harvest data.

Clear disease patterns emerged during the trial in all cages, indicating that columnaris disease or *Flavobacterium columnare* was responsible for high initial mortality peaks immediately after stocking. As the columnaris or "saddle-back" disease subsided, along with the initial transport and stocking stress, then iridovirus (a common viral disease of tilapia in the area) resulted in three clear peaks of mortality. This mortality pattern is often indicative of the disease and losses can routinely be as high as 30%.

As the fish got larger, *S. agalactiae* and, to a much lesser degree, *S. inae* were increasingly reisolated from moribund fish in all three cohorts. The mortality patterns indicated that although the incidence of columnaris and iridovirus was similar in all groups, the degree of mortality from *S. agalactiae* was relatively much lower in the vaccine group when compared to the placebo oil and negative controls. Data gathered at harvest substantiated that observation: Survival in vaccinates was 80% compared to 67% survival in the placebo and negative-control groups, representing a 13% improvement in vaccinated fish.

Correspondingly, feed-conversion ratios (FCRs) were about 1.86 in the vaccinates, compared to 2.06 and 2.05 in the placebo and negative-control groups, respectively. This was an approximate 10% improvement in FCR (Table 1).

In this trial, vaccinated fish had improved feed intake and feed utilization. Consequently, they had improved production efficiency performance, with 2.25 mt more fish harvested in the vaccinated population.

Further laboratory challenge studies using Indonesian, Malaysian, Vietnamese, Honduran, Brazilian, Mexican and Ecuadorian strains against the relative commercial vaccine indicated the vaccine cross-protects against multiple geographically diverse isolates.

## Lessons Learned

The success of the first large commercial-scale injection vaccination programs in tilapia to date has been variable, as expected, due to the presence of other diseases and other variables. The initial field trials and large-scale vaccination programs led to the identification of some fundamental factors to implement before any operation should embark on a vaccination program.

**Correct diagnosis.** Before a commercial producer commits to a vaccination program, the underlying cause of mortality needs to be determined by a fish health specialist.

**Antimicrobial susceptibility analysis.** If a bacterial disease is confirmed, a diagnostic laboratory should perform an antimicrobial susceptibility test to determine if the bacteria are susceptible to therapeutic remediation and, if this is the case, which antibiotic is most suitable to control the outbreak.

***S. agalactiae* biotype confirmation.** If *Streptococcus agalactiae* is confirmed as the primary disease, a more detailed biotype analysis is necessary to ensure the right biotype-specific vaccine is chosen for the right reason.

**Healthy fish.** Healthy fish means that there is no sign of clinical or subclinical disease. Fish should be free of disease and stress before, during and for the first two to three weeks after vaccination. That means climatic (water quality) and housing conditions (biomass, handling, etc.) at this stage are crucial.

The best results are obtained in operations where hatchery, nursery, pre-growout and growout areas are separated from each other as well as housing units and equipment. The hatchery and nursery phases should be biosecure, well-controlled and disease-free. This not only gives juvenile fish the best start in life, but also allows vaccines to be administered in a controlled environment.

## Components Of Vaccine Program

There are four key components to effective vaccine programs.

**Correct administration.** The aim is to administer the vaccine in a consistent and proper manner so there is minimal stress on the animals. The correct dose must be given to each and every individual.

**Sufficient immune response.** Correct vaccination and maintenance in a healthy state under suitable housing conditions prior to transfer will trigger a sufficient immune response before exposure to the "challenge environment."

**Population protection.** To achieve population protection, it is important that the entire population is vaccinated, not just a fraction of that population. The aim is to achieve blanket protection in the shortest time frame possible. This is much easier in an all-in/all-out production system, where 100% of stocked fish can be vaccinated.

**Shift the balance.** It is important to note that even if a fish has been vaccinated, it may still be susceptible to disease and infection depending on its health, nutritional and stress status. Therefore, a combination of good management, biosecurity, housing, water quality, nutrition, sanitation, immune stimulation and vaccination will tip the balance toward disease control.

Effective vaccination programs result in a rapid onset and full duration of protection. Over time, such programs have a self-perpetuating or "snowball" effect – with fewer sick and dying fish, there is less bacterial shedding in the water. Less bacterial shedding, in turn, lowers total challenge pressure. Coupled with increasingly more protected individuals, overall population performance will improve.

**Table 1. Results from a field trial with a *Streptococcus* vaccine.**

| Treatment Group | Survival (%) | Feed-Conversion Ratio |
|---|---|---|
| Vaccinates | 80 | 1.86 |
| Placebo-vaccinated controls | 67 | 2.06 |
| Untreated controls | 67 | 2.05 |

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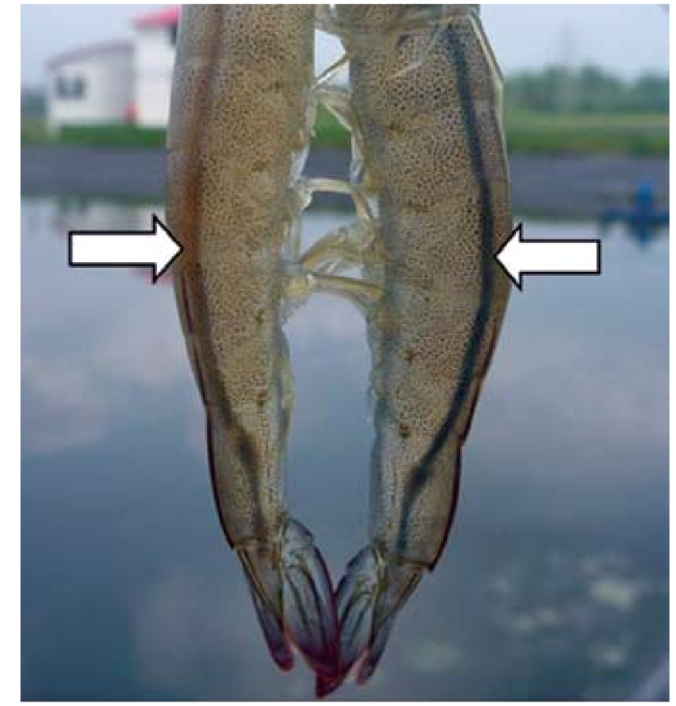
# Intestine Color Check Complements Feed Management In White Shrimp



Balanced feed consumed by white shrimp is seen as a light brown color (left) in the intestines, while intestines with natural food appear with a blackish color.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**Summary:**
Feed tables and feed trays are important tools for aquafeed management. However, tables can be inaccurate when shrimp survival is affected by disease. Feed trays are less effective at high temperatures, when no leftovers are found. A technique based on checking the color of the shrimp intestine can complement the use of feed tables and feed trays.


Efficient feed management is an important tool in farmed shrimp production, particularly when considering that feed cost typically comprises 50% or more of total production costs. In addition, inadequate feed management can affect pond bottom and water quality.

## Intestine Color Check

The author recently developed a technique that uses the color of shrimp intestines to assess feed consumption for efficient use of feed.

To carry out the "intestine color check" technique, about 100 animals from two or three areas of a pond are sampled with a cast net. Balanced feed in shrimp intestines is distinguished by a light brown color, while intestines with natural food (mainly detritus, plankton and benthos) appear with a blackish color.

Overfeeding is considered when, one hour before feeding, 10% or more of the guts sampled show feed color. This is based on the fact that, before providing new feed to the pond, more than 90% of the feed from the previous dose has to be consumed.

On the other hand, when underfeeding is suspected, intestines are checked one hour after feed has been applied to the pond. It is expected that 60% or more of the animals sampled show intestines with feed color. So, feed dose should be increased when 40% or more of the intestines show a blackish color one hour after feeding.

Usually all feed should be consumed during the first three hours after feeding, because uneaten feed loses nutrients through leaching faster after this period, according to Dagoberto Sanchez. Considering that sometimes intestine color checks must be done at different times, proportion values have been established at half-hour intervals after feeding (Table 1). This table was adapted for a trial at a shrimp farm in China from a feed management protocol used by the research and development farm at Kasetsart University in Thailand.

In some cases, when guts are empty or partly empty, the intestine contents are recorded as natural food, because it could mean that feed is not being consumed – perhaps due to the presence of pathogens causing disease. Also, when the gut shows mixed colors, indicating feed in some part of the gut and natural food in the other, feed color is noted, considering that sometimes shrimp eat both types of food.

## Feed Table

This method was tested at an intensive culture farm in Zhanjiang, Guangdong Province, China, during the summer of 2009. During normal production at this farm, feed was broadcast at 6 a.m., 10 a.m., 2 p.m. and 6 p.m. Feed samples at 3% of the volume calculated from the feed table were placed in feed trays for consumption verification three hours after feeding. If the trays were empty, tray verification of the next dose was done one hour after feeding.

During that summer, temperatures ranging from 30 to 34° C made it difficult to calculate the feed dose with feed trays,

**Table 1. Expected ratios of intestine color check during intervals of feed doses.**

| Time After Feeding | Intestine With Artificial Feed | Intestine With Natural Food |
|---|---|---|
| 1 hour | Above 60% | Below 40% |
| 1.5 hours | 50% | 50% |
| 2 hours | 30% | 70% |
| 2.5 hours | 20% | 80% |
| 1 hour before next dose | Below 10% | Above 90% |

**Table 2. Results of three methods for calculating feed dose at an intensive shrimp farm in China.**

| Method | Area (ha) | Stocking Density (shrimp/m²) | Yield (kg/ha) | Weight (g) | Survival (%) | Feed-Conversion Ratio | Time (days) |
|---|---|---|---|---|---|---|---|
| Only feed table* | 0.64 | 147 | 9,797 | 16.22 | 64.2 | 2.04 | 87 |
| Feed table, trays* | 0.64 | 145 | 9,373 | 16.11 | 62.7 | 1.51 | 79 |
| Table, intestine check* | 0.64 | 146 | 10,083 | 16.73 | 64.5 | 1.23 | 70 |

*Average results for 3 ponds/treatment with similar stocking density, larvae, area and feed.

because the feed in the trays was consumed very fast, and leftovers were usually never found. This also happened when the feed dose was raised 30% above the value calculated by the feed table based on the tray readings, and when tray checking was done an hour after feeding. The quick consumption of feed by the shrimp could be explained by the fact that complete digestion of feed at 34° C can take less than one hour, according to Chalor Limsuwan.

On the other hand, when survival was affected by a Taura syndrome virus attack, the feed table became inaccurate for managing the daily feed dose because of the difficulty of determining the pond population when mortality was occurring.

## Feed Trial

A trial was carried out to compare three methods for evaluating feed consumption under these unusual situations. The ponds were grouped into those using only the balanced feed table, ponds using the balanced feed table and feed trays, and ponds using the balanced feed table and the intestine color check.

Results of the trial are shown in Table 2. The use of the feed table complemented with the intestine check proved the most effective way to calculate the daily feed dose, having the best feed-conversion rate and highest yield results of the trial.

Using the feed table alone was the least efficient method, with the highest feed conversion and longest production time, suggesting that complementary tools like the feed trays and/or intestine color check could help lower the cost of feed in the production of cultured shrimp.

At high water temperatures, feed trays were usually empty when checked one hour after feeding.

# Study: *Pangasius* Effect Frozen Fish Fillet Imports In European Union


The entry of *Pangasius* into the E.U. market changed the equilibrium for imported frozen fish fillets.

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**Summary:**
The entry of *Pangasius* into the E.U. market changed the equilibrium for imported frozen fish fillets. *Pangasius* is displacing traditional species like cod and hake. In a study, the largest levels of cointegration among species and exporting countries were found in a group including the five top non-European exporters of fish fillets to the E.U. Exports from the U.S. and Russia showed the highest level of significance in the interaction of their prices with those from Vietnam.

Frozen *Pangasius* fillets entered the European market in the early years of the new century with strong potential for growth. The volume of imports increased from 2,140 mt in 1999 to 226,950 mt in 2009, about 19% of the total volume of frozen fish fillet imports. Over the same period, yearly average prices for *Pangasius* imports decreased from 3.82 to 1.86 euros.

This rapid penetration caused shocks in the European market for imported frozen fish fillets, shifting equilibrium and changing the existing competitive relationships across species and countries.

To examine the situation, the authors performed research using cointegration with vector of error correction to study price interactions in the European Union market for imported frozen fish during the first decade of the new century. The analysis was performed at different levels and with different groups of countries and species, with a special focus on the role of Vietnamese imports in the evolution of prices.

## Study Methodology

Cointegration analysis has already been used by researchers in the field of seafood marketing. It focuses on the study of interactions among prices and quantities of a set of products to assess whether they are competing within the same market or if they can be considered differentiated products.

Quantities and values for the top 10 exporters of frozen fish fillets to the European Union were taken from the Eurostat external trade database. Local and United Nations Food and Agriculture Organization databases were used to identify the relevant species produced by each country. The countries were classified in groups according to fishing areas (North Atlantic, North Pacific and South Atlantic) and membership in specific trade areas with special agreements with the E.U. (Table 1).

Cointegration of price log series was tested with the inclusion of Vietnamese imports in all groups. Three different models were tested for each group. The first test considered only the series of the original members of each group and indicated whether the fillet exports of the involved countries were competing against each other. Lack of cointegration reflected product differentiation, and each country/species was considered as a unique market.

A second model included a Vietnamese series, testing whether *Pangasius* fillets were involved in specific markets and competing with other countries harvesting different species. Finally, a long-run analysis indicated whether the yearly prices of a country could be considered a causal antecedent to the short-term prices of the rest.

## Results

Preliminary bivariate tests were performed to specify whether the evolution of prices and quantities were following a linear or quadratic trend. Quadratic models have shown better performance in describing the evolution of prices through the years for almost all series. The prices for China, Iceland and Vietnam followed clear linear trends, ascending in the case of China and descending in the other two countries.

**Table 1. Groups of countries and relevant species.**

| Group | Countries | Dominant Species | Johansen Test (Quadratic Trend) First Test | Johansen Test (Quadratic Trend) Second Test |
|---|---|---|---|---|
| Southern Fishery | Argentina<br>Namibia<br>Chile | Hake | No cointegration | Rank = 1<br>Sig. = 0.035 |
| Northern Fishery | Faroe<br>Iceland<br>Norway<br>Russia<br>United States | Cod<br>Atlantic pollock<br>Alaskan pollock<br>Haddock | No cointegration | Rank = 2<br>Sig. = 0.010 |
| North Pacific Fishery | Russia<br>China<br>United States | Alaskan pollock<br>Tilapia | No cointegration | Rank = 1<br>Sig. = 0.036 |
| European Free Trade Association | Faroe<br>Norway<br>Iceland | Cod<br>Atlantic pollock<br>Haddock | No cointegration | No cointegration |
| Top Non-EFTA | Argentina<br>Vietnam<br>China<br>Russia<br>USA | *Pangasius*<br>Tilapia<br>Alaskan pollock<br>Hake | Rank = 1<br>Sig. = 0 | |

Effects from Vietnamese prices were also tested in an exploratory simple regression model with the *Pangasius* series as an exogenous variable. Argentina, Russia and the United States showed better performance with quadratic functions, while all others showed greater significance using linear functions. Although both models resulted in similar conclusions, quadratic models were preferred in assessing the potential effects of price cycles.

Results from the Johansen test for cointegration (Table 1) indicated that no significant relations could be established without considering the potential effects from the Vietnamese figures. But cointegration appeared when the prices or quantities of *Pangasius* imports were taken into account. This result was common to all models in which Vietnam was considered, with the only exception the European Free Trade Association countries. The special relation of these countries to the E.U. could be behind this result.

The largest levels of cointegration were found in the last group, which included the five most important non-European exporters of frozen fish fillets to the E.U. Vietnam, the second-largest exporter, was a natural member of this group. The evolutions of prices and quantities of the fillets exported to the E.U. by these five countries were reduced and explained using a single vector, which provided a common trend for equilibrium. Exports from the U.S. and Russia showed the largest level of significance in the interaction of their prices with those from Vietnam.

*Pangasius* and Alaskan pollock were the species showing the strongest interaction. Significant positive parameters in the VECM between USA and Vietnam (Table 2) suggested that both countries were following similar pricing policies with the fillets exported to the E.U. Vietnam showed the more significant relations with U.S. prices for different time lags, and the positive sign indicated that prices changed in the same way as those of Vietnamese *Pangasius*. Analysis with series of quantities confirmed substitution of different species with *Pangasius* and Alaskan pollock (Vietnam and U.S.), while these species followed similar evolutions in their trends for prices and quantities.

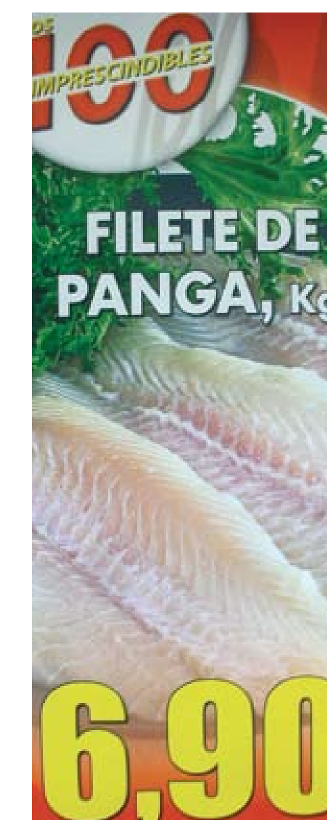
## Perspectives

The cointegration analysis verified market delimitations at a commodity level across frozen fish fillets from different species and countries of origin. Traders and consumers could be considering whitefish fillets of different species as if they were, at some level, the same undifferentiated product, which allows working with the different series as a single market.

The entry of *Pangasius* into the E.U. market changed the equilibrium in the market for imported frozen fish fillets. The evolution of prices also related to imports from Vietnam in the majority of the groups considered.

If the "law of one price" stands for this market, then the species with the most competitive prices are those that lead the evolution of the market. With increased quantities traded, *Pangasius* and Alaskan pollock are competing with the rest of the filleted fish and displacing traditional species like cod and hake in the E.U.

Part of the wild whitefish market is also being replaced by farmed species. However, wild Alaskan pollock is also contributing to substitution and has shown the potential for competing with the massive supply of farmed *Pangasius*.




Attractive pricing has allowed *Pangasius* to compete with other whitefish in Europe.

# *Pangasius* In Norway?

## *Study Finds Extrinsic Cues Influence Consumer Judgments, Purchases*

*Pangasius* offers a new seafood alternative for Norwegian consumers. Photo by Dr. Michael McGee.

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**Summary:**
In a study of Norwegian consumers asked to evaluate *Pangasius* fillets, the extrinsic cues corporate social responsibility, endorsement and country of origin had different effects on evaluative variables. Furthermore, these variables all had positive and significant effects on consumers' purchase intentions. The general conclusion was that importers of new food products like *Pangasius* can benefit from focusing on extrinsic cues when intrinsic cues are hard to evaluate or are unknown.

To a substantial number of Norwegians, the idea of importing fish from abroad seems rather strange. Since Norway is the world's 10th-largest seafood producer and the world's second-largest seafood export nation after China, it may intuitively feel somewhat peculiar to find unfamiliar imported species of fish in the frozen food departments of Norwegian supermarkets.

Anecdotal evidence suggests that while importing seafood not naturally found in the nearby habitat (e.g., canned tuna, fresh swordfish) is unproblematic, the imports that directly compete with fish traditionally found on the Norwegian dinner table are considered more peculiar. While this attitude may be due to protectionism, consumer dogmatism or consumer ethnocentrism, it raises some important challenges for the international producers of farmed fish.

In a study, the authors explored how three extrinsic cues influenced consumer judgments of a new product introduced to the food sector in Norway: frozen *Pangasius* fillets.

### Extrinsic Cues

According to usual definitions, extrinsic cues are lower-level cues that can be changed without changing the product. Examples of such cues in relation to food are the brand under which a product is sold, the image of the producer and where the product was produced. These kinds of cues are comparable to what branding literature describes as secondary brand associations, where a brand can benefit from being associated with positive sources like the country of origin, a specific distribution channel, celebrity endorsement or an event.

Unlike extrinsic cues, intrinsic cues are directly related to the product. An example could be the weight and sugar content of a chocolate bar.

Obviously, products can have a variety of extrinsic cues related to them, but the study specifically focused on three: corporate social responsibility, country of origin and celebrity endorsement. Moreover, the authors wanted to explicitly test how these cues influenced important issues like consumers' perceptions of the value and quality of *Pangasius*, as well as the effect on belief in future product success.

### Corporate Social Responsibility

The first extrinsic cue expected to influence how consumers judge new food product introductions is the corporate social responsibility (CSR) of the firm. Conceptualized as pro-social corporate endeavors, previous research indicates that negative CSR views can have unfavorable effects on product and brand evaluations, while being associated with positive CSR can result in more favorable consumer responses.

Related to the introduction of *Pangasius* in Norway, there are several reasons why an extrinsic cue like CSR would significantly impact consumer judgments. For example, several Norwegian food producers have experienced severe declines in consumer confidence and/or sales after histories of alleged fraud attempts by a dairy producer, pollution of seawater from salmon farms, cost savings leading to shockingly bad hygiene at a fresh fish producer, and *Escherichia coli* bacteria found in meat products, which actually led to the death of one young boy.

The aftermath of these stories is that CSR is given increasing weight when consumers evaluate firms. However, CSR is believed to affect mainly product popularity, not perceptions of quality and value. The reason is that in strict terms, behaving in an ethical and pro-social manner does not improve the objective quality or value of products. These facets are related to the products themselves and not to the producers' behavior in the marketplace.

## Endorsements

Consumer judgments of *Pangasius* should be affected by positive word of mouth from credible sources. The impression that consumers tend to heavily emphasize word of mouth when judging experience and credence seems to be rather accepted. Statements from chefs and other opinion leaders are typically considered credible due to the expertise of these sources.

However, while endorsements should positively influence perceptions of quality and value, the effect on product popularity is dubious. Chefs and other experts are often considered credible when it comes to the objective quality of a food product, but they are not associated with the same kind of expertise on what consumers purchase for home consumption. While the typical restaurant contains a great deal of ingredients and fresh products that the chefs would positively endorse, a significant amount of these are not commonly found in household kitchens.

## Country Of Origin

Previous studies found that a product's country of origin (CoO) significantly affects consumer evaluations of it. Of particular interest is that CoO effects seem to depend on consumers' product knowledge.

As *Pangasius* were only recently introduced to the Norwegian market, consumers' knowledge of them is naturally very low. Moreover, previous research has established that not only quality and value perceptions are affected by a product's CoO, but also the expectations of its future success.

## Study Design

To test the effects of CSR, CoO and endorsement on perceived value, quality and product popularity, the authors recruited 348 consumers to participate in the study, each randomly assigned to the eight experimental conditions.

The data were collected with a scenario-based procedure in which subjects were exposed to eight different newspaper stories about *Pangasius* imports, along with survey measures of their impression of quality, value and future product popularity. The somewhat mixed results of this experiment are portrayed in Table 1.

## Findings, Implications

These findings suggested that CSR did not influence consumer perceptions of how popular a product will be in the marketplace. While previous research found CSR supported positive consumer responses, this did not seem to be the case for expected product popularity. Knowing that product popularity is not a variable affected by CSR enables marketing managers to more efficiently measure their firms' performance on issues that really matter in relation to CSR.

Credible endorsements had a positive effect on consumer judgments of perceived quality and perceived value. While the effects of a negative/positive variation can more or less be expected by logic, the study results implied that even minor differences in the positivity of an endorser's statements have significant effects on consumer perceptions of value and quality.

For marketers, this implies that the "over selling" often seen from paid endorsers is probably not necessary. More modest statements are probably sufficient to achieve the positive outcome wanted, while also standing out as more credible than exaggerated proclamations.

Country of origin did not affect perceived quality or perceived value, but did affect expected product popularity. While the non-significant results were somewhat surprising, given the effects of CoO found in previous research, it may nevertheless be the case that the two countries used in the experiment did not evoke the sort of associations on which CoO effects rest. It may be that exposure to food products from some foreign countries does not activate a mental knowledge structure that encompasses the quality and value differences outlined in the hypotheses section.

Marketing managers who identify positive CoO associations should take actions to activate them among their target consumers. Previous research on the "attraction effect" suggested that as CoO influenced perceived popularity, it indirectly influenced choice share. By indicating their products' CoO with flags, "made in" labels or other features, marketers might benefit from the mere fact that products originating from one country are believed to gain higher levels of success than others.

The importance of CoO is further supported by the interaction between CoO and endorsement. The fact that this two-way interaction had a positive and significant effect on product popularity implied that CoO and endorsement in combination ensured both direct positive effects on quality and value; a direct, positive effect on perceived product popularity and an additional reinforcement of this effect through the aforementioned interaction. This result broadens the marketer's toolbox, as it offers additional "buttons to push."

## Carry-Over

The significant effects of the CSR/endorsement interaction may arise from different psychological mechanisms. One possibility is that CSR does not affect quality perceptions alone, but if an endorser "approves" a product, the credibility of the endorser has a carry-over effect on the judgment of CSR's importance.

Stated differently, CSR comes into play when paired with a positive recommendation from a credible source. Marketing managers could therefore combine different elements in a promotional message and achieve greater impacts on positive judgments.

## Purchasing Intention

In an attempt to complete the chain of events, the authors empirically tested how perceived quality, value and product popularity affected the consumers' intention to purchase *Pangasius*. In addition, they included variables for perceived risk and consumption habits – both of which influence the probability of adopting new product introductions – in the model.

The regression model presented in Table 2 shows that all dependent variables had a significant effect on purchase intentions. Moreover, the effects were positive for all variables except perceived risk, for which the effect was negative, as expected.

These results implied that importers of *Pangasius* and marketers have several options in their quest for successful market entries. Marketers can focus on extrinsic cues and be assured they indirectly affect purchase intentions.

Obviously, purchases are the optimal goal for marketing firms, and knowing how to influence perceptions of value and quality by focusing on extrinsic cues provides the possibility of moving promotional targets one step backward in the perceptual chain. This is important for products that hold more experiential and credence quality – for example, food products like *Pangasius*.

**Country of origin did not affect perceived quality or perceived value, but did affect expected product popularity.**

**Table 1. Effects of corporate social responsibility, country of origin and endorsement on consumer perceptions.**

| | Product Popularity | Perceived Quality | Perceived Value |
|---|---|---|---|
| **Main Effects** | | | |
| Corporate social responsibility (CSR) | 0.101* | 1.154 | 0.939 |
| Endorsement | 0.796 | 6.114 | 3.056 |
| Country of origin (CoO) | 3.448 | 0.213 | 0.357 |
| **Interaction Effects** | | | |
| CSR x endorsement | 2.047 | 3.410 | 1.282 |
| CSR x CoO | 0.008 | 0.094 | 0.596 |
| Endorsement x CoO | 3.650 | 0.386 | 1.172 |
| CSR x endorsement x CoO | 0.045 | 0.136 | 0.273 |

* F-value

**Table 2. Drivers of purchase intentions.**

| Variable | Beta | t-value | Sign. level |
|---|---|---|---|
| Product popularity | 0.345 | 4.240 | (P < 0.001) |
| Perceived quality | 0.145 | 1.804 | (P < 0.1) |
| Perceived value | 0.235 | 2.218 | (P < 0.01) |
| Perceived risk | -0.258 | -5.282 | (P < 0.001) |
| Consumption habits | 0.325 | 7.790 | (P < 0.001) |

# Moisture Retention Treatments Connected To Odors In Tilapia Fillets

Adverse effects on odor and flavor found in raw and cooked tilapia fillets suggest caution in processing the fillets with moisture-retention agents, which do not perform as expected for other fish and seafood.

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**Summary:**
An investigation into ammonialike odors in raw, cooked and frozen tilapia fillets that could result in product rejection traced the odors' source to chemical treatments related to moisture retention. Fillets exposed to treatments with pH over 9.0, with or without phosphate, exhibited the odors. Frozen storage for less than 30 days enhanced odors in products treated with phosphate-free blends with lower pH. Increasing weight gain and moisture content generally corresponded with treatments with higher pH solutions.

Earlier in 2011, buyer and regulatory complaints culminated in a study to determine the cause for unusual odors and flavors in tilapia fillets. The products in question appeared to be in good shape with firm texture and appealing muscle colors, but they emitted an off-odor when thawed or cooked.

The odor was distinct from previous complaints about earthlike or geosminlike aromas and taste that have been associated with some fish from certain pond-farming operations or locations. The odor was more ammonialike.

Eventually, commercial consequences included container shipments detained by federal inspections claiming probable product decomposition. The product was not decomposed in the classic sense due to mishandling or thermal abuse, but the fillets were judged as tainted product.

To gain further understanding of the situation, the National Fisheries Institute supported an immediate response study by the University of Florida's Aquatic Food Products Lab in Gainesville.

## Fillet Treatment

The initial intent of the study was to determine the cause of the odor. Prior exposure to moisture-retaining agents during processing was a clue. The work carefully arranged harvest of live tilapia and imported frozen samples with no previous exposure to treatments or tainted water. All samples were examined to assure no initial detection of off-odors.

These skinless fillets, both fresh and thawed, were exposed to a variety of treatments used to control moisture content during frozen storage. The treatments included typical phosphates applied as single agents or blends, a variety of so-called phosphate-free blends and a new variety of high-pH blends with and without a limited or reduced amount of phosphates. The non-phosphate blends contained combinations of carbonates, citrates, salt and other ingredients.

Overall, 15 different treatments were applied as 2.5% dips for a standard 60-minute exposure at 5° C. The fillet to dip volume was controlled at a 1:2 ratio. This mode of treatment was consistent with common commercial practice.

After each treatment, the fillets were drained, evaluated with subjective measures for odor and appearance, then individually vacuum packaged for frozen storage at -25° C. After one month of storage, the fillets were slowly thawed and judged for sensory characteristics as both raw and cooked tilapia. The assessments were conducted by a team of national and university seafood sensory experts based on standard reference profiles.

## Results

The ammonialike odors were immediately obvious in all tilapia fillets exposed to treatments with initial solution pH over 9.0, with or without phosphate components. The adverse ammonialike attributes were evident in both raw and cooked fillets, and cooking appeared to enhance detection.

Likewise, frozen storage for less than 30 days appeared to enhance the odor and flavor detection for products treated with the phosphate-free blends with solution pH less than 9.0. In this case, detection was not obvious immediately following treatments, but occurred after the frozen product was stored, shipped and/or purchased. The levels of ammonialike odors detected by sensory experts would result in probable regulatory actions to reject the products as decomposed or tainted.

In contrast, the tilapia fillets treated with phosphates alone did not develop ammonialike odors. However, these products had a very objectionable appearance and texture because the raw muscle was translucent and soft. The fillets treated with blends with lower phosphate concentrations resulted in better appearance and texture, but emitted borderline off-odors.

Depending on the treatments used, the moisture content in the tilapia fillets ranged from 76.0 to 77.0% in the control with no treatment to 81.4% with a respective gain in product weight up to 13.0%. A crude estimate would indicate a 3.0% weight gain for each 1.0% increase in moisture content. Elevated moisture content generally aligned with increasing weight gain. In general, increasing weight gain corresponded with the treatments with higher pH solutions.

## Perspectives

Adverse sensory consequences for appearance, odor and flavor of raw and cooked fillets suggest caution in processing tilapia fillets with moisture-retention agents. They do not perform as expected for other fish and seafood. Sensory problems appear more pronounced for treatments that involve additive solutions with pH in excess of 9.0.

Many of the current so-called phosphate-free and low-phosphate blends have relied on combinations of additives with elevated pH that can result in ammonialike aromas and flavors. These treated products would be objectionable to consumers and potentially subject to regulatory rejection and penalties for apparently decomposed products.

Detection of treatments without required labeling for additive use could result in additional penalties and buyer rejection. The reputation of an emerging, favorite seafood selection could be in jeopardy unless firms and buyers apply appropriate controls.

*Editor's Note: This work was conducted by the authors with support provided through NFI's scholarship funds. A full report can be obtained from Barbara Blakistone at the National Fisheries Institute, bblakistone@nfi.org.*

# Off-Flavors In Aquacultured Products

## *Part III: Effects Of Feeds, Processing, Storage*

Off-flavor compounds that result from lipid oxidation can be reduced through proper packaging that restricts oxygen transfer, low storage temperatures and reduced storage time.

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**Summary:**
Increasing the lipid content in aquafeeds results in an increased level of n-6 fatty acids in fish muscles that can contribute negatively to aromas. Off-flavor compounds produced by low-molecular-weight amine compounds normally present in fish are further degraded into ammonia or other nitrogenous compounds during storage. Gutting also affects flavor. Off-flavors can be reduced through packaging that restricts oxygen transfer, incorporation of antioxidants, low storage temperatures and reduced storage time.

A current trend in fish production is to increase the lipid content in diets to spare proteins, improve feed conversion and decrease the amount of waste produced by the fish. The fatty acid composition of fish muscle tissues reflects that of the diets given to the fish.

Diets containing higher amounts of n-6 fatty acids are responsible for an increased level of n-6 fatty acids in the fish muscles. Consequently, an increase in the relative amount of n-6-derived volatile aldehydes will be produced.

These compounds are generally thought to contribute negatively to the general aroma of fish muscle. Consistently, sensory results show a high value for the off-flavor effects of a high n-6 fatty acid diet.

### Lipid-Derived Volatiles

Farming of carnivorous fish has traditionally required large quantities of fishmeal and oil. There is less and less availability of these materials, however, so the use of diets containing vegetable-based alternatives continues to increase.

Many odor-active compounds in the muscles of fish fed plant-based diets result from unsaturated fatty acid oxidation, particularly of aldehydes and alcohols. Aldehydes are probably the most interesting of the lipid-derived volatiles, since they have low odor thresholds.

The most easily perceived volatiles are two unsaturated alcohols *(E)*-2-penten-1-ol and *(E)*-2-hexen-1-ol. Both impart a strong mushroom-like odor. *(E)*-2-hexen-1-ol and *(E)*-2-hexanal exhibit a moss-like odor in fish. *(E,Z)*-2,6-nonadienal has a strong odor like cucumbers, which has been isolated in most seafood products. A grass-like odor observed in fish and crawfish has been related to *(E)*-2-pentenal.

### Off-Flavors From Processing

Several aroma-active compounds in cooked rainbow trout, *Oncorhynchus mykiss*, have been identified as responsible for eliciting off-odors. The compounds were identified as *(E)*-2-nonenal, 2-ethyl-1-hexanol, 2,-methylnaphthalene and 8-heptadecene.

Odor defects in boiled cod, *Gadus morhua*, during storage were related to trimethylamine, butane-2,3-dione, methylpropanal, *(Z)*-3-hexenal, *(Z,Z)*-3-6-nonadienal, and 2- and 3-methylbutanal. In trout, *Salmo fario*, stored at -13° C, cetaldehyde; propionaldehyde; butane-2,3-dione; pentane-2,3-dione; and $C_6$, $C_8$ and $C_9$ carbonyl compounds caused odors.

### Off-Flavors From Storage

Some of these off-flavor compounds are produced by low-molecular-weight amine compounds that are normally present in the fish. During storage, they further degraded into ammonia or other nitrogenous compounds that impact flavor.

Other off-flavor compounds are produced from lipid oxidation during frozen storage. The compounds responsible for unacceptable flavor can be reduced through packaging that restricts oxygen transfer, incorporation of antioxidants, low frozen storage temperatures and reduced frozen storage time.

Fish diets that contain higher amounts of n-6 fatty acids have more volatile aldehydes that contribute to off-flavors.

The volatile compounds produced during the spoilage of cold-smoked aquacultured fish have been traced to various bacteria. The *Lactobacillus* group released large amounts of volatile compounds such as acetic acid, ethyl acetate and n-propyl acetate. Also, dihydrogen sulfide was detected.

The other genus of lactic acid bacteria, *Carnobacterium piscicola*, produced 2,3-butanedione and 2,3-pentanedione, which produce a strong buttery odor. Because these volatiles are not particularly unpleasant, most consumers do not regard the product as spoiled. *Brochothrix thermosphacta*, which usually occurs in low numbers, produces higher amounts of 2-heptanone and 2-hexanone. These two compounds produced a spoilage odor similar to blue cheese.

Gram-negative bacteria produced high levels of volatile compounds such as trimethylamine, disulfide dimethyl, 2,3-butanediol and 2-pentanol. These compounds are often associated with amine, dirty sock or dishcloth odors. *Shewanella putrefaciens* produced trimethylamine, trimethylamineoxide and disulfide dimethyl.

Gutting has effects on the sensory properties of cod, hake and other gadoid fish. The gutting process noticeably increases the development of Gram-negative bacteria. In studies, counts of *Enterobacteriaceae, Shewanella putrefaciens* and *Psewudomonas* throughout ice storage were higher in gutted than ungutted samples. The differences in microbial loads were also reflected in lower sensory scores for both raw and cooked fish.

The off-flavors were due to the accumulation of trimethylamine, as well as elevated concentrations of putrescine, cadaverine, tryamine and histamine. The effects of these chemical changes showed that gutting may subject some fish to more rapid deterioration during ice storage, decreasing shelf life by four days.

The metabolic activity of several species of *Carnobacterium* was studied in cooked and peeled shrimp packaged in a modified atmosphere at 5° C. The bacteria contributed to the spoilage of the shrimp through the production of ammonia, tyramine, various alcohols, aldehydes and ketones. Two ketones – [5*Z*,8*Z*,11*Z*]- and [5*E*,8*Z*,11*Z*]-tetradecatriene-2-one – were recently reported as being responsible for the characteristic aroma of seafood products and also closely related to the flavor of cooked crustaceans.

## Perspectives

The prevention of off-flavors in fish can be controlled to some degree through the implementation of good manufacturing practices. Using quality feeds and raising fish in high-quality waters free of chemical contaminants from biological, industrial or domestic sources are the first steps in the production of fish having high sensory acceptability.

Proper freezing procedures, as previously mentioned, retard many of the undesirable changes that occur during storage. Care of the product from harvest through consumption limits product degradation resulting from undesirable extrinsic changes due to bacterial decomposition and intrinsic, primarily enzymatic changes. It is impossible to eliminate many undesirable changes responsible for off-flavors, but they can be controlled so that consumers receive high-quality products.

*Editor's Note: Part I of this series discussed the effects on aquacultured products of off-flavors caused through the biological production of geosmin and 2-methylisoborneol. Part II addressed the effects of environmental and endogenous factors on unacceptable flavors in fish, crustaceans and mollusks.*

# Tracking Traceability In Seafood

Conferees at the Traceability Research Summit strongly supported further collaboration with FDA in establishing traceability standards for the food industry.

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**Summary:**
Product traceability is an essential food safety mechanism. The new Food Safety Modernization Act challenges the entire seafood value chain to prepare for recalls when food causes adverse health consequences. GS1's Global Traceability Standard requires unique identification of trading partners, products and shipments, as well as date, time and location data. Although issues of interoperability remain, progress in global standardization has improved supply chain efficiency, inventory control, sustainability and consumer confidence.

The National Fisheries Institute (NFI) and Global Aquaculture Alliance are two seafood trade organizations committed to employing sound traceability practices as a food safety tool. The new Food Safety Modernization Act (FSMA) insists that seafood producers, processors and everyone in between be prepared for a recall when there is a "reasonable probability that an article of food will cause serious adverse health consequences," to borrow the U.S. Food and Drug Administration's (FDA) language.

NFI not only supports traceability efforts, but has pioneered them, propelling the seafood community to serve as a leader and model in both domestic and international traceability efforts. NFI's latest work provides guidance on the new world of traceability based upon industry-identified best practices. The debut of "Traceability for Seafood, U.S. Implementation Guide" at the International Boston Seafood Show in March demonstrated NFI's commitment to traceability. Rather than taking a reactive stance, NFI created the guidelines in anticipation of the FSMA traceability requirements.

NFI's traceability guide is not a document created in isolation but is based upon two important publications: the Institute of Food Technologists (IFT) 2009 report on work for FDA's Center for Food Safety and Applied Nutrition titled *Traceability (Product Tracing) in Food Systems* and the June 2010 *Traceability for Meat and Poultry, U.S. Implementation Guide.* FDA commissioned IFT to undertake a major study of product tracing – both forward and backward – over two years before FSMA became law. This signaled to the food industry that FDA was very concerned about the ability to trace products through the food system.

## Commitment To Traceability

The seafood community's commitment to traceability is not only seen in its writings but through its actions. According to NFI, the *Traceability for Seafood, U.S. Implementation Guide* has already been downloaded over 900 times since its March release – almost 10 times a day.

The document endorses GS1's Global Traceability Standard as the accepted method to uniquely identify trading partners (farms, vessels, suppliers, customers, third-party carriers), trading locations (ponds, vessels, warehouses, receiving docks), the products a company uses or creates, the logistics units a company receives or ships, and inbound/outbound shipments. Date, time and location are the basic data needed to mark a species or value-added product from capture to consumer.

The action FDA will take as a result of the FSMA is still unclear. However, NFI is confident that the proactive approach described in the guide represents the best practices going forward for the seafood community.

## Recent Traceability Summit

In an effort to continue this positive momentum, in July, IFT invited traceability leaders from across the spectrum to its Traceability Research Summit in Arlington, Virginia, USA. The summit offered presentations, but the real value to conferees was the workshops that provided important discussion on product tracing and its future. The summit was so successful that those present agreed continued collaboration was crucial for presenting FDA with tracing standards prepared by the food industry for the food supply chain. FDA has already hinted that the agency is impressed with the current initiatives within the food industry.

Participants in the summit had homework to do before the July 14 meeting. They were asked to fill out a survey requesting their opinions on the state of traceability in the next one, five and 10 years. Representatives from trade associations and government were notably conservative in their predictions, but the industry boldly predicted rapid progress in its immediate future.

All of seafood, with the exception of smaller operations, is projected to be able to respond to FDA through some form of electronic communication with data for a recall from an implicated facility within two hours by 2021. The NFI guide allows for human-readable data collection until 2015, when it recommends machine-readable data to be fully implemented.

## Trace Systems

Traceability programs are presently operating in over 75% of the seafood industry, but most need 16 to 24 hours for a complete traceback.

Over 400 hatcheries, farms and processing plants are certified under the Best Aquaculture Practices program, which requires an online traceability plan through Trace Register or chain-of-custody records for traceability verification. GAA's process requires facilities to have records reviewed by third-party auditors as part of their initial or renewal certification audits. The adoption of chain-of-custody verification as an alternative to participation in online traceability will provide a more achievable option for many farms.

The existing Reportable Food Registry (RFR) at FDA is a possible and logical host for tracing information associated with a recall. The RFR is an electronic portal for industry to report when it is reasonable to think a product will cause serious adverse health consequences. The RFR applies to all FDA-regulated categories of food and feed, except dietary supplements and infant formula.

At the IFT summit, some believed that the factors holding the industry back from 100% compliance were the mix of business information technology infrastructure and lack of interoperability, while others listed costs, lack of measurable benefits and lack of regulations as problem areas. Moving the traceability initiative forward, however, are global standardization and collaboration among governments as the benefits of supply chain efficiency, inventory control, support to sustainability requirements and consumer confidence are recognized by the industry.

## Need For Interoperability

As noted above, a key to tracing is making sure one electronic system can talk to another. This is the focus of another part of IFT's initiative in understanding and enhancing the traceability of products.

The summit attendees predicted that by 2016, 50% of the supply chain will be participating in an interoperable system. To make this a reality, IFT is continuing research on how existing systems can be adapted to facilitate tracing within the industry.

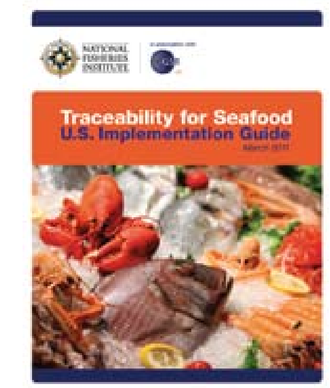
The report of phase 1 of IFT's work, funded by the National Center for Food Protection and Defense (NCFPD), will be available on its website in August. Funded by the NCFPD and IFT's Traceability Improvement Initiative (of which NFI's Fisheries Scholarship Fund is a funding partner), phase 2 of the work will assess three commercially available product-tracing systems and prototype an interoperable architecture to be used with a plant, suppliers and recipients in a supply chain in a mock recall situation.

A seafood processor has already offered to be the model for industry-supplied data used to determine if the interfaces between existing systems are sufficient to trace a product.

## Perspectives

Inarguably evident in the world of commodities is the emerging leadership of seafood. With its history and experience with FDA's Hazard Analysis and Critical Control Point program as the time-honored tool of food safety – and now the NFI's traceability guide as a tool for recalls – the seafood community is a voice to which the entire food industry should listen.

While it certainly helps that seafood has been implementing its own traceability techniques, it is also reassuring that traceability efforts will continue as NFI takes its place on the advisory panel for IFT's Traceability Improvement Initiative, work that is of keen interest to everyone in the food industry.




The proactive measures in NFI's guide represent best practices for the seafood community.

# Feeding The World In 2050

## *Huge Food Projections Point To Sustainable Aquaculture*

Present scenarios of demographic growth, consumption and availability of food resources reiterate the importance of aquaculture in contributing to human development with high-quality aquatic food.

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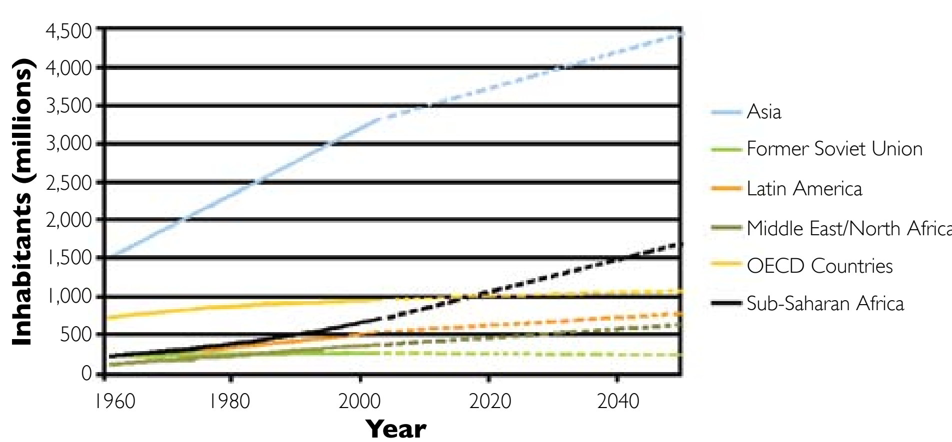
**Summary:**
Global population is expected to reach 9 billion by 2050, with regions like Sub-Saharan Africa increasing exponentially in population. To support projected food demands, production must rise an estimated 70% above current values. Efficient utilization of feed-grade nutrient sources and their conversion to nutritious aquatic food will be essential. Aquaculture can play a key role in raising food in limited space, but changes in climate and other areas should be considered at physical, human and resource levels.

The current global population of 6.7 billion is expected to show continued growth until 2050, reaching 9 billion at moderate forecasts. However, relative population numbers also tend to shift among different world regions. Developing countries will likely hold a higher share of inhabitants, with Asia and Sub-Saharan Africa accounting for over 60% of the global population (Figure 1).

The Food and Agriculture Organization (FAO) of the United Nations recommends that 3,000 kcal/day should be available per person in any population to guarantee that each individual has sufficient healthy food. Regional food availability, an approximation of food consumption, currently ranges from 2,366 kcal/person/day in Sub-Saharan Africa to 3,955 kcal/person/day in Organisation for Economic Co-operation and Development (OECD) countries. In Asia, whose population today reflects over 50% of the global total, food is currently available at an average 2,793 kcal/person/day.

Food security premises suggest equally shared food availability among regions. This may be especially important in the next decades under a changing panorama of population growth and distribution.




Sources: FAOSTAT (1961-2003), UNSTAT (2050), Agrimonde (2005)

**Figure 1.** Current and projected global population trends.

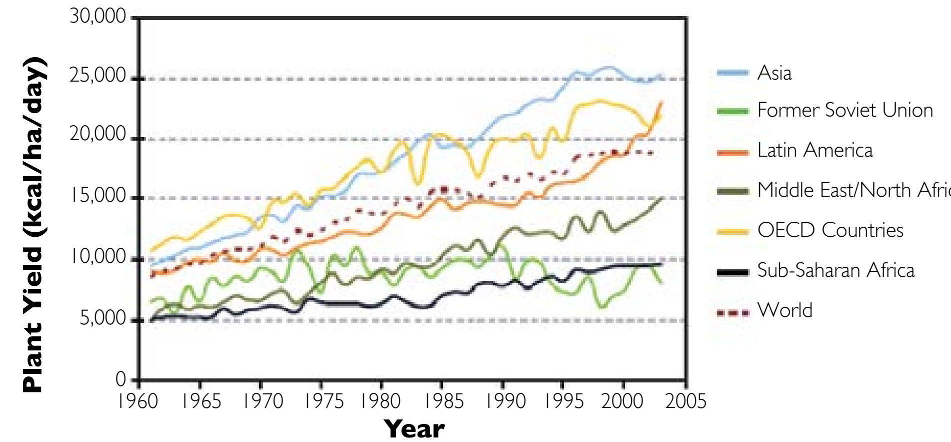
Given current food production trends, availability may be particularly critical for areas of Sub-Saharan Africa and Asia.

### Food And Feed Resources

Future scenarios of increasing global population will require effective increases in food availability. The general food production necessary for attending population demands in 2050 has been estimated by FAO at an additional 70% of the current produced volume. This is expected to be accomplished by both expansion of productive frontiers and increases in food production efficiency per farmed area. These strategies may obviously be limited by spatial and technological constraints.

In spite of the rise in production efficiency verified in such regions as Latin America, the Middle East and North Africa, average global food yields per hectare have remained stable in the last 10 years (Figure 2). Facing the projections for human food demand, alternatives will be very necessary to meet regional needs.

Animal feed represents an additional component in the balance between produced and available food. Nearly 50% of total food resources is estimated to be channeled into animal feeds, and with increased rates of global meat consumption, additional pressure over available food sources are expected to attend the farming systems.




Sources: B. Dorin, Agribiom, Agrimonde (2009)

**Figure 2.** Regional plant food yields per hectare of cultivated land.

According to projections, the current annual meat production of 228 mmt should be doubled in 2050 to meet expected global consumption that would put further pressure upon the availability and price of grain raw materials for feed manufacturing. Adjusting for the huge population increments in food-deficit countries would include the access to near-food-grade raw materials, some of which are currently used for animal feeds. Furthermore, farmed meat production may be challenged by its limited efficiency in food transformation, with reported averages of 7:1 and 4:1 feed energy efficiency ratios of plant feed sources to cattle and swine/poultry production, respectively.

Another essential fact in the panorama of global availability of food resources is nutrient wastage. Up to an estimated 30% of global food production is not channeled for nutrition purposes. From the global average of 4,800 kcal/day/person food produced, 600 and 800 kcal are lost in the production fields and in the processing and distribution chains, respectively. Increasing output efficiency in food chains can contribute to valuable extra supplies of food and feed resources for the growing human population.

### Challenges, Opportunities For Sustainable Aquaculture

According to FAO, fish and shellfish are among the main animal proteins consumed globally. However, the availability of these high-quality nutrient sources has, for a long time, not depended exclusively on the capture of wild stocks. Considering FAO estimates of an average annual seafood consumption at 17 kg/person, predicted food fish demand would increase from the present 120 to at least 220 mmt in 2050, with aquaculture expected to provide over 70% of the total volume required.

Present scenarios for demographic growth, consumption and availability of food resources reiterate the importance of aquaculture in contributing to human development with high-quality aquatic food. Aquaculture may see opportunities to increase its consistency as an alternative protein source within the global food supply system. On the other hand, to provide a sustainable supply of aquatic food, aquafarming should include a variety of sound practices.

## Raw Materials, Energy

Future trends suggest increased utilization of some types and grades of aquafeed raw materials in human food. Therefore, feed manufacturing could largely depend on lower-grade raw materials – including those recovered from crop wastes – that may be improved by processing and biotechnological transformation into consistent nutrient sources for farmed species.

This variety of available raw materials with different qualities and costs would further require strategic diversification in feed formulation and processing strategies to allow manufacturers flexibility according to availability and cost-benefit relationships.

An additional contribution to increasing food efficiency is related to the energy expenditures of farmed species. Farming aquatic animals may represent a way to increase nutrient and energy-transfer efficiency from available raw materials into meat. Farmed aquatic animals may convert feed energy at significantly higher efficiency – down to 2.5 calories feed/calorie seafood – than their terrestrial counterparts, at 7:1 and 4:1 for bovines and swine/poultry, respectively. Under current perspectives, increased efficiency in the utilization of feeds and feed ingredients may be a necessity for better and fairer use of food resources in farming systems.

## Water Resources

Aquaculture can play a key role in adding quality food relative to the space limitations recognized for terrestrial farming. Expansion as well as creation of new aquatic-farming frontiers through responsible practices may be feasible in most countries through application of conventional species and rearing techniques.

Freshwater farming in ponds and available water bodies has been identified as a water-saving food production system. Mariculture of plants, filter-feeding and fed aquatic organisms may be expanded over vast available coastal and even offshore areas worldwide to produce several types of seafood.

Moreover, the possibility of exploring the three-dimensionality of water environments may provide additional efficiency for aquafarming systems in available space. Aquaculture may improve food security in food-deficit countries via the rearing of low-cost species in rather simple farming systems.

## Changes Coming

As with any farming system, aquaculture can be directly or indirectly affected by climate change, extreme weather events and seasonal, as well as long-term conditions. Recognition of the potentially changing global climate and its effects upon the environment will be an important step in planning the future development of aquaculture.

This may involve flexibility in species choice, rearing practices, scale and market relationships. With some uncertainty remaining over specific climate changes, continued improvement of aquaculture practices to maximize outputs during successful crops may be an important input for climate change adaptations. This should be further combined with financial analysis through forecasts of regional and global trends.

Available records from commercial aquaculture practices over relevant time periods could also be compiled and related to environmental data in order to check for possible relationships, trends and predictions. Consistent supplies of aquatic food via aquaculture development could then be proposed in agreement with global changes at physical, human and resource levels.

U.S. shrimp imports from Mexico were up sharply in June, but seasonal production will not show up in earnest until September.

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**Summary:**
Overall U.S. shrimp imports rose about 18% from May to June, but value-added imports were up. Vietnamese white shrimp imports continued higher, with black tigers limited. June's YTD figures for fresh whole salmon showed continued decreases in imports. With imports from Chile 68.6% higher, the country is regaining market share from Norway. Imports of frozen whole tilapia increased 42.3% since May, but were still down YTD. Frozen tilapia fillet imports jumped in June, but the market continued to drop gradually through August. Given the large growth of *Pangasius* imports, prices have slid. However, the undertone in mid-August was generally steady.

# Peeled, Cooked Imports Up, HLSO Shrimp Down YTD

June shrimp imports to the United States were down 3.7%, leaving year-to-date (YTD) imports up only 1.9% (Table 1). Imports from Thailand were down slightly in June, as were imports from Ecuador. Vietnamese imports continued higher, likely due to increased production of white shrimp. Likewise, imports from India continued up sharply from a year ago. Mexican imports for June were up sharply, but seasonal production will not show up in earnest until September.

Led by India, June imports of headless, shell-on (HLSO) shrimp including easy-peel were up sharply for 16-20 and 21-25 shrimp. Imports of most other count sizes were lower. In fact, HLSO imports were down 17.5% in June and about even on a YTD basis. Peeled imports were generally higher. Thailand supplies the bulk of peeled shrimp, but a significant increase in peeled imports came from Indonesia, Vietnam and India. Cooked shrimp imports were slightly higher in June and about even YTD. Breaded shrimp imports were higher in June and also somewhat higher YTD.

## Shrimp Market

Latin American HLSO shrimp are currently mostly steady. Inventories are reported generally light, and June imports were supportive of that indication. In recent weeks, the market had seen some weakness due mostly to a seasonal lull in demand. That quiet demand will likely continue into September as vacations come to a close and U.S. schools reopen. The outlook for this market is unsettled.

Asian white HLSO shrimp with counts of 16-20 and 21-25 have been weak and generally under selling pressure as imports from India dominate offerings. Replacement offerings of Indian shrimp have also trended lower, putting further pressure on inventories. There have also been some limited offerings of 26-30 count shrimp. Smaller-count shrimp have been generally steady, with much of the Asian raw material destined for value-added product.

In addition, value-added offerings of 16-20 through 26-30 shrimp have seen some weakening with pressure from Indian offerings. The balance of the value-added white shrimp market has been steady. Asian offerings will likely see a seasonal increase. However, most report that current U.S. inventories are light. Buying interest is mixed, especially given the uncertain economic situation, so the outlook here is possibly steady but also unsettled.

## Black Tiger, U.S. Shrimp

Black tiger shrimp are generally full steady with some stronger offerings noted for a generally tight supply. Supplies from Vietnam are particularly limited and not expected to improve until late this year. Indian supplies appear adequate.

The Texas commercial shrimp season opened on July 15, and boats have reportedly been returning with good landings and wide size distribution. As a result, a weak trading environment has developed across all sizes of HLSO brown shrimp.

In white shrimp, further weakness was noted in U15 through 21-25 shrimp. Slow sales and the fact these reportedly comprised the bulk of the catch contributed. Conversely, smaller counts have been full steady to firm amid a declining supply situation. The 61-70 and larger-count peeled shrimp continued to strengthen as a result of still-limited inventories. 71-90 and smaller-count shrimp were weak.

**Table 1. Snapshot of U.S. shrimp imports, June 2011.**

| Form | June 2011 (1,000 lb) | May 2011 (1,000 lb) | Change (Month) | June 2010 (1,000 lb) | Change (Year) | YTD 2011 (1,000 lb) | YTD 2010 (1,000 lb) | Change (Year) |
|---|---|---|---|---|---|---|---|---|
| Shell-on | 35,383 | 32,783 | 7.9% | 42,836 | -17.4% | 193,098 | 194,646 | -0.8% |
| Peeled | 37,530 | 30,414 | 23.4% | 35,421 | 6.0% | 187,581 | 169,058 | 11.0% |
| Cooked | 14,948 | 10,787 | 38.6% | 14,919 | 0.2% | 81,255 | 89,640 | -9.4% |
| Breaded | 8,603 | 7,710 | 11.6% | 7,088 | 21.4% | 45,274 | 43,330 | 4.5% |
| Total | 96,997 | 82,193 | 18.0% | 100,698 | -3.7% | 510,221 | 500,577 | 1.9% |

Sources: U.S. Census, Urner Barry Publications, Inc.

Chile continues as the top source for U.S. salmon imports.

# Whole Salmon Imports Continue Down, Fillets Up 2%

June's YTD salmon imports to the United States continued the year 2.5% lower than year-ago levels (Table 2). Fresh whole fish imports saw YTD figures decrease 10.5%. Fresh fillet imports were 2.2% up from 2010 YTD levels. Total month-to-month data showed a decrease for June of 11.2% when compared to May's imports.

## Whole Fish

June's fresh whole fish YTD figures revealed continued decreases – 10.5% below June 2010 YTD figures. Month-to-month data showed a decrease of 9.0% since May, as well. Comparing June 2011 to June 2010, there was a 8.6% decrease. Canadian imports were 13.4% lower YTD and slightly lower month to month.

The Northeast whole fish market through July and early August was barely steady to weak for smaller fish. Supplies were full adequate to ample with whole fish continuing to come into the U.S. market from all parts of the world. Demand was quiet to fair at best, and the undertone was unsettled for the smaller fish. Mid-to-larger whole fish were steady to firm; supplies were adequate to barely adequate for a moderate demand. All sizes were at or below their three-year price averages.

The West Coast market was barely steady to weak through July and continued to be weak on smaller fish at the beginning of August. Supplies were fully adequate to ample for a dull demand. Larger fish, on the other hand, were full steady to firm. Supplies were light for a moderate demand. Like the Northeast market, all sizes were well above their three-year averages.

## Fillets

U.S. imports of fresh salmon fillets continue with Chile the top importer and Norway number 2. During June, Chile exported 7.3 million lb, while the combination of Norway, Faroe Islands and Canada exported around 3.2 million lb.

Overall, June YTD levels were 0.4% lower than year-ago levels with month-to-month data indicating 9.5% lower numbers. Chile was 68.6% higher YTD when compared to YTD 2010. Norway's YTD levels were 60.5% lower than 2010 YTD, while Canada's levels were 27.7% lower YTD.

The Chilean fillet market, like the whole fish markets, was barely steady to weak from around Memorial Day through the first few weeks of August. The market has seen some volatility, and the undertone is about steady. Supplies are adequate to fully adequate for a quiet to dull demand. All Chilean fillets, however, are well their above three-year averages.

The European fillet market is about steady to weak, and demand is dull. Since late May, market prices have dropped U.S. $1.60 on 2- to 3-lb C-trim fillets.

**Table 2. Snapshot of U.S. salmon imports, June 2011.**

| Form | June 2011 (lb) | May 2011 (lb) | Change (Month) | June 2010 (lb) | Change (Year) | YTD 2011 (lb) | YTD 2010 (lb) | Change (Year) |
|---|---|---|---|---|---|---|---|---|
| Fresh whole fish | 14,059,826 | 15,457,096 | -9.0% | 15,386,867 | -8.6% | 92,868,464 | 103,723,348 | -10.5% |
| Frozen whole fish | 386,019 | 173,842 | 122.1% | 625,893 | -38.3% | 2,423,911 | 2,730,705 | -11.2% |
| Fresh fillets | 12,560,113 | 13,948,072 | -10.0% | 11,479,257 | 9.4% | 71,444,238 | 69,912,892 | 2.2% |
| Frozen fillets | 11,103,793 | 13,320,522 | -16.6% | 13,106,196 | -15.3% | 66,885,658 | 63,155,101 | 5.9% |
| Total | 38,109,751 | 42,899,532 | -11.2% | 40,598,213 | -6.1% | 233,622,271 | 239,522,046 | -2.5% |

Sources: U.S. Census, Urner Barry Publications, Inc.

# Fresh Tilapia Imports Firming, Frozen Fillets Recovering?

Traders have reported the market for frozen tilapia fillets has gained support, and prices remained steady as of mid-August.

The frozen fillet tilapia market has gained more stability after months of holding a bearish undertone. The fresh tilapia market, on the other hand, firmed slightly on larger-sized fillets due to short supplies.

## Frozen Whole Fish

In June, U.S. imports of frozen whole fish increased 42.3% from the previous month, but when compared to the same month a year ago, this figure was 25.7% lower (Table 3). On a YTD basis, imports were 15.5% lower.

## Fresh Fillets

In regard to the suspect figures for imports from Costa Rica, a discrepancy in official figures from the U.S. Census Bureau was found. As one would expect, a drop of more than 1 million lb would have most certainly caused a supply shock. While holding everything constant, Economics 101 theory would have indicated skyrocketing prices.

This didn't happen, and no supply shortage was reported. However, when looking at the official import figures for fresh tilapia fillets and "Marine Fish NSPF Fillet Fresh," Urner Barry found drastic changes from their historical behavior. Hence, one could assume that these figures could have been potentially entered incorrectly to their pertaining commodity code.

When computing these figures with the assumed error, imports were 8% higher on a YTD basis. However, since these figures are hard to prove, an appropriate assessment was not possible, since the market firmed on larger fillets, while smaller ones remained steady through August.

## Frozen Fillets

Although imports of frozen tilapia fillets increased dramatically from the previous month, June figures showed that these were 24% lower when compared to the same month a year ago. On a YTD basis, imports of frozen fillets were about 10% lower. The market continued to drop gradually through August. However, many traders reported the market gained some support, and prices remained steady as of mid-August.

It is important to take into account that when replacement costs go up, these do not always translate into higher prices in the U.S. market. In other words, the U.S. market might not absorb the higher costs induced by factors other than supply and demand. In this case, while holding everything else constant, rising replacement costs would reduce the importers' selling margins.

**Table 3. Snapshot of U.S. tilapia imports, April 2011.**

| Form | April 2011 (lb) | March 2011 (lb) | Change (Month) | April 2010 (lb) | Change (Year) | YTD 2011 (lb) | YTD 2010 (lb) | Change (Year) |
|---|---|---|---|---|---|---|---|---|
| Frozen whole fish | 6,976,902 | 4,902,881 | 42.30% | 9,398,605 | -25.77% | 37,170,970 | 44,004,910 | -15.53% |
| Fresh fillets | 3,523,320 | 3,548,409 | -0.71% | 4,126,686 | -14.62% | 25,789,363 | 27,653,553 | -6.74% |
| Frozen fillets | 21,176,454 | 16,598,489 | 27.58% | 27,913,222 | -24.13% | 127,699,028 | 142,246,343 | -10.23% |
| Total | 31,676,676 | 25,049,779 | 26.45% | 41,438,513 | -23.56% | 190,659,361 | 213,904,806 | -10.87% |

Sources: U.S. Census, Urner Barry Publications, Inc.



On the frozen fillet market, for example, replacement costs went up close to 28% from September 2010 to January. The factors were floods, higher costs and limited production, among others. As a result, importers raised prices in the U.S. to offset these costs by passing them along the distribution chain.

During this time, prices went up 21%. Thereafter, and as many importers reported, trading activity in the U.S. wound down, as high prices discouraged both importers and U.S. buyers. Given this situation, and the fact that replacement costs were still relatively high, importers reduced their orders from overseas, and many kept offering levels in the U.S. high in order to control inventory movement. Since April, offering levels from China have come off considerably as exporters try to reignite buying interest in the U.S. Heavy harvesting has taken place since May.

# U.S. Demand For *Pangasius* Continues Expansion

## Channel Catfish

According to U.S. Census data, U.S. imports of channel catfish were nil in June. This brought total YTD imports to 2.6 million lb. As a result, the market continues short and unquoted due to limited availability.

## *Pangasius*

Imports of frozen *Pangasius* fillets to the United States declined 11.1% when compared to the previous month. However, when compared to the same month a year ago, imports showed an increase of 51.4%.

Given the large growth of imports, prices have slid slightly since then. However, the undertone in mid-August was generally steady.

The *Pangasius* market had a bearish undertone through the end of July. However, the situation changed, and the market gained stability, according to many traders. In general, one can safely affirm that demand for *Pangasius* has been expanding, given the large growth of imports while holding all other factors constant.

**Table 4. Snapshot of U.S. catfish imports, June 2011.**

| Form | June 2011 (lb) | May 2011 (lb) | Change (Month) | June 2010 (lb) | Change (Year) | YTD 2011 (lb) | YTD 2010 (lb) | Change (Year) |
|---|---|---|---|---|---|---|---|---|
| *Pangasius* | 14,302,276 | 16,087,156 | -11.10% | 9,444,268 | 51.44% | 79,325,150 | 51,960,464 | 52.66% |
| Channel catfish | – | 84,037 | -100.00% | 473,372 | – | 2,664,321 | 8,188,464 | -67.46% |
| Total | 14,302,276 | 16,171,193 | -11.56% | 9,917,640 | 44.21% | 81,989,471 | 60,148,928 | 36.31% |

Sources: U.S. Census, Urner Barry Publications, Inc.

# Floating Closed Containment

## *Sustainable, Economically Efficient Solution For Finfish Culture*

Solid-wall tanks are towed into position and "sunk" to a defined level. Safety and bird protection fence and netting are often added.

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**Summary:**
Floating, solid-wall culture systems that incorporate low-pressure pumping, oxygen supplementation, solid-waste separation and efficient feed management offer a variety of benefits over net pens. Fish are protected from predators and some diseases through segregation from wild animals. Solid waste impacts are limited by containment. The floating enclosures can be sited close to markets. Capital costs are greater than those for net pens, but operating costs are more than offset through feeding efficiency gains.

In recent decades, seafood production has reached a point of maximum sustainable yield. For many species, including salmon, Atlantic cod and tuna, wild catches have declined due to overfishing and habitat destruction.

Aquaculture has grown to fill the widening gap between supply and potential demand, and almost half of global seafood demand is now provided from intensive aquaculture production. Aquaculture has problems of its own, though.

Ocean water quality is not always consistent or optimal for fish growth, and wastes from net pen fish farms can harm the environment. Moreover, net pens are very transparent to interactions between the farmed fish and wild aquatic life. Predators become persistent in seeking ways to attack the fish, and toxic plankton drift into the pens, often killing entire groups. Wild fish, drawn by uneaten feed drifting through the porous walls and floors of the net pens, can exchange parasites and diseases with the farmed fish.

### Closed-Containment Aquaculture

A consistent, optimum rearing environment can be provided by land-based recirculating aquaculture systems, also called RAS systems. These facilities include screens to remove waste solids, biological filters to consume dissolved wastes, ultraviolet lights to kill viruses and harmful bacteria, and gas exchangers to remove carbon dioxide and add oxygen. In short, RAS systems consistently provide a man-made equivalent to all the beneficial services provided by nature in the wild environment, but without the plankton, predators and diseases.

These services come at a steep cost, however. Land-based RAS systems are expensive to build, require constant attention by highly skilled operators and consume large amounts of electrical energy.

### Enclosed Culture

AgriMarine Industries began operating closed-containment aquaculture in 2000 at a land-based site in British Columbia, Canada. After experiencing firsthand the costs and equipment challenges of that system, the company went "back to the drawing board" to reconsider the costs and benefits of each component of the idealized RAS system.

The analyses showed that some services, such as solid waste removal, steady current and dissolved oxygen, cheaply provide great benefits to farmed fish and the surrounding waters. Dissolved solids and carbon dioxide removal can, within reasonable limits, be safely borne by the environment.

The design solution is a "middle way," a floating, solid-walled enclosure with an innovative low-pressure pumping system, supplemented oxygen and integrated solid-waste separation that draws clean, plankton-free water from the depths beneath the farm site. More importantly for the bottom line, the design is scalable.

The floating enclosures are cheaper to build than land-based tanks, and can be made spacious enough to contain the thousands of tons of fish typically grown by modern aquaculture operations. Where land-based RAS systems typically function as suppliers to specialty markets, the floating tanks can be feasibly adopted on a global scale.

### General Layout

The general layout of an AgriMarine floating solid-wall farm resembles a conventional net pen farm. The "tanks" are



This six-tank facility in China operates summer and winter in a freshwater reservoir. During cold periods, warm water from deep below the tanks is pumped through the tanks so no freezing occurs, and fish growth continues.

arranged in a rectangular grid, with up to 10 planned at each site. Strong ropes and chains secure the tanks to anchors set on the seabed, and floating walkways provide access to a service barge.

But whereas the barge attached to a net pen farm may contain crew quarters, a feed warehouse and feeding machines, the service center of the AgriMarine solid-wall farm houses a larger variety of machinery for delivering oxygen and handling substantial amounts of solid waste in addition to feed. Full-scale farms can produce almost 10 mt of solid fish manure every day – waste that would otherwise make its way into the ocean.

Results to date indicate that the composted fish manure is an excellent soil amendment that can provide a useful benefit for crop farmers in neighboring coastal communities. Because of reduced demands on the environment, floating solid-containment farms can be located in a greater variety of locations, including adjacent to transportation hubs and towns where the farm workers live. In fact, reduced transportation time and cost afforded by siting farms close to markets can offset capital costs, so that responsible aquaculture need not always be the more expensive option.

## Feed, Risk Management

Production costs at any aquaculture operation are dominated by feed and risk. The high-protein diets fed to carnivorous fish such as salmon and tuna result in the highest protein-conversion efficiency of any food animal – up to four times that for beef production – but such diets are expensive. Fish farmers are therefore very careful to ensure that no feed is wasted and that every meal is fully digested before the next is fed.

With financial success so dependent on feed management, it makes sense for farmers to invest in a rearing system designed to collect every pellet of uneaten feed and return it to the surface, where the farmer can immediately see it. Similarly, natural variations in the dissolved-oxygen content of ocean water can be stressful or fatal to fish. Only a few hours of oxygen deficiency can kill fish, even after years of care and investment.

Supplemental oxygenation is impractical in net pen systems because water exchange with the surrounding ocean is uncontrolled, and the added oxygen is often swept away. Solid-wall systems add supplemental oxygen under controlled flow. Farmers can be assured that the fish receive all the oxygen they need while being careful to avoid waste, just as with feed.

## Capital Costs

Up-front capital costs for solid-wall systems are greater than those for net pen farms, but both are small by comparison to other livestock-rearing operations. For salmon reared in a solid-wall system, capital costs amount to about 10% of revenue. Typical net pens require about 5%, while the value of land allocated to dairy or sheep rearing, for instance, can be much higher.

A single 24-m-diameter enclosure can produce 3,000 mt of salmon over a 20-year period, possibly worth U.S. $18 million in the wholesale market and requiring over $7 million for feed. The additional $500,000 for a secure and efficient rearing environment would be considered a wise investment by most farmers willing to consider the avoided risk to their fish, and by governments concerned about the health of oceans. The operating costs for pumps, oxygen and monitoring systems are more than offset through feeding efficiency gains.

## Fish Health

Since 2000, AgriMarine has successfully grown chinook and Coho salmon, Atlantic salmon and rainbow trout. The culture of each species presents a unique set of challenges. Overall, the Atlantic salmon did well, and notably did not become infested with sea lice, which are sometimes a serious problem in net pens. Fish were affected only by the diseases they brought with them from the hatchery, and this showed the importance of separating fish groups from each other.

The solid-wall tanks and separation of feces from effluent water help ensure that disease organisms are not spread among fish groups on the same farm or between wild and farmed fish. Where an aquaculture producer has several sites in the same market area, it is preferable to rear only fish of the same age on a given site, so they are all harvested near the same time. In doing so, all equipment can be disinfected prior to introduction of the next generation. Solid-wall tanks are designed to be lifted from the water for this purpose so that all components can be thoroughly cleaned.



## Case Study: China

AgriMarine first put the results of its research to work in China in September 2009, when it began farming steelhead trout in Guanmenshan Reservoir, located about 320 km north of Dalian.

The company has since expanded the demonstration farm to four tanks with a rearing capacity of 200,000 fish and an additional four tanks planned for construction and delivery later this year. The farm currently produces rainbow trout and chinook salmon, which reach 4 to 5 kg in 15 to 20 months, and plans to add Coho salmon in the future as the company targets the lucrative Chinese market.

Temperatures at Guanmenshan range from -20° C during winter to 28° C in summer. Operations continue year-round despite freezing surface conditions because the water in the tanks, maintained at a temperature of 4° C, is kept in continuous circulation. In summer, water is pumped from the depths of the 30-m-deep reservoir to keep tank temperatures sufficiently low. The farm does not filter the water before sending it into tanks, nor does it use pesticides or antibiotics.

## Outlook

AgriMarine's short-term plans focus on developing more farm sites in China, as well as expansion into eastern Canada through joint venture partnerships. The company is also seeking to establish footholds in well-developed salmon-producing countries and has recently set up a subsidiary in Norway as AgriMarine Norway A.S. in order to license its technology throughout northern Europe.

# Hatchery Production Of Spiny Lobsters

## *Meeting Growing Demand For Premium Product*

*Panulirus ornatus*, the most valuable tropical spiny lobster species, can be grown to 1-kg size in 18 months.

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**Summary:**
The spiny lobster is a premium seafood whose culture has traditionally depended on wild-caught seedstock. With the closure of the life cycle of *P. ornatus*, an Australian company is helping shift the farming paradigm to more sustainable hatchery production. Lobster Harvest developed a range of feeds that improved the rate of lobster metamorphosis and also designed specialized larviculture tanks. The unique hatchery technology is approaching the commercialization phase.

The spiny lobster is regarded worldwide as a premium seafood, with China the main export market for most product in recent years. This is especially the case for the tropical species *Panulirus ornatus*, for which the demand far exceeds supply.

The overwhelming market preference is for live animals in good condition on arrival and during holding. *P. ornatus* are particularly well suited to transport and holding. They are also prized for their 0.8 kg or larger size, beautiful colors and firm, pearly flesh that is perfect for serving raw as sashimi. In many Asian countries, serving *P. ornatus* is an honor for guests as well as a sign of the hosts' success and high status.

*P. ornatus* is the most valuable of all tropical spiny lobster species. In the past, most product was sourced from wild fisheries in southeastern Asian and the Torres Strait. Farmed lobsters, which can be grown from the puerulus stage at less than 1 g to 1 kg in 18 months, now constitute a large proportion of the supply to this market.

### Wild Postlarvae

In an article by Bruce Phillips and Ravi Fotedar in the January/February 2010 *Global Aquaculture Advocate*, the authors outlined how Vietnam provided up to 4,000 mt/year of farmed product to meet the growing demand from China. This farming enterprise is based on the capture and growout of wild postlarvae (pueruli and juveniles).

Since a high point in 2007-2008, a combination of reduced catches of postlarvae and diseases has led to a fall in farm production from Vietnam. From 2007 to 2010, the numbers of seedstock *P. ornatus* caught in Vietnam slipped from 2.1 million to 0.9 million. The resulting decline in production cost the industry millions of dollars.

Other neighboring countries are now taking up the aquaculture of tropical spiny lobsters based on the capture of postlarvae. However, both the lack of sustainability in terms of fisheries management and the inconsistency in catch of postlarvae limit the size and growth of the industry.

Closure of the life cycle of *P. ornatus* provides the opportunity for selective breeding and genetic improvement.



Commercial hatchery production will provide a more consistent supply of seed to allow lobster culture to further advance.

**Table 1. Mean survival rates of spiny lobster larvae when fed mussels (control) or three new diets (A, B, C).**

| | Control | Diet A | Diet B | Diet C |
|---|---|---|---|---|
| Successful metamorphosis to puerulus | 1.1% | 11.9% | 12.2% | 12.7% |
| Juveniles produced | 0.3% | 5.5% | 5.6% | 8.1% |

**Table 2. Performance of spiny lobster phyllosoma larvae raised to puerulus and juvenile stages in varied culture systems.**

| | 40-L Upweller | 220-L Conical Tank | New 250-L Conical Tank |
|---|---|---|---|
| Mean survival to puerulus | 3.3% | 0.4% | 8.5% |
| Mean survival to juvenile | 0.7% | 0.3% | 3.5% |

An Australian company, Lobster Harvest Ltd., is set to shift the lobster-farming paradigm away from the capture of wild seedstock to more reliable and sustainable hatchery production of spiny lobsters.

### *P. ornatus* Propagation

In most aquaculture enterprises, the demand for seedstock is met by propagation from hatchery production. This is certainly the case for shrimp, finfish and mollusks. Unlike these species, though, where the larval phase lasts only a few days or weeks, larval development in spiny lobsters takes many months. During this period, the phyllosoma larvae undergo more than 20 instars before metamorphosis to the postlarval puerulus stage.

Fortunately, *P. ornatus* is one of the most rapidly developing spiny lobsters, with a larval phase of "only" five months rather than the 10 to 12 months for some other species. For this reason, in addition to its rapid growth rates from postlarvae to market size and favored market characteristics, *P. ornatus* was chosen by Lobster Harvest as the species for potential hatchery propagation.

Due to the long and complex larval phase, hatchery rearing of spiny lobsters has proven difficult. M.G. Kailis began investing in *P. ornatus* propagation over 10 years ago by funding research carried out by the Queensland Department of Primary Industries in Cairns, Australia. M.G. Kailis produced the world's first hatchery-reared *P. ornatus* postlarvae in 2006 at its facility in Exmouth, Western Australia. More postlarvae were produced in subsequent years by Lobster Harvest, the company M.G. Kailis set up for the purpose of commercializing lobster propagation.

## Larval Nutrition

The successful culture of larvae depends on optimizing their nutrition, and this has typically consisted of feeding fresh diets of *Artemia* during early larval development, followed by supplementary chopped mussel gonad for older larvae. For both these fresh items, there may be problems of inconsistency in quality, such as reduced nutritive value or increased loads of infectious microorganisms, which reduce success in the hatchery.

Although a semi-moist or encapsulated formulated diet consisting of commercial ingredients is a worthy ideal for which to strive as a replacement for live diets during the larval phase, there has historically been little success. However, Lobster Harvest developed a range of feeds for mid- to late-stage phyllosoma that improved the rate of metamorphosis, the traditional bottleneck of spiny lobster aquaculture (Table 1).

Three alternative diets (A, B, C) were compared to the control diet of chopped mussels. There was a marked improvement in the successful metamorphosis to puerulus with all three alternatives. Further, diet C produced the highest rate of successful molting from puerulus to the juvenile stage.

With a larval phase of "only" five months and rapid growth, *P. ornatus* is an obvious choice for development.

These findings propelled the potential hatchery production of seedstock into the commercial-ready state. With 5 to 8% mean survival from egg hatch to the juvenile stage, this diet technology is now being scaled up from the small 15-L experimental tanks to an industrial level.

## Larval Culture Systems

The culture systems for phyllosoma rearing have received considerable attention and historically vary markedly in size. The important considerations for larval culture are that contact be minimized between animals and for animals with their culture vessel surfaces, while ensuring good feed accessibility, optimum hygiene and high-quality water.

Phyllosoma have been cultured in vessels from 15-L bowls to industrial-scale tanks of 250 L in 2010 and more recently in 1,000-L tanks. The authors compared production-scale culture of larvae in 40-L New Zealand upwellers, standard 220-L conical tanks originally used for *Artemia* production, and newly designed 250-L larviculture tanks. All animals were fed a diet consisting of a combination of enriched *Artemia*, chopped mussels and the new larval diets.

There were large differences in larval performance between designs of culture tanks (Table 2). The highest overall survival through metamorphosis to puerulus, 8.5%, was for the new 250-L conical tanks, with survivals ranging 6.5 to 10.2%.



Mean survival to the juvenile stage was 3.5%, ranging from 1.9 to 4.4%. The other tanks produced considerably fewer pueruli (0.4 to 3.3%) and juveniles (0.3 to 0.7%).

The superior performance of the new tank design has provided confidence to scale up operations to the 1,000-L larviculture tanks to achieve higher efficiency in hatchery rearing. Multiple units are being built and installed for pilot-scale commercial production of juvenile seedstock from the Exmouth facility.

## Breeding, Genetic Selection

The F$_1$ juveniles produced from 2006 to 2008 were grown to sexual maturity and produced three F$_2$ larval cohorts that were successfully cultured to the juvenile stage in 2010, with more F$_2$ cohorts cultured in 2011. The production of F$_2$ larvae was the first true closure of the life cycle of *P. ornatus* – and the first for any spiny lobster species – providing the opportunity for selective breeding and genetic improvement. It is estimated that production traits in crustaceans can typically be improved by up to 15% per generation through selective breeding.

## Perspectives

The unique hatchery technology of Lobster Harvest is approaching the commercialization phase.

Importantly, lobster survival to the juvenile phase is over 5%, providing a hatchery-rearing efficiency equivalent to other high-value cultured species.

Lobster Harvest expects to enter commercial hatchery production by 2013. This new hatchery production could be readily incorporated to improve the existing cage culture of tropical spiny lobsters, which is located mainly in Vietnam and elsewhere in Southeast Asia. Since the industry is currently solely reliant on the capture of wild seedstock for growout, a central hatchery could offer the stability needed for further investment and expansion of the entire sector.

The company recently exported hatchery-produced F$_1$ and F$_2$ *P. ornatus* juveniles, along with more than 10,000 hatchery-produced slipper lobster seedstock, to a growout test site in Sabah, Malaysia, where they are being cultured under typical farming conditions in ocean cages. In addition, Lobster Harvest is testing a pelleted growout diet for tropical spiny lobsters developed over the past four years. Laboratory trials in Perth, Western Australia, have demonstrated superior survival and pigmentation in lobsters given the formulated feed compared to fresh diets.

# Seaweed Farming Offers Avenue Toward Greater Food Security

Seaweed can be a key part of self-sustaining marine culture systems that produce food, feed and biofuel. Photo courtesy of Paul Dobbins, Ocean Approved.

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**Summary:**
Seaweed farming is a sector of aquaculture with proven history and huge potential. In the future, large-scale marine seaweed farms could serve simultaneously as raw material sources for biofuel and aquatic animal feed, and provide food for the world's growing human population. IMTA development will advance our knowledge of how to farm seaweeds and use seaweed products. Will seaweed be known as an "ocean vegetable"? Be realistic today, but remain farsighted about future possibilities.

Even though aquaculture is known as "the world's fastest-growing food-producing sector," its current annual production of about 60 mmt is not even 1% of the world's total current food supply.

If aquaculture is ever to contribute more significantly, it must evolve to become an integrated marine agronomy producing macroalgae (seaweeds) as its primary crop. It would then be more like terrestrial agriculture and have the potential to be self-sustaining – growing feed for its own aquatic livestock – and to contribute to future needs for human food by reaching into the vast and under-utilized expanses of the oceans.

## Not New

Seaweed-based marine agronomy is not a new idea. In Asia, seaweed farming for food has been developed in several countries over the past 50 years. In China, over 10 mmt of seaweed is now farmed yearly. About half serves as food for the Chinese people, and much of the rest is processed for the extraction of marine colloids. Japan and South Korea are also major growers of seaweed. Japan pioneered the farming of *Porphyra* species, better known as "nori" in Japanese cuisine.

Today, with this experience in Asia and the growing realization that future human needs for both food and energy may exceed our capacity to produce them, people in the West are thinking again about seaweeds as a possible source of both.

## How To Get There?

But the vision leaves open the question of how we get from here to there. The challenges are formidable and will need policy accommodation and sustained development effort to overcome. From a policy point of view, the idea needs deeper scrutiny as part of the broader food and energy security debate.

Given the likely environmental impacts of agricultural expansion, does the potential for large-scale ocean farming as an alternative merit the effort needed to make it happen? And, if the answer is yes, will people accept that this is a wise and necessary use of some of our ocean space? That is a big question, at least in many Western countries where aquaculture (especially fish farms) in coastal waters has often been contentious. Would the idea of seaweed farms be any less so? No matter that these might be located in areas well offshore eventually, development of the know how will initially need to be done in near-shore locations.

Nor will development be easy. There are big hurdles to overcome to farm in more exposed, deeper waters, yet this is where farms must eventually be if they are to produce on a scale that would add materially to global food production.

There are also challenges related to the supply of carbon dioxide and nutrients to seaweed farms if the plants are to grow optimally. Although there is an overabundance of carbon dioxide in the oceans and also of nutrients in some areas, the rate at which growing plants consume them must be matched by the



Kelp can grow to be known as an "ocean vegetable." Photo courtesy of Paul Dobbins, Ocean Approved.

rate at which they are made available in the water that flows past them. For big plantations, this can be problematic and will call for careful site selection and/or adaptive farm design.

Then there are matters of cost and how to process the raw seaweed to extract maximum value from it. Agriculture has had thousands of years to achieve its present levels of cost efficiency. Farming of seaweeds is new. Advances in farm design and operation, harvesting and processing, and the selection of seaweed strains for optimal performance all lay ahead.

We must be realistic about what might be possible today, but remain farsighted about what may be possible in the future. Activity in three areas suggests that these questions are now beginning to receive the attention they need.

## Biofuels

First, there is resurgent interest in biofuel, with seaweed being promoted as a possible biomass source. The U.S. company Bio Architecture Lab, for example, is developing enzymes that will improve the efficiency of converting seaweed biomass into biofuel and has partnerships to commercialize the technology with Statoil in Norway, Empresa Nacional del Petróleo in Chile and DuPont in the U.S. As discussed in a recent U.S. Department of Energy report (www.pnl.gov/publications/abstracts.asp?report=308267), this requires seaweed production on a large scale at low cost and, necessarily, the funding and momentum that such partnerships will generate will serve to advance the field in general.

In particular, development may well lead to an emphasis on the recovery of co-products as a means of increasing the value derived from the raw biomass. The most obvious co-product is food, or at least ingredients for animal feed. This is especially the case for co-production of biofuel and aquaculture feeds, because aquatic animal livestock do not need carbohydrate in their feed in the same way that terrestrial livestock do.

## Integrated Multitrophic Aquaculture

A second activity driving development is integrated multitrophic aquaculture (IMTA). Its premise is that nutrients released by farmed fish can be recovered by seaweeds and invertebrates farmed alongside them. In this way, the potential for eutrophication is mitigated, and the productive capacity of near-shore aquaculture areas can be increased.

However, the system relies on external inputs of nutrients in feed. A future marine agronomy would internalize this dependence by growing its own feed ingredients and thereby be self-sustaining. IMTA development is a step toward this – an important one, because its focus on seaweeds will advance our knowledge of how to farm them and how to make best use of them once they are harvested.

## Ocean Vegetables

The third development that promises to move this concept forward is the startup of new farms in Western countries to produce seaweeds as "ocean vegetables" for human consumption. This has the advantage that it can be done profitably on a small scale and the merit that it coincides with trends in society toward consumption of less meat and more vegetables.

An example of a company pursuing this idea is Ocean Approved in Maine, USA. With the tagline "Kelp, the Virtuous Vegetable," it has been selling kelp noodles, kelp slaw and other products to Whole Foods and other specialty stores in the northeastern U.S. for three years.

Starting with seaweed harvested from natural beds off the coast of Maine, it seeded its first farm ropes in 2010. This year it harvested its first farmed product and will shift to all farmed production. It is a small start, but as the first coastal seaweed farm in the U.S., it will demonstrate the opportunity and develop the know-how on which a bigger industry can be built.

## Increasing Human Demand

It is worth remembering that 39 years from now, as the United Nations Food and Agriculture Organization projects (www.fao.org/news/story/en/item/35571), we will need to grow 70% more food to meet increasing human demand. That is 5 billion mt annually with the use of all the land, freshwater and fertilizer that this implies.

The idea that food might be grown at sea without these inputs is surely something to consider in planning for our future food security. The advances described above are helping to keep that option open. But policy innovations are needed, too, and that calls for a long-term vision of what these early efforts might, one day, be able to achieve.

As global food demands rise, seaweeds can help meet the need. Photo courtesy of Paul Dobbins, Ocean Approved.

# Trials: Digestibility Enhancer Can Offset Cholesterol Content In Shrimp Feed

Lipid digestion in shrimp is largely an intracellular process in the hepatopancreas.

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**Summary:**
Cholesterol is an essential nutrient for penaeid shrimp. Trials by the authors found that a digestibility enhancer based on natural emulsifiers was as effective as purified cholesterol in improving shrimp growth and feed conversion. After 70 days of culture, harvested biomass was 30% higher than the control for both treatments. A digestibility enhancer was also found effective with white shrimp.

Cholesterol is an essential nutrient for penaeid shrimp. It is a key constituent of cell membranes and a precursor for steroid and molting hormones. Fluctuations in the availability and price of the main sources of cholesterol for shrimp feed – marine ingredients and feed-grade cholesterol – are a serious concern for shrimp feed formulators.

## Cholesterol Bottleneck

Shrimp have no or very limited capacity to biosynthesize a number of lipid molecules essential for normal growth, including cholesterol, highly unsaturated fatty acids and phospholipids. Published cholesterol requirements for different species of shrimp range from 0.25 to 0.50%. Cholesterol levels below 0.10% limit growth in *Litopenaeus vannamei*, even if the other nutrients are formulated to satisfy normal requirements.

All protein meals and fats from animal origins contain cholesterol, but ingredients from marine sources – including fishmeal, fish oil, squid meal and shrimp meal – are particularly rich sources. With its 0.25-0.35% cholesterol content, fishmeal is often the major cholesterol source in practical feed formulations for shrimp.

Sharp price increases for fishmeal and fish oil have resulted in the significant replacement of these ingredients with fats and proteins of vegetable and terrestrial animal origins that have limited levels and availability of cholesterol. As a result, it has become increasingly difficult to maintain adequate levels of available cholesterol in shrimp feed formulations. Supplementation of purified cholesterol is often needed to fully cover the requirement.

Cholesterol is purified from wool grease (lanolin), a by-product collected during the washing of sheep wool. The cost and availability of feed-grade cholesterol fluctuates with the variations in global supply and quality of wool grease.

Diminishing sheep stocks and increasing competition for lanolin derivatives (e.g., to synthesize steroids) have become serious concerns. Feed volumes required by the shrimp industry are expected to keep growing, whereas fishmeal levels will continue to be reduced.

## Digestibility Enhancers

Lipid digestion in shrimp is largely an intracellular process in the hepatopancreas epithelium, from which lipids are transported to the target organs via the haemolymph as lipoproteins. The formation and absorption of lipid micelles from the lumen of the hepatopancreas tubuli is therefore a limiting step in the lipid digestive process.

Digestibility enhancers based on natural emulsifying agents selected for their compatibility with shrimp digestive systems have proven capable of complementing the process of emulsification, increasing the efficacy of th lipase activity and absorption of dietary fats in the hepato-pancreas. This, in turn, improves the ability of shrimp to efficiently use fats as essential components and sources of energy for growth.

## Cholesterol Replacement Trials

Two trials were set up by the authors to evaluate if the use of a digestibility enhancer based on natural emulsifiers could reduce the need for cholesterol supplementation in the diet of black tiger shrimp, *Penaeus monodon*. Experimental pelleted diets were formulated to satisfy the nutritional requirements of *P. monodon*, except for cholesterol.

Three diet formulations were used: a control diet with no cholesterol supplementation and a background concentration of 0.10% cholesterol provided by fishmeal and shrimp head meal (CON), a positive control diet supplemented with 0.15% cholesterol to a level of 0.25% cholesterol in the diet (CON+) and a test diet supplemented with Aquagest S, a commercial digestibility enhancer based on an optimized blend of natural emulsifiers (TEST).

To verify initial findings, a second trial was run using different batches of raw materials. This resulted in slightly different proportions of fishmeal (35%) and defatted soybean meal (25%), and a higher background of cholesterol in the feeds. In trial 2, CON, CON+ and TEST contained 0.15, 0.30, and 0.15% cholesterol, respectively.

The experimental setup consisted of nine cylindrical, 1-mt, flat-bottom tanks. Seawater was prepared by pumping it through a 1-µ filter bag and recirculating it over a 1.6-mt coral biofilter. Salinity was adjusted to 25 ppt by the addition of underground freshwater, and 3 mg/L hypochlorite powder was applied for 24 hours for disinfection.

Mean water renewal over the whole culture period was 28%/day. Shrimp of 0.3- to 0.4-g weight were initially stocked at 20 shrimp/tank and acclimated for one week prior to the start of the trial. Water temperature (27.5 ± 0.7° C), salinity and other quality parameters remained within acceptable limits during the tests.

**Table 1. Growth performance of black tiger shrimp fed experimental feeds during 70 days (trial 1). Different letters in the same row denote significant difference (P < 0.05).**

| | CON (0.10% cholesterol) | CON+ (0.25% cholesterol) | TEST (0.10% cholesterol + enhancer) |
|---|---|---|---|
| Survival (%) | 88.3 ± 5.8 | 90.0 ± 5.0 | 91.7 ± 7.6 |
| Initial weight (g) | 0.65 ± 0.04 | 0.64 ± 0.02 | 0.66 ± 0.02 |
| Final weight (g) | 5.90 ± 0.40[a] | 7.80 ± 0.40[b] | 7.50 ± 0.20[b] |
| Final biomass (g) | 103.00 ± 2.00[a] | 137.00 ± 9.00[b] | 134.00 ± 8.00[b] |
| Feed-conversion ratio | 3.9 ± 0.2[a] | 3.1 ± 0.2[b] | 3.4 ± 0.1[b] |

**Table 2. Feed formulations for traditional feed and novel feed with a digestibility enhancer for white shrimp (trial 3).**

| | Traditional Feed | Novel Feed | Difference |
|---|---|---|---|
| Crude protein (%) | 35.80 | 34.80 | -3% |
| Crude fat (%) | 8.70 | 8.20 | -6% |
| Crude ash (%) | 9.10 | 9.40 | +4% |
| Moisture (%) | 9.59 | 9.64 | +1% |
| Watersol phosphorous (%) | 0.48 | 0.32 | -34% |
| Cholesterol (%) | 0.18 | 0.10 | -44% |
| Phospholipids (%) | 0.93 | 0.85 | -9% |
| EPA (mg/g dry matter) | 4.8 | 5.0 | +4% |
| DHA (mg/g dry matter) | 5.7 | 4.8 | -16% |
| n-3 HUFA (mg/g dry matter) | 11.9 | 11.1 | -7% |

**Table 3. Growth performance of white shrimp fed experimental feeds during 70 days (trial 3). "*" denotes significant difference (P < 0.05).**

| | Traditional Feed | Novel Feed | Difference |
|---|---|---|---|
| Survival (%) | 91.7 | 93.3 | +2% |
| Initial weight (g) | 1.02 | 1.02 | – |
| Final weight (g) | 11.31 | 12.74 | +13%* |
| Growth (g/week) | 1.03 | 1.17 | +14%* |
| Feed-conversion ratio | 2.29 | 2.31 | – |

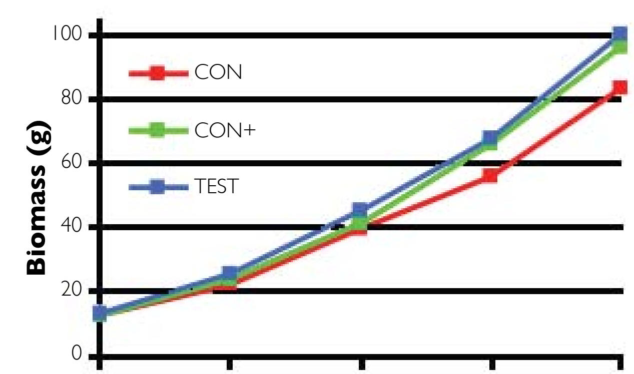


**Figure 1.** Total tank biomass (average from triplicate tanks) of *P. monodon* fed 56 days on experimental feeds (trial 2).

## Results

In trial 1, overall shrimp growth of up to 1.4 g/week and survival close to 90% were excellent under the conditions of clearwater culture. Growth and feed conversion were significantly improved by the supplementation of 0.15% cholesterol. After 70 days of culture, harvested biomass was 33% higher for the shrimp fed the diet supplemented with cholesterol (Table 1).

The digestibility enhancer was as effective as the purified cholesterol in improving growth and feed conversion. After 70 days of culture, harvested biomass was 30% higher in the TEST treatment compared to the negative control.

Overall shrimp survival was lower in trial 2, averaging 77 to 85%. However, the trends in growth response observed in this independent trial – run with different shrimp and different batches of raw materials for feed preparation – generally matched those of the first trial (Figure 1).

## White Shrimp Study

By improving the utilization efficiency of dietary lipids, shrimp formulations can be made more cost-effective by reducing the formulated values for phospholipids, cholesterol and n-3 highly unsaturated fatty acids (HUFAs). The compensation of lower dietary specifications for essential lipids by the application of a digestibility enhancer was demonstrated in a nutritional trial in Indonesia with white shrimp.

The partial replacement of traditional sources of phospholipids, purified cholesterol and n-3 HUFAs (including fishmeal, fish oil, purified cholesterol, soybean lecithin and squid meal) resulted in improved growth performance and reduced the dependency of formulation costs on bottleneck ingredients (trial 3: Tables 2 and 3).

# New generation of software solutions

## Innova production management system

### Take the guessing out of processing

In today's globalized market, food processors are faced with lower margins as a result of pressure from powerful retailers and increased raw material prices. With 70-75% of the cost of the final product stemming from the raw material, processors must keep close track of yield and giveaway.

Profit margins are under such pressure that it only takes a few small "mistakes" to turn black figures into red. Conversely, very small increases in yield can have a major positive impact on the bottom line. In order to survive in this competitive and financially difficult marketplace, processors must therefore focus fully on yield and have complete control of the entire production process.

Yield, quality and throughput are key criteria for any fish producer. It's easy to be good in one of these if you're ready to sacrifice the other two, but getting the right balance is much harder. Implementing automation and information technology for process control has become an absolute necessity for any processor. Now there is software that allows managers to monitor every processing stage in real time, and even remotely, in order to optimize production performance.

### Monitoring and controlling profitability

With reliable real-time yield management software such as Marel's Innova Production Management System, processors can improve profitability significantly. The yield control and monitoring module allows real-time monitoring of the yield and provides answers to critical questions like: "Where are we losing value? On what line? What machine? What supplier?" Armed with this knowledge, processors have the ability to immediately intervene should the actual yield deviate from the expected.

### Traceability and quality management

Consumer awareness of issues such as traceability, sustainability, food safety and product quality has never been higher and will undoubtedly continue to grow. What's more, their concerns are mirrored in the rules and regulations imposed by government authorities. For modern food processing companies, the implementation of an efficient traceability and quality management system contributes to strengthening image, increasing safety and optimizing internal processes.

### How does it work?

The software has a modular structure with individual program modules working together to create one integrated solution. While documenting the internal production processes, the software ensures that data is available online at any given point in time during the production cycle, thereby enabling managers to ensure full traceability and greatly improve the complete manufacturing process.

The software supports the full spectrum of process plant equipment, providing the most integrated processing solution available and opening a wealth of fresh opportunities in production management.

In short, the software ties it all together by providing:

- a bridge between the factory floor and the ERP system
- real-time process control and reporting
- traceability
- inventory and order processing
- quality control and food safety
- continuous process improvement.

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## Philippe Léger New Managing Director Of INVE Aquaculture


Philippe Léger

Philippe Léger has been appointed the new managing director of INVE Aquaculture, a global leader in the research, development, production and marketing of feed and health solutions for aquaculture hatcheries and farms.

Léger was a co-founder of *Artemia* Systems, a company established in 1983 that set the standard for *Artemia* quality and live food enrichment. INVE Aquaculture became part of the INVE Group in 1991.

"In past years, we have tweaked our portfolio of nutritional specialties and developed a successful range of health products for disease prevention," Léger said. "This was achieved by strengthening our Innovation Department. We have further enforced our market presence and supply chain. With these changes, we are confident INVE Aquaculture will continue offering pioneering solutions to the ever-evolving aquaculture industry."

For further information, visit www.inve.com.

## Aquatic Eco-Systems Acquires Green Sky Growers

Aquatic Eco-Systems, Inc. of Apopka, Florida, USA, has acquired Green Sky Growers, a hydroponic and aquaponic operation based in Winter Garden, Florida. AES will continue the work in promoting sustainable living started by Bert Roper under the Green Sky name.

"The Roper family is pleased to welcome Aquatic Eco-Systems as the new owner of Green Sky Growers," Roper said. "AES has over 30 years of industry expertise, and their innovative research on aquaculture and hydroponics will continue as AES uses the rooftop site for both food production and as a learning facility for clients from all over the world."

"With Green Sky Growers, we are able to combine state-of-the-art technology with conventional and innovative growing techniques," AES President Todd Childress said.

Green Sky Growers will be a one-stop solution for new design ideas, garden troubleshooting, education and installation assistance. The facility will cater to commercial growers, homeowners and those looking to tackle urban gardening.

For more about Green Sky Growers, facility tours and current products, visit www.greenskygrowers.com.

## Umami Seafood Confirms Tuna Spawning At Croatia Farm

Umami Sustainable Seafood Inc., a holding company of fish-farming operations supplying sashimi-grade northern bluefin tuna to the global market, has obtained DNA evidence confirming natural spawning of bluefin tuna at its Kali Tuna facility in Croatia.

Genomics Laboratory Macrogen Inc. confirmed that larvae hatched from eggs collected from Kali Tuna's broodstock holding pens resulted from natural spawning activity. This was the third consecutive year spawning took place at the operation.

Kali Tuna has been working toward growing over 1,000 young tuna into mature broodstock at its farms in Mexico and Croatia. The goal is to release millions of fertilized eggs and fry into the wild every year.

"This event marks a major milestone," Oli Valur Steindorsson, Umami CEO, said. "Although we still have a lot of work to do, I am more confident than ever that we will be able to dramatically increase the world's access to this highly valued food source, without any degradation in quality, while at the same time, decreasing pressure on the world's wild populations."

For more information, visit www.umamiseafood.com.

**People, Products, Programs**

Please send short news items and photos for consideration to:

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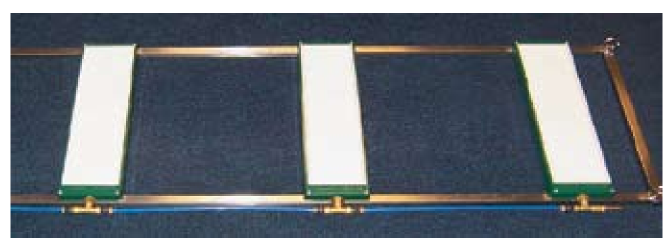
Dryden diffusers can be used individually or in a manifold unit.

## Dryden Aqua Ceramic Diffusers Deliver Sturdy Performance

Ceramic diffusers are the best means of diffusing oxygen into water without wasting oxygen. However, ceramic diffusers tend to be fragile, or the bubble size is too large for efficient oxygen transfer.

Dryden Aqua diffusers are manufactured from a solid cast aluminum base that has been protected against corrosion. The ceramic plate is epoxy bonded into the cast and prevented from experiencing any torsional movement. The diffusers have a high transfer coefficient – the oxygen diffusion cloud that comes out looks like milk.

Dryden Aqua ceramic diffusers are designed to operate at 2.5 bar, but they are pressure tested at up to 20 bar. The diffusers can be used as individual units or as a manifold on a stainless steel frame.

A leading commercial fish farm treated 1,000 mt of salmon supported by Dryden Aqua ceramic flat plate diffusers with only 30 cylinders of oxygen. This was half the amount used by their previous flat-plate diffuser system.

For more information, visit www.drydenaqua.co.uk.

The Andromeda farm uses nets and cages made from Dyneema fiber. Photo courtesy of Andromeda.

## Andromeda Chooses Dyneema Cage Nets

Andromeda, one of Greece's top-five aquaculture companies, uses nets and cages with Dyneema ultra-high-molecular-weight polyethylene fiber to sustain healthy growth and profitability in raising sea bream. Andromeda is considering Dyneema nets for seabass, as well.

"Net cages made with Dyneema fiber are lighter and stronger than cages made in traditional fibers," Andromeda Purchasing Manager Antonis Raftopoulos said. "They are worth the investment, as they lead to overall savings of 10 to 15%."

Lightweight nets of Dyneema fiber are easier to handle and require 40% less use of antifoulants than nylon nets. They need less cleaning and also resist fish bites and predators.

DSM Dyneema is the inventor and manufacturer of Dyneema, the world's strongest fiber. Offering maximum strength and minimum weight, Dyneema is up to 15 times stronger than quality steel and up to 40% stronger than aramid fibers on a weight-for-weight basis. Durable Dyneema floats on water and is extremely resistant to moisture, ultraviolet light and chemicals.

Further information on DSM Dyneema is available at www.dyneema.com.

## Louisiana Shrimpers Trial Enzyme Treatment To Prevent Black Spot

In an effort to bring top-quality, more eco-friendly shellfish to market, the shrimp industry in Louisiana, USA, has begun testing an innovative sulphite-free enzyme treatment to prevent melanosis, or "black spot," in harvested shellfish.

Marketed as Prawnfresh Plus, the new treatment involves dipping shrimp into a tank containing saltwater and the enzyme. The active ingredient has achieved "generally recognized as safe" status in the United States and is approved for use in the European Union, Australia, Canada, New Zealand and South Africa.

More than a dozen Louisiana fishermen have participated in trials. Texas A & M and Louisiana State University were also enlisted to compare PrawnFresh Plus with sodium metabisulfite.

"Prawnfresh Plus could prove to be very beneficial to Gulf shrimp fishermen," Karl Turner, president of Sea Fresh Solutions LLC, the exclusive distributor of Prawnfresh Plus in North America, said. "It leaves no chemical residues or taints, resulting in a better quality catch that will bring the best possible price."

For more information, visit www.seafreshsolutions.com or call +1-504-914-3178.

## SEPTEMBER

**Asian Seafood Exposition**
September 6-8, 2011
Wanchai, Hong Kong
Phone: +852-3105-3961
Web: www.asianseafoodexpo.com

**Humber Seafood Summit 2011**
September 7-8, 2011
Grimsby, North East Lincolnshire, United Kingdom
Phone: 01472-582400
E-mail: fisherdj@grimsby.ac.uk

**National Fisheries Institute Annual Meeting**
September 12-15, 2011
Colorado Springs, Colorado, USA
Web: www.cvent.com/events/2011-nfi-annual-meeting/event-summary-dbc11072f7384a059dfb83f37c4ba7f7.aspx

**AquaAfrica 2011**
September 13-16, 2011
Malawi, Africa
Phone: +27-0-12-8076720
Web: www.aasa-aqua.co.za/site/conferences/

**Genomics in Aquaculture Symposium**
September 14-17, 2011
Heraklion, Crete, Greece
Phone: +30-28210-83960
Web: www.gial2011.com

**Acvapedia 2011**
September 15-18, 2011
Tulcea, Romania
Phone: +40745454938
Web: www.acvapedia.ro

**Surimi School Europe**
September 20-22, 2011
Madrid, Spain
E-mail: surimiman1@yahoo.com, jae.park@oregonstate.edu
Web: http://surimischool.org/sur-eu.html

### Seafood and Aquaculture Events

Send event listings in English to:
Event Calendar
5661 Telegraph Road, Suite 3A
St. Louis, Missouri 63129 USA
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## OCTOBER

**2011 World Seafood Congress**
October 1-6, 2011
Washington, D.C., USA
Web: www.cvent.com/events/2011-world-seafood-congress/event-summary-59d5f565a4fe4373b5920c0acdbd4b6c.aspx

**Conxemar 2011**
October 4-6, 2011
Vigo, Spain
Phone: 34-986-433-351
Web: www.conxemar.com/ingles/feria.htm

**Groundfish Forum**
October 13-15, 2011
Barcelona, Spain
E-mail: aldamol@itn.is
Web: www.groundfishforum.com

**Fish Culture Techniques Workshop**
October 17-19, 2011
Fort Pierce, Florida, USA
Phone: +1-772-242-2506
Web: www.fau.edu/hboi/Aquaculture/AQacted_WorkshopSchedule.php

**Aquaculture Europe 2011**
October 18, 2011
Rhodos, Greece
Phone: +32-59-32-38-59
Web: www.easonline.org/meetings/aquaculture-europe-event/ae-2011

**Recirculating Aquaculture Systems Workshop**
October 20-22, 2011
Fort Pierce, Florida, USA
Phone: +1-772-242-2506
Web: www.fau.edu/hboi/Aquaculture/AQacted_WorkshopSchedule.php

**Aquamar Internacional**
October 26-28, 2011
Hermosillo, Sonora, Mexico
Phone: +52-55-9117-0515
Web: www.aquamarinternacional.com

## NOVEMBER

**China Fisheries and Seafood Expo/Aquaculture China**
November 1-3, 2011
Quindao, China
Phone: +1-206-789-5741 ext. 334, +86-10-58672620
Web: www.chinaseafoodexpo.com

**Global Outlook for Aquaculture Leadership (GOAL) 2011**
November 6-9, 2011
Santiago, Chile
Phone: +1-314-293-5500
Web: www.gaalliance.org/GOAL2011/

**Expo Pesca/AcuiPeru**
November 10-12, 2011
Lima, Peru
Phone: 511-201-7820
Web: www.thaiscorp.com/expopesca_new/site/index_en.php

**International Sturgeon Conference**
November 23, 2011
Warsaw, Poland
Web: www.aller-aqua.com/cms/front_content.php?idcat=560&changelang=3

## DECEMBER

**Shanghai International Fisheries and Seafood Exposition**
December 8-10, 2011
Shanghai, China
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Web: www.sifse.com/en/


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