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**On the cover:**
With white, mild-flavored flesh and plentiful supplies from Vietnam, Pangasius has become a top farmed species.

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**Global aquaculture advocate**
September/October 2014

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**From The President**

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Finding Solutions Through Collaboration

In its young history, aquaculture has shown a remarkable ability to innovate and reinvent itself. For example, when white spot virus caused a global epidemic during the 1990s, the shrimp-farming sector responded with specific-pathogen-free stocks and more biosecure production methods that allowed it to quadruple production. Advances continue at an ever-increasing pace at every level of the production chain, including diagnostic labs, breeding programs, hatcheries, farms, feed mills and processing plants. It is inspiring to witness the ingenuity and determination of the men and women who are driving these incremental improvements. Together, they are lifting the overall efficiency and sustainability of aquaculture.

However, as the industry grows, it is inevitably confronting challenges, especially from disease outbreaks and resource constraints, which are simply too complex or broad in scope to be overcome by individual businesses or even individual countries. For example, the shrimp-farming sector is now strained by early mortality syndrome (EMS), and the feed sector is struggling to overcome environmental and social issues regarding use of fishmeal.

If left unaddressed, these issues threaten to cause stagnation or decline of the aquaculture sector. They require a broader collaborative effort. As Albert Einstein once said, “You can't solve a problem on the same level that it was created. You have to rise above it to the next level.” This is GAA’s mission — to harness the strength of collaboration to enable the sustainable development of aquaculture.

Over the years, GAA has been proud to have worked with businesses, academia, NGOs and government organizations to resolve a range of such broad environmental, social and market issues including mangrove conversion, eutrophication, child labor, antibiotic usage, artificial trade barriers and animal welfare. In that process, the resulting best management practices have been captured in GAA’s comprehensive Best Aquaculture Practices certification standards. The standards provide ongoing, third-party assurance that responsible practices are in place.

The upcoming GOAL 2014 meeting in Ho Chi Minh City, Vietnam, will be an important opportunity to discuss today’s most daunting issues and develop consensus solutions. We invite buyers, producers, researchers, investors, NGOs and government organizations to join us in these discussions. Among the key issues to be discussed at GOAL are EMS, the sustainable use of fishmeal in feeds, food safety and marketplace accessibility.

In the case of EMS, an ongoing GAA survey is revealing improvements in diagnostic testing, management methods, feed additives and genetic improvement, which promise an imminent recovery and rebound of the sector. To better manage the mounting risk of outbreaks, the GOAL program will also include discussions about the need for improved zone management to control such factors as trans-boundary movement of animals, proximity of farms and discharge of wastes. These are broad policy issues that input and collaboration from many levels, including the regulatory and financial sectors.

In the case of fishmeal sustainability, GAA will seek to bridge the gap in certification standards between feed mills and fishing vessels. It will also provide a forum for discussion of innovations in fishmeal substitution to reduce the pressure on fishmeal supplies. If we can overcome such major obstacles through collaboration, we will unleash continuing innovation and sustainable growth. In so many ways, the promise of aquaculture relies on unity and cooperation.

Global Aquaculture Alliance

Aquaculture is the future of the world’s seafood supply. Be part of it by joining the Global Aquaculture Alliance, the leading standards-setting organization for farmed seafood.

Access science-based information on efficient aquaculture management. Connect with other responsible companies and reach your social responsibility goals.

SUSTAINING MEMBERS
Akin Gump Strauss Hauer & Feld
Ammon International, Inc.
Anova Food Inc.
Apex Frozen Foods
Aquaculture
Aquatic Aquaculture Ltda.
A.Z. Urnas Inc.
Blue Mar Group
Blue Ridge Aquafeed
CamaraChica Inc.
Channel Fish Processing Co., Inc.
Diet Source Seafood
DNI Group, LLC
DSM Nutritional Products
Fega Maricultura P.T.
Fortune Fish Co.
Gorton’s Seafood
Great Southern Seafood Imports Co.
H & N Foods International, Inc./Epuck
H & T Seafood, Inc.
Harvest Select
International Marketing Specialists
iPura Food Distributors Co.
Long Johns Silver’s, LLC
Makaha Seafood LLC
Maritime Products International
Merck Animal Health
Miraco, Inc.
North Coast Seafoods
Odysea Enterprises, Inc.
Ocy Bay Seafoods
Ocean City Corp.
Pacific Supreme Corp.
Quich Foods
Rabcon Resources
Sacro Seafood, Inc.
Seafood Development Corp.
Seattle Fish Co.
Seattle Fish Co. of New Mexico
Seattle Shrimp & Seafoods Co., Inc.
Slide Gordon & Co., Inc.
Solea, LLC
Star Agro Marine Exports Ltd.
Tampa Bay Fisheries, Inc.
Tampa Maid Foods
The Fishin’ Co.
The Great Fish Co.
Trident Seafoods
United Seafood Enterprises, L.P.

ASSOCIATION MEMBERS
All China Federation of Industry and Commerce Aquatic Production Chamber of Commerce American Feed Industry Association Asociacion Latino Americana de Plantas de Rendimiento de Acuacultura Brasilera de Criadores de Camarao
Australian Prawn Farmers Association
Bangladesh Shrimp & Fish Foundation China Aquatic Products Processing and Marketing Association Fats and Proteins Research Foundation, Inc.
Indiana Soybean Alliance
Indonesian Aquaculture Society International Fishmeal and Fish Oil Organization Malaysian Shrimp Industry Association Marine Products Export Development Authority National Fisheries Institute National Rindurers Association Oceanic Institute
Prince Edward Island Seafood Processors Association
SalmonChile
Salmon of the Americas
Seafood Importers Association of Australasia
Seafood Importers and Processors Alliance
Soy Aquaculture Alliance
Thai Frozen Foods Association
Universidad Austral de Chile
U.S. Soybean Export Council
Washington Fish Growers Association
Washington State Chinacan Relais Council
World Aquaculture Society
World Renderers Organization

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After Productive Vietfish, GAA Builds Momentum In Vietnam

The Global Aquaculture Alliance made a splash at the Vietnam Fisheries International Exhibition (Vietfish 2014) in Ho Chi Minh City, Vietnam, in early August. In addition to exhibiting at the three-day exhibition – hosted by the Vietnam Ministry of Agriculture and Rural Development and organized by the Vietnamese Association of Seafood Exporters and Producers – GAA actively participated in the opening ceremony and conference program, and met individually with a number of key industry leaders in an effort to advance the organization’s mission of finding the world through responsible aquaculture.

“Vietfish was a great experience for GAA, giving us the opportunity to renew old ties with groups like VASEP, while forging new relationships with groups like the Vietnamese Pangasius Association,” said Peter Redmond, vice president of market development for GAA’s Best Aquaculture Practices (BAP) division. “We were touched by the generosity and hospitality provided. Vietfish was a great opportunity to familiarize ourselves with the supply chain of the aquaculture industry.”

Vietfish 2014 kicked off with an opening ceremony that included Redmond among the distinguished guests invited to participate in the ribbon cutting. GAA staff later sponsored a welcome reception and took to the stage to present awards to three Vietnamese companies for their commitment to the BAP third-party certification program. Mihn Phu Seafood Group, Stapimex Group and UTXI Aquatic Products Processing Group were recognized with GAA’s “Commitment to Excellence” awards. All three companies are working independently to advance responsible aquaculture in Vietnam.

On August 6, Roper participated in a panel discussion at the Vietnam Pangasius Forum as a marketplace expert. The forum was organized by VASEP and the European Union-funded SUPA (Establishing a Sustainable Pangasius Supply Chain in Vietnam) project.

After Vietfish 2014, the GAA staff visited the Mihn Phu Aqua Mekong Shrimp Vet Laboratory, Vietnam’s first shrimp pathology lab. The primary mission of the lab is to support research toward sustainable aquaculture for Mihn Phu and its partners. The lab also provides free services and consultancy to thousands of farmers in Vietnam and colleagues throughout Southeast Asia.

GAA actively participated in the August 7 conference program at Vietfish. Redmond and Ken Corpston, BAP’s Asia-Pacific coordinator, led a seminar titled “BAP Certification and Market Opportunities.” Also representing GAA was Jane Bi, BAP’s market development manager for Asia, and Nguyen Thi Thanh Binh, who works with BAP-certified facilities in Vietnam on behalf of GAA.

On August 6, Roper presented GAA awards to (from left) Minh Phu President and CEO Le Van Quang, Stapimex Technical Manager Nguyen Dang Khoa and UTXI Vice Chairman Nguyen Huong Nhu. Also on stage was VASEP General Secretary Truong Dinh Hoe.

GAA Co-Hosts, Exhibits At China Aquatic Expo

Forum on early mortality syndrome, which continues to take a toll on the global shrimp-farming sector, although advancing knowledge is leading toward improved practices and better control of the disease. Carson Roper, international business development manager for the Best Aquaculture Practices (BAP) certification program, spoke on market-place issues at the conference. Also attending the expo were Jane Bi, BAP’s market development manager for Asia, and Ken Corpston, BAP’s Asia-Pacific coordinator.

The Global Aquaculture Alliance was collaborating with National Fish and Seafood and the Sustainable Fisheries Partnership (SFP) in a project to bring sustainable shrimp farmers door to door certification (BAP) certification. With the support of GAA, National Fish and Seafood will pilot the first four groups of shrimp farmers in Vietnam, Indonesia and India. These four groups will be targeted to launch the first Aquaculture Improvement Projects through SFP to document improved practices at the farm and zonal levels. Farms within the groups will practice similar culture methods and be located within the same geographic region. Although operating independently, they will receive centralized direction and review regarding compliance with certification standards and quality management. The system is expected to provide sufficient transparency for effective desktop audits in preparation for site audits and formal certification.

“We are very excited with this collaboration,” said Peter Redmond, BAP vice president of market development. “It is great to see the whole supply chain working together to get the job done and deliver meaningful change on the ground, while delivering more two-star BAP shrimp to the marketplace.”

GAA Partners With National Fish, SFP On Project For Small Farms

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GAA Signs MoU With China Aquatic Alliance

GAA President George Chamberlain (left) joined Chen Si, president of the Zhanjiang branch of CAPMPA, in formally signing the memorandum.

The Global Aquaculture Alliance has signed a memorandum of understanding (MoU) with the China Aquatic Products Processing and Marketing Alliance (CAPMPA) in which the two organizations will work collaboratively to advance responsible aquaculture in China and globally through the exchange of information and research.

GAA President George Chamberlain (left) presented the awards to Gouldian President Le Zhang and representatives of Allied Pacific at the China International Aquatic Products Exposition.

GAA and CAPMPA inked the agreement during the inaugural China International Aquatic Products Exposition in Zhanjiang, China, on June 18. GAA exhibited at the exposition and participated in the CAPMPA-organized forum.

“This is an extremely important agreement,” said Peter Redmond, vice president of market development for GAA’s Best Aquaculture Practices (BAP) division. “We recognize the role that CAPMPA plays on both the domestic front and export front, and together we believe that we can bring about real change and deliver greater sustainability. The China MoU?”

GAA President George Chamberlain signed the MoU on behalf of GAA along with Chen Si, president for Zhanjiang Aquatic Products Promoting and Marketing Alliance, the Zhanjiang branch of CAPMPA.

In the MoU, CAPMPA agreed to help identify and enroll facilities in the BAP program to increase the number of BAP-certified facilities in China and to help identify marketplace endorsers in China. CAPMPA will also tap GAA’s expertise in its efforts to establish good aquaculture practices in China regarding food safety, environment responsibility, social responsibility and animal welfare.

In return, GAA pledged to help identify market endorsers to further promote responsibly produced Chinese farmed seafood products to retailers and foodservice operators worldwide. GAA also agreed to offer training and seminars to help Chinese producers apply the BAP standards and improve their practices.

GAA Presents Excellence Awards

GAA presented Zhanjiang Gouldian Aquatic Products Co. Ltd. and Allied Pacific Group with “Commitment to Excellence” awards during the China expo in recognition of their commitment to BAP certification.

To qualify for the award, a company’s first facility must be certified for at least seven years, offer a minimum of three-star product and demonstrate knowledge of ecosystems and communities in which it operates beyond the requirements of the BAP standards.
Auditor candidates and observers represented eight countries at the Adelaide course.

The Global Aquaculture Alliance’s Best Aquaculture Practices (BAP) division presented its first auditor-training course in Australia from June 1 to 7. Held at the Rockford Hotel in Adelaide, the course was attended by returning auditors and new auditor candidates, and eight observers.

The course covered all BAP certification standards and included a seafood HACCP course for processing plant auditor candidates. The course was taught by BAP Vice President Lisa Goché and Jeff Peterson, BAP director of quality control.

New GAA Members From Vietnam, India

As an international non-profit, non-governmental association, the Global Aquaculture Alliance (GAA) serves producers, processors, marketers and retailers of seafood products worldwide. All aquacultures in all sectors are welcome in the organization.

SeaVina Joint Stock Co. is GAA’s newest Vietnamese Member. SeaVina is a seafood processor and exporter based in Can Tho City, Vietnam. Established in 2009, it exports shrimp and pangasius to Europe, Asia, Africa, Australia and the Middle East.

In conjunction with the Global Seafood Shareholding Co. in Vietnam’s Kien Giang Province and the Grobest Industries Ltd. feed mill in Bien Hoa, Dong Nai, Vietnam, SeaVina supplies shrimp bearing labels with three stars under the Best Aquaculture Practice (BAP) certification program. The SeaVina processing plant produces both black tiger and white shrimp in a variety of raw, cooked and value-added forms.

BAP Holds Certification Workshop In Vietnam

The Global Aquaculture Alliance’s Best Aquaculture Practices (BAP) division held a successful farm certification workshop in Can Tho, Vietnam, on June 11. Organized with assistance from the Vietnamese Association of Seafood Exporters and Producers, the workshop was attended by more than 90 participants from the Pangasius, shrimp, tilapia and barramundi sectors. Representatives from government agencies, certification bodies and NGOs were also in attendance.

The workshop included updates on BAP’s multi-species farm standards and the process of certifying farms. It was taught by BAP Asia-Pacific Regional Coordinator Ken Corpron with assistance from Thi Thanh Binh Nguyen, BAP’s authorized representative in Vietnam.

“The BAP topics generated lively discussions, and participants expressed great satisfaction with the workshop, asking that follow-up workshops be scheduled to cover some subjects in greater detail,” Corpron said.

BAP’s management team regularly holds such workshops in Southeast Asia and worldwide to help move farmers closer to certification.

GAA Maintains Commitment To Social Justice

GAA will continue to proactively address these matters by working with all aquaculture stakeholders on practical solutions.

GOAL 2014 Workshop To Address Fishing Issues

To address the issue of social justice aboard fishing vessels for reduction fisheries, GAA will include this as a key topic at an October 7 feed workshop featuring representatives of leading seafood non-governmental organizations before the organization’s GOAL conference in Ho Chi Minh City, Vietnam. GAA recognizes that all relevant organizations and government agencies need to be at the table if solutions are to be realized. For more information on the GOAL 2014 program and attending the feed workshop, contact GAA Communications Manager Steven Hedlund at +1-207-517-2314 or steven.hedlund@gaaalliance.org.

Long John Silver’s Endorses BAP Certification

Long John Silver’s, the United States’ largest quick-service seafood restaurant chain, to the growing list of retailers and foodservice operators that endorse Best Aquaculture Practices (BAP) certification.

In adopting BAP certification as part of its sustainable seafood procurement policy, Long John Silver’s will work with the Global Aquaculture Alliance and its suppliers to ensure that its farmed seafood, when available, is sourced from BAP-certified facilities.

“As a seafood restaurant leader, our mission is to promote seafood, and we are really focusing on sustainability,” said Marie Zhang, chief food innovation officer and senior vice president of research and development, quality assurance and supply chain at Long John Silver’s. “We think we can work with GAA to promote sustainably farmed seafood that’s not just good quality, but that’s also environmentally and socially responsible.”

Currently, all farmed shrimp sold at Long John Silver’s restaurants originate from BAP-certified farms in India and Ecuador, she said. The partnership with GAA will help enable Long John Silver’s to secure other products sourced from BAP-certified farms.

Owned by the LFS Partners consortium based in Louisville, Kentucky, USA, Long John Silver’s has more than 1,200 restaurants. In addition to being a market endorser, the company is joining GAA as a sustaining member.
As the Best Aquaculture Practices certification program extends its presence across the globe, BAP welcomes the addition of new shrimp farms in Asia and processing plants that handle shrimp, tilapia, salmon, Pangasius and mussels in various parts of the world. BAP also welcomes three newly certified feed mills in Vietnam and Thailand.

Hundreds of BAP-certified facilities worldwide now supply seafood produced in compliance with the BAP standards developed by the Global Aquaculture Alliance. By implementing Best Aquaculture Practices standards, program participants can better meet the demands of the growing global market for wholesome seafood produced in an environmentally and socially responsible manner.

### Table 1. Recent BAP certifications around the world.

<table>
<thead>
<tr>
<th>Farm/Facility</th>
<th>Location</th>
<th>Country</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandhya Marines Ltd. – IOM 1</td>
<td>Visakhapatnam, Andhra Pradesh</td>
<td>India</td>
<td>Shrimp</td>
</tr>
<tr>
<td>The Unison Frozen – TSM 3</td>
<td>A. Muni, Rerning</td>
<td>Thailand</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Continental Corp. Unit 2</td>
<td>Visakhapatnam, Andhra Pradesh</td>
<td>India</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Confederate Cove Mussels</td>
<td>Borden-Carleton, Prince Edward Island</td>
<td>Canada</td>
<td>Mussels</td>
</tr>
<tr>
<td>C.P. Thailand – Klang</td>
<td>Klang, Rayong</td>
<td>Thailand</td>
<td>Shrimp</td>
</tr>
<tr>
<td>C.P. Vietnam Corp.</td>
<td>Phong Dien District, Thu Thien Hue Province</td>
<td>Vietnam</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Cimasa Ciudad de Mantos, S.A.</td>
<td>Duran, Guayas</td>
<td>Ecuador</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Investment Commodities Fisheries Corp.</td>
<td>Binh Tan District, Ho Chi Minh City</td>
<td>Vietnam</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Ocean Edibles International</td>
<td>Villaflor District, Taru, Naut</td>
<td>India</td>
<td>Shrimp</td>
</tr>
<tr>
<td>Aquarangas Dos Lagos S.A. de C.V.</td>
<td>Otsua, Chiapas</td>
<td>Mexico</td>
<td>Tilapia</td>
</tr>
<tr>
<td>Farta Comsor</td>
<td>Puerto Montt</td>
<td>Chile</td>
<td>Salmon</td>
</tr>
<tr>
<td>Seven Seas Fish Co., Ltd.</td>
<td>Raymond, British Columbia</td>
<td>Canada</td>
<td>Salmon</td>
</tr>
<tr>
<td>Tunexas Hongyo Fisheries</td>
<td>Furing County, Yunnan Province</td>
<td>Chile</td>
<td>Tilapia</td>
</tr>
<tr>
<td>Zhongshan Da Song Frozen Food Co., Ltd.</td>
<td>Zhejiang, Guangdong</td>
<td>China</td>
<td>Tilapia</td>
</tr>
</tbody>
</table>

### Feed Mills

<table>
<thead>
<tr>
<th>Farm/Facility</th>
<th>Location</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.P. Vietnam – Bau Xeo</td>
<td>Trang Bom District, Dong Nai</td>
<td>Vietnam</td>
</tr>
<tr>
<td>C.P. Vietnam – Ben Tre</td>
<td>Chau Thanh District, Ben Tre</td>
<td>Vietnam</td>
</tr>
<tr>
<td>Gold Co. Specialties Co., Ltd.</td>
<td>A. Singhanakorn, Songkhr</td>
<td>Thailand</td>
</tr>
</tbody>
</table>

Recognizing aquafeed supply as one of the major challenges facing aquaculture, GAA is setting aside an entire day, in addition to one hour of the plenary, to aquafeed at GOAL 2014 in Vietnam. The goal of the day-long breakout – which takes place on October 7 from 9 a.m. to 5 p.m. at the Park Hyatt Hotel, adjacent to the Sheraton Saigon – is to generate a series of recommendations that GAA can present to the aquafeed sector as it continues on its path toward greater sustainability. The recommendations will be summarized during a GOAL panel discussion on October 9.

Key questions to be posed at the breakout include: What is needed to ensure a responsible aquafeed supply? What roles are innovation and technology playing in improving feed formulations? How can aquaculture compete for ingredients with other food sectors, especially for marine protein ingredients? What is the outlook for the fishmeal and fish oil supply? What can the industry do to address allegations of labor abuse abroad? What is the outlook for the fishmeal and fish oil supply? What can the industry do to address allegations of labor abuse abroad? How can the aquafeed industry address concerns about animal welfare?

The aquafeed breakout will be moderated by Melanie Siggs of HRH The Prince of Wales’ International Sustainability Unit, who also moderated the aquafeed breakout at GOAL 2013. Confirmed to speak at the breakout are Andrew Mallison of IFFO, Anton Immink of the Sustainable Fisheries Partnership, Libby Woodhatch of Seafish’s Responsible Fishing Scheme, Lukas Manomaitis of the U.S. Soybean Export Council, Steve Hart of the Soy Aquaculture Alliance, Art Jabber of Aquafide, independent consultant John Kilpatrick, Johannes Pucher and Ulfert Focken of the Life Science Center of the University of Hohenheim in Germany, and Katrina Nakamura and Pramod Ganapathiraju of Labor Screen Safe and the Sustainability Incubator.

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Additional speakers may also participate. Please check the GOAL 2014 program webpage for the latest list: www.gaaliance.org/GOAL2014/goal-program.php.
Leadership and Learning

Help make aquaculture’s journey toward greater production and sustainability possible by joining the 300-plus seafood professionals from around the world who attend GAA’s annual Global Outlook for Aquaculture Leadership conference. Through GOAL, GAA strives to carry out its mission of responsible aquaculture by providing a venue at which leadership development, cooperation and education are encouraged.

Why Attend GOAL?

Since its inception in 2001, GOAL has evolved into a must-attend event for many top-level seafood executives and aquaculture thought leaders. GOAL features three days of information and analysis on industry, retail and foodservice, government, academia, the investment community and the NGO community. Join other seafood thought leaders representing thousands of outlets and millions in buying power in Ho Chi Minh City, as GOAL returns to Vietnam after a nine-year hiatus.

Program Highlights

As outlined in the program schedule on the following pages, GOAL 2014 sessions and breakouts cover the issues faced by those in the aquaculture and seafood industries. The schedule also includes time for discussion and consideration of possible solutions.

Feed: A day-long workshop on aquafeed sustainability is the highlight of Day 0. Moderated by Melanie Siggs of HRH The Prince of Wales’ International Sustainability Unit, it will feature representatives of various ingredient sectors, including fishmeal, soymeal, processed animal proteins and other alternatives. Competitors for feed ingredients and social responsibility are among the subjects to be addressed in depth.

A Day 2 panel featuring Jeff Sedacca of National Fish & Seafood and Anton Immin of Sustainable Fisheries Partnership will center on work being done to engage small-scale shrimp farmers in the responsible aquaculture movement through certification. George Watene of the 4C Association will also present on the coffee industry’s 4C approach to sustainability through industry collaboration and smallholder engagement.

China’s Marketplace: As CEO of Wuhan Lanesync Supply Chain Management Co., Ltd., Zhu Changjiang has 20 years of experience in seafood and foodservice, as well as insights into the restaurant and logistics industries. A Day 3 keynote, he will share perspectives on how to succeed in the burgeoning Chinese marketplace. Zhu’s company supports 35,000 restaurants and hotels, and also operates 200 retail outlets.

Aquaiculture Insurance And Risk Management: “Investment capital” has been identified by GAA as one of aquaculture’s major challenges. Øistein Thorsen, principal consultant at Triel, will lead off Day 2 with a presentation encouraging the investment community to invest in aquaculture, followed by a panel on aquaculture insurance and risk management, headed up by Paddy Secretan of ALMS Ltd.

GOAL 2014

2014 HO CHI MINH CITY VIETNAM

OCT 7-10 SHERATON SAIGON HOTEL & TOWERS

Join Us In Vietnam

GOAL is attended by a cross-section of representatives from industry, retail and foodservice, government, academia, the investment community and the NGO community. Join other seafood thought leaders representing thousands of outlets and millions in buying power in Ho Chi Minh City, as GOAL returns to Vietnam after a nine-year hiatus.

Health Management: On Day 1, GAA’s George Chamberlain will lead a panel on “lessons learned” from early mortality syndrome (EMS) to develop a strategy on disease risk management. Shrimp pathologist Tim Flegel of Mahidol University is among the panelists. Chamberlain will also present the preliminary results of GAA’s EMS case study.

Small-Scale Farmers: A Day 2 panel featuring Jeff Sedacca of National Fish & Seafood and Anton Immin of Sustainable Fisheries Partnership will center on work being done to engage small-scale shrimp farmers in the responsible aquaculture movement through certification. George Watene of the 4C Association will also present on the coffee industry’s 4C approach to sustainability through industry collaboration and smallholder engagement.

Food Safety: Food safety is one of the major pillars of the Best Aquaculture Practices third-party certification program. On Day 2, Steve Otwell of the University of Florida and Ivan Bartolo of Seafood and the Seafood Importers and Processors Alliance will present on the impacts of existing and forthcoming U.S. and E.U. food safety legislation on imported seafood.

Marketplace Access: Moderated by GAA’s Peter Redmond, Day 3’s roundtables are a GOAL fixture. More than 20 prominent North American and European retailers, foodservice operators, suppliers and NGOs will take the stage to address the challenges facing aquaculture, including Chris Brown of ASDA, Ally Dingwall of Sainsbury’s, Charlotte Maddocks of Tesco, Julian Mahieu of Delhaize, Jean-Louis Meuric of Davigel/Nestlé, Huw Thomas of Morrisons, Marie Zhang of Long John Silver’s and Joe Zhou of Red Lobster.

To set the stage on Day 1, attendees will hear overview reports on global production for major farmed species from experts Jim Anderson of the World Bank and Ragnar Tvetenes of the University of Stavanger. Their figures will reveal ongoing changes in supply due to disease and other problems that shift markets and affect pricing. As traditionally strong producing areas falter, others rise.

Production Trends: To set the stage on Day 1, attendees will hear overview reports on global production for major farmed species from experts Jim Anderson of the World Bank and Ragnar Tvetenes of the University of Stavanger. Their figures will reveal ongoing changes in supply due to disease and other problems that shift markets and affect pricing. As traditionally strong producing areas falter, others rise.

Scan to access the GOAL 2014 registration page.

www.gaalliance.org/GOAL2014
Scan to access the GOAL 2014 registration page.
**Day 1 – Wednesday, October 8**

**GOAL 2014: Production Data, Disease Management**

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
<th>Speaker(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30 a.m.</td>
<td>Registration: Sheraton Saigon, Level 3</td>
<td>Wally Stevens, Global Aquaculture Alliance</td>
</tr>
<tr>
<td>8:00-8:15 a.m.</td>
<td>Opening Remarks</td>
<td>Peter Redmond, Best Aquaculture Practices</td>
</tr>
<tr>
<td>8:15-8:45 a.m.</td>
<td>Keynote: Accessing the Chinese Marketplace</td>
<td>Zhu Changliang, Wuhan Lanesync Supply Chain Management Co. Ltd.</td>
</tr>
<tr>
<td>8:45-9:00 a.m.</td>
<td>Presentation</td>
<td>To be announced</td>
</tr>
<tr>
<td>9:00-9:45 a.m.</td>
<td>Retail Roundtable #1</td>
<td>To be announced</td>
</tr>
<tr>
<td>9:45-10:15 a.m.</td>
<td>Coffee Break</td>
<td>To be announced</td>
</tr>
<tr>
<td>10:15-11:00 a.m.</td>
<td>Retail Roundtable #2</td>
<td>To be announced</td>
</tr>
<tr>
<td>11:00-11:45 a.m.</td>
<td>Retail Roundtable #3</td>
<td>To be announced</td>
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<tr>
<td>11:45 a.m.—12:30 p.m.</td>
<td>Retail Roundtable #4</td>
<td>To be announced</td>
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<tr>
<td>12:30-1:00 p.m.</td>
<td>Closing Remarks</td>
<td>Travis Larkin, The Seafood Exchange</td>
</tr>
</tbody>
</table>

**Featured Retail Roundtable Panelists**

Mike Berthet, M & J/Brookes
Patrick Blow, Marks & Spencer
Estelle Brennan, Lyons Seafood
Chris Brown, ASDA
Josanna Busby, Delhaize America
Rich Castile, Giant Eagle
Bill DeMento, High Liner Foods
Ally Dingwall, Sainsbury’s
Steve Disko, Schnucks Markets
Anton Imink, Sustainable Fisheries Partnership
Charlotte Maddocks, Tesco
Julian Mahieu, Delhaize
Jean-Louis Meuric, Davigel/Nestlé
Ari Jadwin, AquaFude
Steve Hart, Soy Aquaculture Alliance
Anton Immink, Sustainable Fisheries Partnership
Jeff Sedacca, National Fish & Seafood
Anton Imink, Sustainable Fisheries Partnership
Steve Othwell, University of Florida
Ivan Bortolo, Seafood, Seafood Importers and Processors Alliance

**Day 2 – Thursday, October 9**

**GOAL 2014: Challenges**

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
<th>Speaker(s)</th>
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<tbody>
<tr>
<td>8:00-8:15 a.m.</td>
<td>Opening Remarks</td>
<td>To be announced</td>
</tr>
<tr>
<td>8:15-8:45 a.m.</td>
<td>Keynote: Investing in Aquaculture</td>
<td>Østein Thoresen, Trei</td>
</tr>
<tr>
<td>8:45-9:30 a.m.</td>
<td>Panel: Aquaculture Insurance and Risk Management</td>
<td>Paddy Secretan, AUMS Ltd. and Cesar Real, RMB Insurance Brokers</td>
</tr>
<tr>
<td>9:30-9:45 a.m.</td>
<td>Leadership and Innovation</td>
<td>Ted van der Put, IDH (the Dutch Sustainable Trade Initiative)</td>
</tr>
<tr>
<td>9:45-10:00 a.m.</td>
<td>Leadership and Innovation</td>
<td>George Walence, 4C Association</td>
</tr>
<tr>
<td>10:00-10:30 a.m.</td>
<td>Panel: Providing Small-Scale Farmers Access to the Marketplace</td>
<td>Jeff Sedacca, National Fish &amp; Seafood</td>
</tr>
<tr>
<td>10:30-11:00 a.m.</td>
<td>Coffee Break</td>
<td>To be announced</td>
</tr>
<tr>
<td>11:00-11:30 a.m.</td>
<td>Presentation: Preferred Freezer Services Aquaculture Innovation and Leadership Award</td>
<td>To be announced</td>
</tr>
<tr>
<td>11:30 a.m.—12:30 p.m.</td>
<td>Panel: Recommendations From Aquafeed Workshop</td>
<td>To be announced</td>
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</table>

**Day 3 – Friday, October 10**

**GOAL 2014: Market Issues**

<table>
<thead>
<tr>
<th>Time</th>
<th>Subject</th>
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</tr>
</thead>
<tbody>
<tr>
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Charlotte Maddocks, Tesco
Julian Mahieu, Delhaize
Jean-Louis Meuric, Davigel/Nestlé
Kathleen Mullen-Lee, FishWise
Wendy Norden, Monterey Bay Aquarium
Down Purchase, Marine Conservation Society
Carl Salamone, Wegmans
Jeff Sedacca, National Fish & Seafood
Huw Thomas, Morrisons
David Wier, Meijer
Scott Williams, B&J’s Wholesale Club
Laky Zeraduchi, Seafood Direct
Shane Zhang, Long John Silver’s
Joe Zhou, Red Lobster/Darden Restaurants
In late July, National Fish & Seafood, Inc. launched a project to broaden the accessibility of third-party aquaculture certification to benefit small-scale shrimp farmers and drive improvements in environmental protection, biosecurity and traceability.

From the early days of the seafood sustainability movement to today’s on-the-ground work with small-scale shrimp farmers, National Fish & Seafood, a U.S.-based division of Pacific Andes International Holdings, has positioned itself as an industry leader in seafood sustainability. The company’s newly coined slogan, “Investing Today For Seafood Tomorrow” — which will make its official debut at the Global Aquaculture Alliance’s GOAL 2014 conference — resonates across all of its activities.

Those activities date back to GAA’s formation in 1997. National Fish & Seafood is a Founding Member of the non-profit organization and since then has been actively involved at the board level, supporting GAA’s mission of responsible aquaculture. The company has also witnessed first-hand the growth of GAA’s Best Aquaculture Practices (BAP) third-party certification program.

Today, National Fish & Seafood is affiliated with more than 50 BAP-certified processing plants, spanning three species (shrimp, tilapia and Pangasius) and six countries (China, India, Indonesia, Malaysia, Thailand and Vietnam). The majority of the shrimp is from farms contracted by National Fish & Seafood through partnerships with local processing plants, allowing the company to control production. The company has also hosted more than 100 hours of responsible shrimp aquaculture seminars in India, Indonesia, Thailand and Vietnam since 2004. This degree of partnership ensures supply chain integrity and prevents supply disruptions.

What’s more, in 2012, National Fish & Seafood committed at a corporate level to sell only shrimp from facilities with two, three or four BAP stars. However, family farmers can be marginalized in the sustainability movement. That’s why National Fish & Seafood is collaborating with GAA and the Sustainable Fisheries Partnership (SFP) on a project to bring small-scale shrimp farmers closer to BAP certification. With the support of GAA, National Fish & Seafood will pilot the first four groups of shrimp farmers — two in India, one in Vietnam and one in Indonesia. These four groups will be tapped to initiate the first Aquaculture Improvement Projects through SFP to document improvements in practices being made. National Fish & Seafood will strive to provide marketplace access for more than 120 small-scale farmers.

National Fish & Seafood is also pioneering the concept of network integration within the global seafood industry. Network integration is different from vertical integration in that National Fish & Seafood owns the product, not the facility, giving the company the flexibility to overcome supply disruptions, which is especially important during outbreaks of diseases such as early mortality syndrome.

National Fish & Seafood is also working with Farmforce to develop state-of-the-art technology for seafood traceability. The software is helping to change the game by using mobile technology to make traceability and compliance an integral part of small-scale farm production. The use of a mobile, cloud-based platform for tracking traceability on the farm presents a new and cutting-edge innovation that will give the company real-time access to each farm’s activities.

National Fish & Seafood, Inc.  
11-15 Parker Street • Gloucester, Massachusetts 01930 USA • Tel: +1-978-282-7880 • Web: www.nationalfish.com
Simply Reliable

H & T Seafood and its affiliated companies comprise an integrated group that combines effective sourcing with modern processing and a nationwide distribution system to supply top-quality seafood products to restaurant and supermarket customers throughout North America.

Since its founding in 1993, H & T Seafood has solidly built its business on two guiding principles: competitive pricing, and a passionate dedication to providing our customers with the highest-quality seafood products. The underlying foundation of our business is our long-term supplier relationships, along with a proven track record of supply chain management and a strong financial base.

Competitive Advantages

H & T Seafood is a primary producer of shrimp and swai fillets, as well as a full range of processed fish products. To maintain total quality control, our company owns and operates dedicated processing plants in Vietnam that produce over 10,000 metric tons of seafood products per year.

H & T distributes a full line of shrimp products, including raw, peeled and cooked, along with our all-natural, chemical-free shrimp under our Double Blue Shrimp® label. H & T’s Fresh Harvest® seafood line also includes head-on, headless and a wide range of value-added products. We offer a wide range of fish products that includes swai fillets, tuna, tilapia, salmon, pollock, cod, whitefish, mahi mahi and ocean perch.

Our plants incorporate multiple production lines for efficiency, as well as high-capacity cold storage and freezing capabilities. We are certified under the Best Aquaculture Practices program, and meet various international food safety standards, including HACCP, British Retail Consortium (BRC), International Food Standard (IFS), ISO 22000 and ISO 14000.

Continued Dedication

With over 20 years in business, H & T Seafood is here to stay with annual revenues exceeding U.S. $700 million and growing. Our 2,000 employees worldwide comprise a professional team capable of delivering our expertise and experience to our many customers.

Our home office is located within our 125,000-square-foot distribution center located in Bell, California, USA. Please contact us for your seafood needs, and expect the best every time. We’re Simply Reliable!
For decades, Grobest has operated with quality, professionalism, innovation and integrity, and been committed to promoting sustainable aquaculture in major producing countries across Asia. We believe that only by respecting local cultures and taking part in regional development can bring long-term benefit to all parties.

SUSTAINABILITY
Sustainable aquaculture has to reconcile prosperity with nature. Grobest R&D programs are environment-oriented and people-oriented. We care if we create more value from the natural resources we utilize. Grobest has developed bioactive feed additives and environmentally friendly green feed to improve animal health, growth performance and flesh quality, and at the same time, reduce impacts on the farm environment and water resources.

FOOD SAFETY & TRACEABILITY
Supplying farmed seafood with freshness and safety is not the ultimate goal, but the starting point. Grobest is involved in hatchery, farming, feed and processing for tilapia and shrimp. Every step of our traceability and safety control system is carefully linked to ensure our Best Aquaculture Practices-certified products supplied to consumers are of the highest quality.

SOCIAL RESPONSIBILITY
Grobest grows with local societies. We care about people and the communities surrounding us. Through the Grobest Education Foundation and other programs, we sponsor activities related to education and charity.

Wherever in the world, Grobest upholds its commitments to bring value to life and achieve the ultimate goal of sustainability.
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. Beginning from a single facility in 1989, the company is now a global leader in temperature-controlled supply chain services.

PFS recently completed the rollout of its frozen LTL trucking network providing customers with end-to-end logistics service. PFS can assist customers at every link in the supply chain: from managing drayage services for import/export containers, to facilitating the third-party warehousing of strategic inventories, to ensuring the delivery of products across the United States.

In order to meet the growing needs of its customers, PFS recently opened two new facilities located in San Leandro, California, and Miami, Florida. The San Leandro facility adds 15 million cubic feet of cold storage to the company’s total footprint, contains three different temperature zones and is the largest facility the company has built to date. This is the company’s seventh facility in California and its first in northern California. The newest Miami location (its fourth facility in Florida and third in southern Florida), adds 9 million cubic feet of cold storage space and on-site inspection capability to the company’s presence in Florida. Both facilities are open for business.

DEDICATION TO INNOVATION

As part of the company’s continuing domestic expansion, PFS is currently managing the development and construction of new projects in several strategic regions. The company is expanding one of its existing warehouses in Houston, Texas, as well as constructing its eighth warehouse in its home state of New Jersey. The Houston expansion will add 5 million cubic feet of cold storage, and the New Jersey facility will add 8 million cubic feet.

Additionally, the company is constructing its first warehouse in the state of Washington. The warehouse, located in Richland, will add over 40 million cubic feet of cold storage capacity and will feature automation throughout the facility. The facility has an automated shuttle track system that provides 207 miles of pallet support and can handle 50 rail cars per day. Upon completion, the Richland facility will be the largest single cold storage facility built at any one time in the world.

STRATEGIC LOCATIONS, SUSTAINED GROWTH

All PFS facilities are strategically and conveniently located. Locations include port areas, strategic intermodal hubs and highly traveled distribution lanes throughout California, Georgia, Florida, Illinois, Massachusetts, New Jersey, New York, Pennsylvania, Texas, Virginia and China.

PFS continues to follow the vision of Founder and CEO John J. Galiher. The company strives to be a multinational gateway service provider through the use of state-of-the-art, ecologically sensitive facilities in every country. PFS continues to aggressively pursue markets where it can meet the needs of customers engaged in the international import/export of frozen seafood, aquaculture products, proteins and any commodities that require supply chain services. The company’s sustained growth stems from its reputable customer service and its commitment to hiring outstanding people with the talent and drive to perform.

Preferred Freezer Services
1 Main Street, 3rd Floor • Chatham, New Jersey 07928 USA • Tel: +1-973-820-4070 • Web: www.preferredfreezer.com
Mazzetta Company, LLC

Mazzetta Company literally goes to the end of the earth for its customers. Mazzetta Company sources products from 20 countries around the world. By extending its reach around the globe for well-managed, environmentally sound aquaculture and wild-caught fisheries, Mazzetta Company is able to meet an ever-increasing demand for premium-quality fish and shellfish. Based on this diversity, Mazzetta Company enthusiastically touts the benefits of certified products. At a minimum, a certified product – be it under Best Aquaculture Practices, the Marine Stewardship Council or another program – carries a measure of social, environmental and food safety principles. Certification alone does not satisfy Mazzetta Company’s requirements, but the benefits are such that striving to increase the percentage of certified products the company offers remains an annual goal. Likewise, Mazzetta Company has a short-term goal of significantly expanding the requirements of its third-party social-auditing program. These audits ensure the absence of child labor, forced labor, human trafficking, harassment and abuse, and guarantee worker health and safety.

Quality Assurance

Mazzetta Company’s on-the-ground presence and extremely high standards, driven in large part by a layered audit process, separate Mazzetta Company from its competitors. Mazzetta Company’s quality-assurance program is comprised of three main pillars: third-party food safety audits, internal quality assurance audits and third-party social audits. Many of the farms and facilities Mazzetta works with are regarded among the most modern and professionally managed seafood companies in the world. They incorporate state-of-the-art production procedures, comprehensive training, employee medical-screening programs and sophisticated recall and traceability procedures. In addition, their record-keeping systems, HACCP programs and approved vendor control programs are excellent, and their laboratory analytical capabilities and sanitation methods exceed industry standards.

As of 2014, 100% of Mazzetta Company’s warmwater shrimp are BAP-certified. Achieving this goal has a lot to do with the internal high standards of Mazzetta Company, but it is also likely a reflection of the continuing maturation of the shrimp aquaculture industry. It is Mazzetta Company’s belief that by awarding business to farms and plants that are committed to sustainability through high certification standards, they reaffirm their own commitment to these important issues.

Shared Commitment to Sustainability

Mazzetta Company’s operating practices aim at meeting customers’ needs without compromising the ability of future generations to meet their own needs. This idea has been embraced in the marketplace through terms like sustainability and corporate responsibility.

At Mazzetta Company, business decisions that consider preserving environmental resources have always been a part of the bottom line. Being responsible in every aspect of business decision making not only helps to produce the highest-quality products, but also demonstrates to customers a shared commitment to the products they bring to their family’s dinner tables. In the long run, Mazzetta Company sees that as the right decision for the growth and viability of the industry, and also essential to ensure that future generations have the same resources available to them that exist today.

Mazzetta Company, LLC
P. O. Box 1126 • Highland Park, Illinois 60035 USA • Phone: +1-847-433-1150 • Web: www.seamazz.com

Commitment
to quality
to our customers
to the people who share in our hard work
to the future of our industry
to the future of our planet

At Mazzetta Company, we’ve always understood that the seafood business is about more than just seafood.
MSD Animal Health aquaculture business is focused on developing and delivering scientifically proven and economically valuable health solutions for the major farmed fish species around the world.

Our company has been involved in many of the innovations that have occurred in the global fish-farming health area over the past 30 years. This has given us a leadership position in the industry.

Our participation in the GOAL 2014 conference celebrates a series of breakthroughs in supporting aquaculture worldwide. This year, MSD Animal Health registered vaccines for *Streptococcus*, *Tenacibacterium maritimus*, iridovirus and *Pisirickettsia salmonis* (SRS), and extended claims for our AQUAFLOR® (florfenicol 50%) product. All of these developments fill gaps in the range of solutions available to fish farmers.

**BREAKTHROUGH INNOVATIONS**

Our business has grown from its pioneering roots with the merger of companies that have been responsible for some of the major scientific breakthroughs in the field of aquaculture health. Notable among these are the first-ever commercial fish vaccine (Wildlife 1976), the first European registered fish vaccine (AVL 1982), the first IPNv and recombinant IPNv vaccines (Intervet Norbio® 1994), the first oral vaccine and first oral virus vaccine (AVL 1993 and 1999), the first registered fish antibiotic (Coopers 1975), the first tilapia vaccine, the first oil adjuvanted vaccine in Japan and the first PDv vaccine (2008).

In addition to its long history of innovation in vaccine development, MSD Animal Health has developed pharmaceutical products suitable for treating fish destined for E.U., Japanese and U.S. markets, meeting the highest regulatory standards required. These include the parasiticide SLICE® for the treatment of sea lice and AQUAFLOR® for treating a wide range of bacterial infections.

**STRATEGIC COMMITMENT**

MSD Animal Health is committed to the science of healthier fish to meet the challenges the aquaculture industry faces now and in the future. Our focus is to work closely with fish farmers, fish health experts, and veterinary and industry partners to develop and deliver innovative, integrated fish health platforms to meet the needs of sustainable aquaculture production worldwide.

In line with this strategic commitment, we have developed a series of health programs to support our business around the world. These include an active strain collection and identification program conducted with our customers farming tilapia worldwide. The SLICE® sustainability, SLICE® Monitor and Ring Fence programs support best practices for sea lice treatment using SLICE® in Europe, Canada and Chile. We have introduced PD Monitor in support of the Norvax® Compact PD vaccine now widely used in all at-risk farms in Norway, Ireland and Scotland.

MSD Animal Health has two dedicated aquaculture innovation sites, in Bergen, Norway, and Singapore. These sites have the teams and facilities to conduct the work required to develop aquaculture vaccines and other medicines for the future.
Changing The Paradigm

Feed Is An Investment, Not A Cost

Focus on feed...the bottom line

Managing costs is a primary focus because feed normally is the largest single cost item when compared to all other inputs. Frequently, the approach taken when managing this cost item is to reduce the total cost of the feed used and/or reduce the unit cost (price) of the feed. In either case, the focus is on “cost.”

Is this the best business strategy? Likely not, because it is a much better business practice to consider what we pay for feed as an investment and not as a cost. Cost is an outlay of money required to get something, whereas an investment is an outlay of money with the expectation of gaining a profit. In the latter case, the focus is on return on investment, not just cost or price. Almost any additional cost may be justified if the return is increased.

If the above assumptions are correct, then the primary profit opportunities in aquaculture do not lie in production ponds, but rather in the minds of the influencers and decision makers concerned with feed purchases. The challenge thus becomes changing the paradigm so that feed is viewed as an investment and not as a cost.

Feed Drives Production

Feed influences the outcomes and productivity of aquaculture animal production systems to a far greater extent than does for warm-blooded animal production systems to a far greater extent. Feed 2 was arbitrarily designated to produce maximum growth. Feed 9 was 28% protein. Feed 1 was presented in Table 1.

The results of the 35-day study are provided in Table 1.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Growth (g/week)</th>
<th>Percentage of Control</th>
<th>Statistics*</th>
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</thead>
<tbody>
<tr>
<td>Feed 1</td>
<td>2.41</td>
<td>100</td>
<td>a</td>
</tr>
<tr>
<td>Feed 2</td>
<td>1.92</td>
<td>90</td>
<td>a, c</td>
</tr>
<tr>
<td>Feed 3</td>
<td>1.92</td>
<td>90</td>
<td>a, b</td>
</tr>
<tr>
<td>Feed 4</td>
<td>1.72</td>
<td>81</td>
<td>a, c</td>
</tr>
<tr>
<td>Feed 5</td>
<td>1.52</td>
<td>71</td>
<td>e, f</td>
</tr>
<tr>
<td>Feed 6</td>
<td>1.51</td>
<td>71</td>
<td>f</td>
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<tr>
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</tr>
<tr>
<td>Feed 8</td>
<td>1.48</td>
<td>69</td>
<td>e, f</td>
</tr>
<tr>
<td>Feed 9</td>
<td>1.32</td>
<td>62</td>
<td>c, d, e</td>
</tr>
</tbody>
</table>

* Treatments associated with the same letter are not statistically different at the 5% level.

Summary:
In aquaculture, managing feed costs is a primary focus because feed normally is the largest single cost input. Changing decision making regarding feeds from a focus on cost only toward viewing feed as an investment can result in greater profitability. High-performance aquaculture must meet demanding criteria in terms of palatability, acceptability, particle size and texture, buoyancy, water stability and nutrient profile. In addition, aquatic animals are much more susceptible to pesticide and mycotoxin feed contaminants. Feeding methods are also more demanding.

High-performance aquaculture feeds must meet these more demanding criteria in their formulation, manufacture and application. The lack of attention to these criteria results in lower-performing feeds, declining productivity and reduced profits.

Feeds Perform Differently

In 2013, Zeigler Brothers undertook a project to compare the growth performance of different commercial shrimp feeds available in the Western Hemisphere marketplace. The feed trial was conducted in an indoor research facility using recirculated clearwater. On November 7, each of the 0.03-m³ tanks were stocked with five animals averaging 8.43 g in weight from a commercial shrimp hatchery in the continental United States. Each feed was fed to eight replicates with feeding occurring 15 times a day. Salinity was 33 ppt, and the temperature was 29°C. Lighting was provided 12 hours on and 12 hours off. The results of the 35-day study are presented in Table 1.

Eight of the feeds had 35% protein, while feed 9 was 28% protein. Feed 1 was specially formulated to produce maximum growth. Feed 2 was arbitrarily designated to control the feed to which all other feeds were compared on a percent-age basis. Shrimp growth through the study was considered normal for this type of experiment. Shrimp given feed 1 grew the fastest, 2.51 g/week, which was statistically different than all other feed treatments except the control, in which shrimp grew at a rate of 2.13 g/week. The growth rates for all of the other feed treatments was numerically (some statistically) lower than that of the control. The different commercial feeds resulted in different weekly rates of growth, from 1.32 to 2.13 g. From this controlled-conditions study, it cannot be concluded that these feeds would perform in the same manner under commercial pond conditions, but it does clearly illustrate that different commercial feeds do indeed perform differently when comparing growth rates, which are directly related to the dietary integrity of each feed when not influenced by natural productivity.

Although the growth data are quite definitive, no data was accumulated on feed efficiency, survival, stress tolerance, integrity of the immune system and resistance to disease. These and many other factors affecting profitability are well known to be related to nutrition, feeds and feeding.

We Can Do Better

Economic modeling using current economic data showed that a 15% improvement in growth could absorb a 25% ($0.29/kg) increase in feed cost and still break even. This clearly illustrates that making feed-purchasing decisions based on the lowest-cost feed is quite likely to marginalize profit opportunities. A much more successful and profitable aquaculture industry is on the horizon, if and when the paradigm can be changed to view feed purchases as an investment and not as a cost. Both customers and suppliers alike would be well served through a concerted team effort to change the paradigm.

Bottom Line: Invest more wisely in feeds and watch profits grow.
focus on feed

New IFFO Position: Fish As Food Or Feed

Marine sources of protein and oil can carry anti-nutritional factors that compromise growth and fish health. To date, only marine ingredients provide the long-chain omega-3 oils in farmed fish that are important for good human nutrition.

Low-Level Species

The use of small, bony fish for reduction to a dried protein (fishmeal) and oil fractions is a well-established industry and was historically based on stocks of fish for which there was little or no direct human consumption market. Populations of these species can be large. The largest fishery in the world, with an annual catch of approximately 5 mn, is for the Peruvian anchoveta. The fish are near the beginning of the food chain and can be grouped under a heading of low-trophic-level species (LTLS). The protein and oil they contain, however, can be used in a number of applications, the most important of which is as ingredients for farmed animal feed and, in the case of oil, for health food supplements.

Recently, concerns have been expressed over this industry, claiming the use of LTLS species for animal feed deprives marine animals as well as local communities of a nutritious food source. Fisheries are said to be badly managed and environmentally unsustainable. Farmed fish consume more wild fish than they convert to growth, critics say.

The Biological Argument

In 2012, the Lenfest Ocean Program report “Little Fish, Big Impact” highlighted the views of a wide panel of fishery scientists on the vulnerability of forage fish, i.e., the small species that form the prey for larger fish and marine mammals. The report called for more precautionary approach to stock management to recognize the dependence of the wider ecosystem on a stock, rather than managing the stock to maintain a reproductive and viable population of the target species. While the need for an ecosystem approach is becoming more recognized, many of the Lenfest report’s conclusions were based on questionable economic arguments.

Recent reports in the media and from some lobby groups have misrepresented the value of small fish and ignored the good management practices now in place in many fisheries and improvement projects driven by market demand. Claims that it is wrong to feed fish to farmed fish ignore the decreasing amounts of fishmeal used in feed, the increasing amounts of fishmeal recovered from fish processing entering fishmeal production. FAO’s significant levels of the protein content previously supplied by fishmeal has already been substituted with soya and other land-based proteins.

Summary:

The use of small, bony fish as feed for farmed fish is important for global food security and appropriate if fisheries are well managed and do not deplete local communities of food. Although its overall production is rising, aquaculture is using less fishmeal and fish oil in feed formulations, and increasing amounts of this fishmeal and oil come from by-products of fish processing. Stock management regulators should balance the need for healthy ecosystems with the need for a viable industry, making decisions based on the best scientific advice.

The Social Argument

Many countries, particularly in the developing world, have poor nutrition, and the protein contained in LTLS fish caught locally is a possible option. There is an argument for local fish to be directed for human consumption rather than conversion to feed for high-value farmed species for export to other markets. However, this assumes the local consumers want to eat the wild species landed and denies the community earning income from farming that can be used for discretionary purchases of food or other goods and services. Despite years of marketing and promotion by government and independent activists, the consumption of anchovies in Peru for human consumption is still extremely low at around 2% of the catch, leaving a significant surplus.

A recent trend finds fewer whole fish used in fishmeal production. Species that previously were reduced, such as herring, mackerel and blue whiting, now have human consumption markets offering better returns for fishermen and processors. This reduction has been offset by an increasing amount of by-products and trimmings from fish processing entering fishmeal production.

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New IFFO Position: Fish As Food Or Feed

IFFO – The Marine Ingredients Organisation

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Anchovy fisheries support fishmeal production in many areas of the world.

members of IFFO that all stocks must be managed in a responsible manner to ensure the long-term survival of the industry and the fish stocks on which it relies. The main stock used for reduction, Peruvian anchoveta, was recognized in a 2008 study by the Fisheries Centre at the University of British Columbia in Canada as well managed. The permitted catch is regulated each year to protect recruitment of juveniles and to respond to environmental changes.

Approximately 42% of the global fishmeal and fish oil production comes from factories that are certified to the IFFO Responsible Supply standards, an independent third-party scheme that is accredited under ISO 65 guidelines and includes a requirement to observe the FAO Code of Conduct for Responsible Fisheries.

The level of precaution applied to the stock management is a matter for regulators, who should balance the need for a healthy ecosystem with the need for a viable industry, making decisions based on the best and most current scientific advice. IFFO members support responsible management of fisheries and believe calls to remove fishmeal from animal feeds ignore the availability of responsibly sourced raw material and remove incentive for improvements.

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A 2012 report for FAO concluded that feeding fishmeal and fish oil to farmed fish and crustaceans did not deplete community resources. The 2014 “State of World Fisheries and Aquaculture” reports for FAO concluded that feeding fishmeal and fish oil to farmed fish and crustaceans did not deplete community resources.

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ties of food, but increased the effective annual supply of fish for human consumption by 7 to 8 mmt. “Halting industrial fishing would lead to an immediate loss of fish for food,” the report said. “The practice of using fish as feed is viable, that is, is capable of surviving as a practice within the coming decades.”

Annual fishmeal production has been steady at around 4.5 mmt for the last few years, yet feed volumes have increased with the growth of aquaculture, necessitating a reduction in the percentage of fishmeal used. Much of the protein content has already been substituted with soya and other land-based proteins to the level where further reductions could incur a penalty in fish growth or health. Typical inclusion rates for farmed salmon diets are now at around 10% fishmeal, compared to 40% or more in the past.

Small species of oily fish of the kind used in fishmeal and fish oil can be rich in the important long-chain omega-3 fatty acids. If there is no direct human consumption of these species, inclusion in the diets of farmed fish can transfer these nutrients into products demanded by consumers.

**The Economic Argument**

Although, in principle, it would be wrong to deprive local populations of fish for direct human consumption, there is also the consideration of the rights of fishers to market their catch for their best return. If they receive greater economic returns by selling their catches for reduction rather than direct human consumption, regulators would be interfering with market mechanisms and the livelihoods of fishers if policies seek to influence sales.

One of the main references arguing against the use of small species of fish for the production of fishmeal is the previously mentioned Lenfest report “Little Fish, Big Impact.” This report quoted the value of forage fisheries globally as U.S. $5.6 billion, compared to the value of the larger fish that eat them at $11.3 billion. Therefore, it is better to leave these fish in the water as food for larger, more valuable fish. Unfortunately, this argument is flawed for several reasons.

The price of forage fish in the report was taken from a database published in 2007 by U. R. Sumaila and co-workers. This database itself was compiled from prices collected between 1950 and 2002. For much of this period, forage fish had little or no value, and fish oil was routinely burned for fuel. Now, with the opening of markets for health supplements and animal feed since the 1990s, the last decade of the database period, the value of fish oil has increased by four to five times, and the value of fish protein has tripled, with a corresponding increase in the value of the catch.

The report compared the landed price of, for example, anchoveta with that of tuna. This compared two different stages of the food chain and undervalued the LTLS fish, which, as stated, have little value as whole fish. Their value is realized when they are reduced to their constituent protein and oil for further applications. A more relevant comparison would use prices of products as consumed by humans, for example, farmed salmon partly fed on fishmeal from anchoveta versus tuna.

In hunting prey, predators like tuna expend a significant amount of energy that is therefore not available for growth. Farmed fish, partly fed on fishmeal, are fed without the need to hunt and convert far more of the energy consumed to growth. There are many claims that farmed fish consume five or more times their body weights in wild fish through their diets. This figure is completely out of date, as fishmeal levels in diets have been reduced in favor of soya and other non-marine protein sources. Taken across all species of farmed fish that are given feed, about 1 kg of fish is grown for each 0.3 kg of whole fish used in the diet. Farmed fish are net producers of fish protein. The higher-value farmed species most in demand perform best when their diets include a percentage of fishmeal. Removing fishmeal requires the use of alternative protein sources, usually vegetable, which can incur a growth penalty and may compromise the health of the fish, both resulting in costs to farmers.

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**Next Steps**

IFFO members have demonstrated their commitment to responsible fishery management and will continue to engage with other stakeholders to apply good management practices. Improved programs and liaison with the scientific and NGO communities are key parts of the effort to raise standards for the future. In conjunction with this, IFFO will communicate with regulators and policy makers to help them make informed decisions based on accurate, current data and good science.

**Editor’s Note:** This article was based on a longer document available at www.iffo.net/node/602 that represents the views of the members of IFFO, the international trade association for the fishmeal, fish oil and wider marine ingredients industry. IFFO members represent over 50% of the global production of fishmeal and fish oil and approximately 75% of the traded value.
The use of markers can accelerate the development of shrimp lines with improved soy protein utilization.

**Summary:**
Recent research by the authors discovered genetic markers for the identification of Pacific white shrimp with enhanced capability to convert soy protein when fed a ration that contains little or no fishmeal and high levels of dietary soybean meal, and that some families were more capable of doing so.

**Methods**
At Integrated Aquaculture International in Hawaii, USA, 20 full-sib families were produced from broodstock maintained in the IAI breeding program. From fertilization through hatching, each family was kept in an individual 40-L aquarium. After hatching and until the families reached the P.L.10 stage, approximately 21 days post-spawning, they were maintained in individual 100-L tanks. At P.L.10, 500 postlarvae from each family were divided between two, 700-L round fiberglass tanks with automatic feeders and self-cleaning bottoms. From stocking to a weight of 1 g, the shrimp were fed a standard fishmeal-based diet at a rate approximately equal to 7% of the biomass. When that average weight was reached, all animals were marked with colored elastomer tags on their abdomens to differentiate families and redistributed with four animals from every family in each tank, making 80 animals/tank. This experimental design allocated 20 replicates for each diet and 20 replicates for each family to enable discrimination of family differences in growth rate between diets. A fishmeal-based control diet was fed in 20 tanks, and a soy protein diet was given to shrimp in the other 20 tanks (Table 1).

Table 1. Composition of experimental diets fed to Pacific white shrimp.

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Fishmeal Diet (%)</th>
<th>High-Soy Diet (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fishmeal, Peruvian sardine</td>
<td>20.05</td>
<td>20.05</td>
</tr>
<tr>
<td>Soybean meal, 48%</td>
<td>35.00</td>
<td>64.44</td>
</tr>
<tr>
<td>Wheat</td>
<td>36.89</td>
<td>23.00</td>
</tr>
<tr>
<td>Krill meal</td>
<td>3.00</td>
<td>5.16</td>
</tr>
<tr>
<td>Leucine</td>
<td>1.29</td>
<td>1.87</td>
</tr>
<tr>
<td>Monocalcium phosphate</td>
<td>1.05</td>
<td>1.64</td>
</tr>
<tr>
<td>Vitamin/mineral premix</td>
<td>0.23</td>
<td>0.25</td>
</tr>
<tr>
<td>Fish oil</td>
<td>2.41</td>
<td>3.30</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>0.06</td>
<td>0.13</td>
</tr>
<tr>
<td>DL-methionine</td>
<td>–</td>
<td>0.10</td>
</tr>
<tr>
<td>L-lysine</td>
<td>–</td>
<td>0.10</td>
</tr>
</tbody>
</table>

**Proximate Composition**

| Dry matter                       | 91.00             | 91.00             |
| Crude protein                    | 37.50             | 37.50             |
| Crude fat                        | 7.00              | 7.00              |
| Ash                              | 8.00              | 6.20              |
| Crude fiber                      | 2.20              | 2.84              |

**Nutrient Composition**

| Arginine                         | 2.30              | 2.40              |
| Lysine                           | 2.30              | 2.30              |
| Methionine + cystine             | 1.40              | 1.40              |
| Threonine                        | 1.37              | 1.33              |
| Total phosphorus                 | 1.12              | 1.02              |
| Eicosapentaenoic acid            | 0.42              | 0.41              |
| Docosahexaenoic acid             | 0.46              | 0.44              |
| Cholesterol                      | 0.15              | 0.15              |
| Phospholipids                    | 1.50              | 1.50              |

**Annual global fishmeal production has been relatively stable at around 5 mmt for several decades, but aquaculture has grown rapidly over the same period. While aquaculture only consumed around 5 mmt for several decades, but aquaculture has grown rapidly over the same period.**

**Feeding Trial**
Immediately following the first phase of the study, animals from the top-performing families were combined into 4 tanks/family on the fishmeal control diet and 4 tanks/family on the soy protein diet.

**Table 2. Performance across 20 families of Pacific white shrimp fed diets based on fishmeal or soymeal for eight weeks in the first phase of the study.**

<table>
<thead>
<tr>
<th>Response</th>
<th>Fishmeal Diet</th>
<th>High-Soy Diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survival (%)</td>
<td>95.10 ± 1.02</td>
<td>95.10 ± 1.02</td>
</tr>
<tr>
<td>Initial weight (g)</td>
<td>1.03 ± 0.01</td>
<td>1.02 ± 0.02</td>
</tr>
<tr>
<td>Final weight (g)</td>
<td>11.94 ± 0.21</td>
<td>14.89 ± 0.28**</td>
</tr>
<tr>
<td>Weight gain (g)</td>
<td>10.91 ± 0.20</td>
<td>13.86 ± 0.27**</td>
</tr>
<tr>
<td>Weight gain (%)</td>
<td>1.065 ± 0.24</td>
<td>1.359 ± 0.23**</td>
</tr>
<tr>
<td>Growth rate (g/week)</td>
<td>1.36 ± 0.02</td>
<td>1.73 ± 0.02**</td>
</tr>
<tr>
<td>Feed-conversion ratio</td>
<td>1.29 ± 0.02</td>
<td>1.22 ± 0.02**</td>
</tr>
</tbody>
</table>

* P < .01 ** P < .001

**Summary:**
In recent research sponsored by the Soy Aquaculture Alliance, the authors discovered genetic markers for the identification of shrimp with enhanced capability to convert soy protein when fed a ration that contains little or no fishmeal and high levels of dietary soybean meal, and that some families were more capable of doing so.

**Methods**
At Integrated Aquaculture International in Hawaii, USA, 20 full-sib families were produced from broodstock maintained in the IAI breeding program. From fertilization through hatching, each family was kept in an individual 40-L aquarium. After hatching and until the families reached the P.L.10 stage, approximately 21 days post-spawning, they were maintained in individual 100-L tanks. At P.L.10, 500 postlarvae from each family were divided between two, 700-L round fiberglass tanks with automatic feeders and self-cleaning bottoms. From stocking to a weight of 1 g, the shrimp were fed a standard fishmeal-based diet at a rate approximately equal to 7% of the biomass. When that average weight was reached, all animals were marked with colored elastomer tags on their abdomens to differentiate families and redistributed with four animals from every family in each tank, making 80 animals/tank. This experimental design allocated 20 replicates for each diet and 20 replicates for each family to enable discrimination of family differences in growth rate between diets.

A fishmeal-based control diet was fed in 20 tanks, and a soy protein diet was given to shrimp in the other 20 tanks (Table 1). The diets were formulated to contain approximately 38% crude protein and 7% fat. Soybean meal and other plant proteins were the primary replacements for fishmeal. The fishmeal diet contained approximately 20% fishmeal, a common inclusion level currently found in commercial shrimp feeds. The fishmeal diet also contained soybean meal and wheat. The high-soy diet substituted all of the fishmeal with soybean meal and other plant ingredients.

After eight weeks, each animal was individually weighed and its sex was recorded. The families were ranked according to their growth rates on each diet. In addition, tissue samples were taken for DNA analysis from the six largest males, six largest females, six smallest males and six smallest females from the five fastest-growing families and five slowest-growing families fed the soy protein diet.

**Feeding Trial**
Immediately following the first phase of the study, animals from the five top-performing families were combined into 4 tanks/family on the fishmeal control diet and 4 tanks/family on the soy protein diet.

A six-week feeding trial was conducted to determine the performance of the families fed either the fishmeal or high-soy diets.

Performance, feed conversion and survival were analyzed for differences among diets, families and tanks within families, with family and diet as main factors and initial weight as covariate. The objective was to identify single nucleotide polymorphisms (SNPs) that showed a large positive or negative correlation with the growth rate of shrimp fed a high-soy-protein diet.

The results of the data collected will determine the feasibility...
of using a traditional selection program or a marker-assisted selection program to improve the utilization of soy protein in a strain of *L. vannamei* shrimp.

**Results**

The data from phase 1 indicated that both family and diet significantly affected the performance of shrimp. In general, shrimp fed the high-soy diet outperformed shrimp fed the fishmeal diet. However, the three fastest-growing families performed well on both the fishmeal and high-soy diets (Table 4).

There were also differences in final weights among different families. Some families had the ability to grow better on the soy diet than on the fishmeal diet, while other families grew better on the fishmeal diet. However, the three fastest-growing families performed well on both the fishmeal and high-soy diets (Table 4).

**Perspectives**

These findings indicated that Pacific white shrimp are capable of utilizing and tolerating relatively high levels of dietary soybean meal and that some families are more capable than others of utilizing higher levels of dietary soy. Although these results need to be corroborated, they suggest that selection of families of shrimp with higher tolerance for soy could result in an increased use of soy and other plant proteins that could ultimately result in decreased dependence on fishmeal in dietary formulations for shrimp. Further work is needed to evaluate these findings in longer-term commercial production trials. There is also a need to assess the effects on gut morphology, immune function, flavor and texture of shrimp.

Fifty-three percent of the 5,405 SNPs discovered in this population had significant differences in allele frequency and genotype frequency between the fast- and slow-growing families. The dissimilarity in genotypic frequency of some of the SNPs was related to significant differences in weight between the fast- and slow-growing families. Considering the effects of two or more SNPs on weight simultaneously increases the accuracy of predicting weight from the SNP genotypes. The combined use of six SNPs to predict weight was equal in accuracy to traditional quantitative genetics methods. An additional study is needed to confirm the relationship between the important SNPs and quantitative genetics methods. An additional study is needed to confirm the relationship between the important SNPs and quantitative genetics methods.

Pacific white shrimp are capable of utilizing and tolerating relatively high levels of dietary soybean meal, and some families are more capable than others of utilizing higher levels of dietary soy.
Controlled irradiation can improve the microbiological quality of rendered meals and help eliminate the risk of feed-borne diseases.

**Gamma Irradiation Enhances Nutritional Value Of Animal By-Products**

**Summary:**
Much research to develop substitutes for fishmeal and fish oil in aquafeed has focused on animal by-products such as poultry meal, blood meal, and meat and bone meal. Gamma irradiation treatment presents a possible processing technique for reducing anti-nutrients and improving the nutritive quality of many feed ingredients. Irradiation at up to 50 kGy can convert feed components into easily digestible forms and improve the microbiological quality of rendered meals. However, changes in the physicochemical properties can be noteworthy.

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New potential aquatic species are being studied and cultured each year, creating a need for specialized feed formulas and feed ingredients. However, one of the major challenges faced by the aquaculture industry worldwide is sourcing alternative proteins and oils for aquaculture feeds.

**Animal By-Products**
Because many aquatic species require rations high in protein,
a wide variety of animal and marine meals of very similar appearance are used. Of all the ingredients used in the manufacturing of aquaculture feeds, fishmeal is typically considered the most critical, as it is required in certain quantities for the health and performance of many species.

Much research to develop substitutes for fishmeal and fish oil is now focused on commodity animal by-products such as poultry meal, blood meal, meat and bone meal; oilsseeds, especially soybeans; and microbial proteins. While the fishmeal content of some feeds has been reduced considerably, the complete replacement of fishmeal and fish oil in aquaculture feeds faces challenges. In particular for carnivorous species, vegetable proteins seem to have inappropriate amino acid balance and poor protein digestibility, although the inclusion of animal by-products can help overcome this problem. On the other hand, species that feed at a lower trophic level or that are omnivores can be fed a prepared feed that includes a high percentage of plant proteins.

Anti-Nutritional Factors

A useful way to evaluate a protein is to consider its biological value – not only how rich it is in essential amino acids, but also how well it can be digested by the target species. However, dietary anti-nutritional factors have been reported to adversely affect the digestibility of proteins, bioavailability of amino acids and protein quality of several ingredients widely used for the manufacturing of aquaculture feeds. Gamma irradiation treatment presents a possible alternative and additional processing technique for reducing anti-nutrients and improving the nutritive quality of many ingredients.

Irradiation is a technology that enhances food safety, quality and commerce (Table 1). It is the process in which food is exposed to gamma rays from a radioactive source such as cobalt. These gamma rays can penetrate ingredients, feed and its packaging. Sometimes, it is referred to as “cold pasteurization,” as it does not increase the temperature of the treated material.

Gamma irradiation at doses of 30 to 45 kGy can increase the crude protein digestibility of meat and bone meal (MBM) by 13 to 15%. In addition, the results obtained in experiments carried out to study the effects of different doses of gamma irradiation on nutritive components and chemical aspects affecting the quality of MBM showed that gamma doses of 5 to 20 kGy had no effect on the total acidity values, but increased the values of lipid oxidation and total volatile basic nitrogen.

Whether fat content affects irradiation-induced oxidative changes is unclear. MBM contains less than 2% of the polyunsaturated fatty acids such as linoleic acid and linolenic acid, and studies revealed no significant change in the levels of trans-fatty acids as the irradiation dose increased. However, peroxidation oflard and tallow can be greatly increased with minimum exposure to gamma irradiation.

Ongoing research is investigating the effects of radiation processing on poultry meals, with emphasis placed on the availability of certain amino acids, particularly lysine. Preliminary results indicated that gamma irradiation can induce minor effects on the chemical compositions of the meals. Radiation treatment at a dose level of 5 kGy caused no loss in available lysine, while the contents of peptides increased with increases of the irradiation dose.

Perspectives

The utilization and digestibility of proteins and carbohydrates are improved with the use of radiation by converting the feed components into easily digestible forms. Gamma irradiation also offers potential for improvement of the nutritional values of numerous feed ingredients.

The use of radiation up to 50 kGy can improve the microbiological quality of rendered meals, thus eliminating the risk of feedborne diseases. However, changes in the physiochemical properties of animal by-products can be noteworthy due to gamma irradiation.

Additional research is needed to scrutinize the interactions between protein partitioning and production of key molecules present in animal by-products, which will improve the production of novel feeds.

Table 1. Ionizing radiation doses accepted by the U.S. Food and Drug Administration.

<table>
<thead>
<tr>
<th>Product</th>
<th>Dose (kGy)</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat, wheat flour</td>
<td>0.2-0.5</td>
<td>Insect disinfection</td>
</tr>
<tr>
<td>Fish, mollusk, shrimp (fresh or frozen)</td>
<td>0.3-7.5</td>
<td>Storage extension</td>
</tr>
<tr>
<td>Poultry and meals</td>
<td>2.0-10</td>
<td>Microorganism removal</td>
</tr>
<tr>
<td>Animal feed and pet food</td>
<td>2.0-25.0</td>
<td>Salmonella control</td>
</tr>
<tr>
<td>Enzymes (dehydrated)</td>
<td>Max. 10</td>
<td>Microbial control</td>
</tr>
</tbody>
</table>

You can follow the leader or you can

BE THE LEADER
**Thomas Zeigler**

**Quality Feed, Feeding Key To Advances**

Over 50-plus years at U.S.-based Zeigler Brothers, Inc., Dr. Thomas R. Zeigler has witnessed aquaculture’s growth from niche to mainstream. When Zeigler joined the family company in 1961 as its director of nutrition, the commercialization of aquaculture was just getting off the ground. Today, aquaculture generates half of the global seafood production. As aquaculture has grown, so has Zeigler Brothers. In 1967, Zeigler became the company’s president and shifted its focus from commodity feeds to specialty aquatic and animal nutrition. His fingerprints are on many of the advances in aquaculture diets, from his research with the National Institutes of Health in the 1970s to work with the International Aquaculture Research Centre in the 1980s. He co-founded Vitamin Technologies Inc., which developed more than 70 unique nutritional technologies and products.

As senior technical advisor, past president and chairman of Zeigler Brothers – and a frequent contributor to the Global Aquaculture Advocate – Zeigler is also a big proponent of responsible aquaculture.

**Fishmeal**

“Competition for fishmeal as a feed ingredient based on a finite resource is a hot-button issue as of late. But when it comes to aquaculture, Zeigler isn’t concerned about competition and rising costs for fishmeal. “Am I worried about fishmeal?” Zeigler said. “Absolutely not. When the price of fishmeal gets too high, other commodities will work their way into the formulation of lower-cost feed, and the price of fishmeal will go down. It’s a matter of economics.”

But it’s also a matter of technology. “Fishmeal provides two important categories: protein and omega fatty acids,” Zeigler explained. “Concerning protein, there’s no problem replacing fishmeal with other animal and plant proteins. Concerning unsaturated fatty acids, technology is going to deal with that in terms of those produced in soy, algae and genetic engineering of high-fat plants. Natural selection and genetic engineering do the same thing. The only difference is the speed at which it takes place.”

**Nutrition, Feeding Practices**

Zeigler is far more concerned with nutrition and feeding practices, especially in shrimp aquaculture. In his “Bottom Line” column in the May/June edition of the Global Aquaculture Advocate, Zeigler wrote that improvements in performance through improved genetics and nutrition will not be fully realized unless appropriate feeding practices are implemented. He compared feeding shrimp to feeding a human baby – feed them a high-quality diet, and feed them frequently.

“It’s pretty fundamental,” Zeigler said. “There’s nutrition and the need for a balanced diet, and then there are eating habits. The feed has to be presented to the animals the way the animals want it, not the way people want to present it to them.” He suggested multiple applications of smaller amounts of feed for shrimp, for example.

Zeigler contemplated that greater amounts of shrimp can be produced if feeding practices are improved. But without quality feed that provides proper nutrition, improving feeding practices is a moot proposition.

“The shrimp industry has gone through some tough times, and the mentality is that feed represents the largest single cost of production,” Zeigler said. “The farmers demand lower-priced feed, and the feed companies acquire and produce lower-quality feed, which winds up affecting the productivity of shrimp farms. It’s a downward spiral. There are countries that could probably increase their productivity by 30% if they would just get it right.”

**Disease Factors**

The prevalence of early mortality syndrome (EMS) – and its financial drain on farmers and processors – an only worsening matter. The silver lining is the industry is seemingly learning from its mistakes.

“Early identification of the cause of a disease is key,” Zeigler said. “With EMS, it took a couple of years to realize what was causing it. We need to go all out” when a disease first hits.

“And I can’t comment enough on disease resistance,” Zeigler continued. “Genetic feed and marginal farming practices predispose animals to disease. If you can’t maintain the natural immune systems of the animals through proper management, disease will break out.”

“There’s also the genetic factor,” he said. “People have been breeding these animals for faster growth. I learned years ago that if you concentrate the desirable factors, you’re also concentrating the undesirable factors. Identifying fast growth, that’s fairly easy. But you’re not testing for resistance to disease.”

**Confident Future**

Despite the challenges aquaculture faces, Zeigler is optimistic about the future of aquaculture and its potential to meet the world’s food needs. He is also confident about the future of Zeigler Brothers, which is in its third generation of leadership.

“Personally, I feel that one of the most important aspects of our future is the ability and desire to live by our values,” Zeigler said. “Values are important in corporate success. Our values include a love of what we do and whom we work with, integrity, value (or our continuing contribution) and elegance (or our performance as a team). I think we have a new slogan, ‘Nutrition Through Innovation,’ provides us with a vision that we fully intend to continue as a leader in innovative nutritional products for aquaculture.”
The application of genetic improvement programs in the shrimp industry is relatively young compared to their use with other cultured species like salmon and tilapia. Commercial breeding programs for shrimp started with Pacific white shrimp, *Litopenaeus vannamei*, facilitating the rapid global adoption of this species and displacement of black tiger shrimp, *Penaeus monodon*, as the most cultured shrimp within just a few years. However, unlike those in the salmon sector, shrimp farmers do not follow a common model of cultivation. Those in the Americas mostly apply an extensive, low-density model versus the intensive, high-density model that predominates in Asia. The two cultivation models emphasize different requirements for postlarvae, which presents a challenge to breeding programs trying to satisfy the needs of the two regions.

The application of genetic improvement programs in the shrimp industry is relatively young compared to their use with other cultured species like salmon and tilapia. Commercial breeding programs for shrimp started with Pacific white shrimp, *Litopenaeus vannamei*, facilitating the rapid global adoption of this species and displacement of black tiger shrimp, *Penaeus monodon*, as the most cultured shrimp within just a few years.

Breeding Goals

All breeding programs set goals for the performance of their animals and thereby set “economic weights” for various breeding parameters to achieve the goals. In shrimp, there is a clear difference between the traits that are economically important in Central and South America versus those of Asia.

In the Americas, shrimp production tends to be extensive, with stocking densities ranging 10–30 animals/m² in ponds with areas between 6 and 10 ha. With such large ponds, it is difficult to apply good biosecurity measures and disinfect the water before stocking. Animals in such conditions cohabit with endemic pathogens, so disease resistance is a critical quality in the postlarvae stocked. In the Americas, shrimp farmers look for specific pathogen-resistant (SPR) rather than specific pathogen-free (SPF) lines.

On the other hand, Asian production systems tend to be intensive, with stocking densities from 90 to as high as 200/m² in ponds of less than 1 ha that require mechanical aeration. This model requires high biosecurity, disinfection of water before stocking, the use of crab and bird netting, and other measures. Consequently, most viral diseases tend to appear 60 days or more after stocking, when water exchange increases. Under this scenario, disease resistance is less important than fast growth in a race against time to get the shrimp to harvest size before they are hit by disease.

Early mortality syndrome has changed the breeding emphasis to more balanced models. Open breeders sell broodstock, while closed internal hatcheries sell postlarvae but not broodstock to third parties.
The utilization of F2 broodstocks has led to a major shift in the shrimp industry, with many breeding companies focusing on selective-breeding strategies to improve the disease resistance of shrimp. This has resulted in a shortage of high-quality shrimp postlarvae, which has led to an increase in the demand for genetically improved seed. The industry is facing a significant challenge in meeting this demand, as the narrow genetic base of shrimp produces animals with limited disease resistance. The utilization of F2 broodstocks has led to a more balanced approach in selecting traits, with a greater focus on disease resistance. However, the lack of disease resistance in shrimp postlarvae has led to the development of genetic programs for SPF shrimp broodstock, which are bred specifically for disease resistance.

### Industry Structure

Genetic improvement programs for shrimp have been developed to address the lack of disease resistance in shrimp postlarvae. These programs have been developed to address the limitations of the previous breeding programs. The new breeding programs focus on SPF shrimp broodstock, which are bred specifically for disease resistance. The development of these programs has led to a significant increase in the demand for genetically improved seed.

### Broodstock Segmentation

The increase in the demand for genetically improved seed has led to a significant change in the shrimp industry. The industry is now segmented into various categories, including imported, local, and wild shrimp. The segmentation of the industry has led to a greater focus on disease resistance, with many breeding companies developing genetic programs specifically for SPF shrimp broodstock.

### Industry Challenges

The industry is facing several challenges in meeting the demand for genetically improved seed. The narrow genetic base of shrimp produces animals with limited disease resistance, which has led to a shortage of high-quality shrimp postlarvae. The development of genetic programs for SPF shrimp broodstock has led to an increase in the demand for these programs, but the narrow genetic base of shrimp produces animals with limited disease resistance.

### Industry Opportunities

The development of genetic programs for SPF shrimp broodstock has led to significant opportunities for breeding companies. The development of these programs has led to a greater focus on disease resistance, with many breeding companies developing genetic programs specifically for SPF shrimp broodstock. The development of these programs has led to a significant increase in the demand for genetically improved seed.

### Figure 1

**Broodstock Segmentation in the Americas.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Imported From U.S.</td>
<td>38%</td>
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<tr>
<td>Pedigreed, Specific</td>
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<tr>
<td>Pathogen-Free, Locally Produced</td>
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</tr>
<tr>
<td>Pedigreed, Specific</td>
<td></td>
</tr>
<tr>
<td>Pathogen-Free, Imported From U.S.</td>
<td>23%</td>
</tr>
<tr>
<td>Non-Pedigreed, Mass-Selected From Ponds</td>
<td>18%</td>
</tr>
<tr>
<td>Without Inbreeding Control</td>
<td></td>
</tr>
</tbody>
</table>

### Figure 2

**Broodstock Segmentation in Asia.**

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
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<td>Pedigreed, Specific</td>
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<td>Without Inbreeding Control</td>
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</tbody>
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**Big Picture** Connects Shrimp Disease, Inbreeding

**Inbreeding**

Roger W. Doyle, Ph.D.
Genetic Computation Ltd.
5-6350 Lochside Drive
Victoria, British Columbia, Canada V8Y2T1
rd Doyle@genecomp.com

Summary:
Disease problems on shrimp farms may be partly driven by an interaction between management practices that cause inbreeding in small hatcheries and the amplification by inbreeding of susceptibility to disease and environmental stresses. The possible causal paths to shrimp disease include the relationship between susceptibility to pathogens and other environmental stresses and inbreeding. The author believes inbreeding is fundamentally a management issue that should be controlled at farm level through access to information on the genetic quality of postlarvae and resulting selection of postlarvae suppliers.

The main effect of inbreeding among animals is to make a bad environment worse. As environments deteriorate, inbred animals die faster than non-inbreds. The more inbred the stock, the worse the effect. Suitable stocks are inbred and non-inbreds. Amplification of stress mortality variables has been shown to be a major factor in humans, fish, shrimp and many other animals and plants in laboratory, farm and natural environments. As far as we know, all non-acidental causes of mortality, including disease, nutritional and temperature stress and competition, are amplified by inbreeding.

It is very important to realize that inbreeding does not cause, but amplifies disease mortality. In this, it is like the way that driving amplifies the death rate from highway accidents. Sober drivers have accidents, too, for all kinds of reasons, but the mortality from accidents is higher when drivers are drunk. By analogy, mortality from all kinds of lethal stress, including disease, is higher when stocks are inbred.

**Causal Paths, EMS/AHPN**
The environmental stress of most concern to shrimp aquaculture right now is a disease called early mortality syndrome (EMS) or acute hematopoietic necrosis (AHPN). The causal path diagram in Figure 1 summarizes the current widely held “big picture” relationship between diseases, including EMS/AHPN, and the aquaculture industry.

The disease mortality variable on the right side lumps together various measures of the seriousness of a disease, such as incidence, prevalence and mortality. The biosecurity regulations variable on the left lumps together most, if not all, current and planned regulatory activities intended to diminish the disease problem, such as prohibition of stocks that are not officially free of listed pathogens, prohibitions on the transfer of animals among geographical regions, quarantines and “kill orders” imposed on infected farms and hatcheries.

The causal paths in Figure 1 work in the following way. When inbreeding increases mortality in a farming region, like the emergence of a new pathogen, rising concerns among farmers, hatcheries and breeders puts pressure on bureaucrats, scientists and consultants who, in turn, increase the level of regulatory activity. The path that connects disease to regulation is labeled “Fear” in Figure 1. The fear pathway is positive because what is driving it is a more alarming disease, the effect (regulation) increases, too.

The second causal path in Figure 1 is labeled “Exposure” because the essential purpose of most regulatory activity is to reduce exposure of animals in the farm ponds to pathogens. The exposure pathway is negative, because when regulatory activity goes up, mortality goes down.

Figure 1 is obviously a simplified model of the regulatory relationship. Whenever you simplify a model, you should also simplify the question you are asking of it. Properly, we simply ask, “Is the system stable?”

Any engineer, statistician or audio technician will answer “yes,” because Figure 1 is a negative (or damping) loop. Something outside the loop drives mortality up, fear drives regulation up, increased regulation reduces exposure down, and as exposure goes down, so does mortality.

The model in Figure 1 is self-damping and predicts that when a new pathogen arises, the aquaculture system should...
The ongoing outbreak of early mortality syndrome/acute hepatopancreatic necrosis (EMS/AHPN) has had dramatic impacts on shrimp producers in affected countries in Asia and Mexico. Following reports of the disease being associated with broodstock management—for example, through the use of contaminated polychaetes—there has been a renewed focus on larval quality.

Investing in quality larvae fits well in the holistic approach required to achieve consistently successful shrimp production through the combination of biosecurity measures, stocking of healthy postlarvae and management of rearing conditions by controlling nutrition/feeding, sediment and water quality, and microbial communities.

EMS Treatments

In Mexico, INVE Aquaculture has been evaluating the activities of a commercial biocide and probiotic Bacillus strains against EMS-virulent Vibrio parahaemolyticus strains isolated by the team of Dr. Bruno Gomez-Gill at Centro de Investigación en Alimentación y Desarrollo (Center for Food Research and Development). More specifically, one of the probiotics was shown to inhibit the growth of 10 pathogenic Vibrio parahaemolyticus strains.

The strains of Bacillus had been selected for their ability to inhibit pathogens, be metabolically active in shrimp guts and culture water, degrade organic waste and improve feed digestibility. The practice of nursing postlarvae to a larger size before stocking into ponds has been strongly encouraged since the onset of the EMS epizootic. By itself, this will not solve the problems of EMS/AHPN. However, provided it is done with the appropriate biosecurity and suitable feed and water management, a nursery phase can contribute to improved postlarvae performance. The application of effective nursery protocols, whether in raceways or ponds, allows better control and stabilization of growth conditions, shorter cycles in open ponds and more crops per year.

Study Setup

In early 2014, a trial to evaluate the benefits of a select mixture of Bacillus strains during the larviculture and nursery phases for shrimp was carried out at a commercial hatchery in Mexico. The application of the Bacillus mixture during the initial growth of nauplii through P.L.3 led to a clear improvement in survival. At the end of a second phase reflecting growth to P.L.15, continued probiotic treatment increased overall postlarvae production as well as animal size.
P.L.6, postlarvae were transferred to two, 60-m³ raceways to allow following the performance of the shrimp to P.L.15 during the two-phase production cycle. Microbial products were used in both phases of culture. Finnmar hatchery is managed with limited water consumption. In the first phase, tanks were filled with 50% water, then algal culture until they reached full capacity. In the second phase, the raceways were initially filled fully with water, and no water was exchanged during the whole cycle.

To boost the immune systems of the larva, a complementary feed product was given to the larva at the end of the first phase and then throughout the second phase. Commercial probiotics were applied in the control tanks and the control raceway. The mixture of Bacillus was used for the two treatment tanks and raceways. The Bacillus probiotics were applied when the nauplii were stocked in the tanks and the postlarvae were stocked in the raceway to reach a final concentration of 5 x 10⁵ cfu/mL.

In the first phase, the Bacillus mixture was also applied on a daily basis in order to reach a final concentration of 1 x 10⁵ cfu/mL. In the second phase of rearing, the same mixture was coated on feed to reach a final concentration of 1 x 10⁸ cfu/g.

Results

The application of the selected mixture of Bacillus strains led to a clear improvement in survival. In the first phase of rearing, the survival was increased from 32 to 36% (Figure 1).

At the end of the second phase, this improvement in survival led to an increase in the number of shrimp that could be harvested (Figure 2). At over 1.3 million postlarvae, the number represented a 39% increase in output. Furthermore, the application of the Bacillus probiotic led to the production of almost 10% larger postlarvae (Figure 3).

Perspectives

This trial showed the benefits of applying a mixture of selected strains of Bacillus with proven action against Vibrio pathogens in both early and later phases of larval production. Although no microbiological data were collected during this trial, it is likely several mechanisms were involved in the improvements: colonization of the gut, inhibition or competition with Vibrios leading to a reduced abundance of potential pathogens and improved stimulation of the animals’ immune systems.

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- BAP Certified Tilapia

**SUSTAINABLE LIVING**

- Respects Marine Ecosystems
- Responsible Harvesting
- High Quality

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It seems aquaculture conferences do not typically attract the phycological community, so knowledge on seaweeds, their functions in ecosystems and their numerous uses in our everyday lives remains minimal, especially in the West. However, seaweed aquaculture is very significant. Seaweeds constitute the largest group of organisms cultured at sea since 2004. In 2012, seaweed represented 49.1% of the world mariculture production (Table 1).

In 2012, 95.6% of the world seaweed supply came from aquaculture, and only 4.4% was harvested from wild beds. Compared to what the Food and Agriculture Organization of the United Nations designates as "food fish" – finfish, crustaceans, mollusks and other aquatic animals for human consumption – seaweeds were the first group of organisms to pass the 50% farmed/wild harvest threshold, in 1971.

The global seaweed aquaculture production was 23.8 mmt in 2012 for a value of U.S. $6.4 billion, and it is estimated that production reached 26.1 mmt in 2013. Its average annual growth rate has been 7.7%. From an estimated 10,500 species of seaweeds, only six genera provide 98.9% of the production and 98.8% of the value: Saccharina, Undaria, Porphyra, Gracilaria, Kappaphycus and Sargassum.

At this IMTA site in the Bay of Fundy, Canada, kelps are cultivated in proximity to salmon cages and provide key services to the ecosystem.

It seems aquaculture conferences do not typically attract the physiological community, so knowledge on seaweeds, their functions in ecosystems and their numerous uses in our everyday lives remains minimal, especially in the West. However, seaweed aquaculture is very significant. Seaweeds constitute the largest group of organisms cultured at sea since 2004. In 2012, seaweed represented 49.1% of the world mariculture production (Table 1).

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<td>46.2</td>
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<td>9.1</td>
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<tr>
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<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>1.0</td>
<td>0.7</td>
</tr>
</tbody>
</table>

Table 1. Evolution of the world mariculture production of major species groups.
At the high-end Rosemount Inn in St. Andrews, IMTA salmon and kelp products are combined with other local products into delicious recipes.

can be averaged at around 0.35% nitrogen, 0.04% phosphorus and 3.0% carbon, and nutrient trading credits are valued at U.S. $10-30/kg, $4/kg and $30/mt for the compounds, respectively, the ecosystem services for nutrient bio-accumulation provided by the 23.8 mmt of worldwide annual seaweed aquaculture can be valued at between $892.5 million and $2.6 billion – as much as 40% of its present commer-
cial value. This significant value is, how-

Perspectives
The Western world’s animal-based aquaculture should recognize and take advantage of the environmental, economic and societal benefits provided by seaweeds. If we compare the evolution of food production in 1970 and 2012, aqua-
culture production was 7.0 bmt, split 85/15 between plants and animals, while the total aquaculture production was 90.4 mmt, split 60/40 between seaweeds and animals. The mariculture production was 48.5 mmt, comprised of 49% seaweeds and 51% animals.

Mariculture could appear more bal-
anced than total aquaculture, although, as mentioned above, 96.3% of seaweed aquaculture is concentrated in six Asian countries. Consequently, if aquaculture is to make a major contribution to the efficient and responsible food production systems of the future, far more produc-
tion and application of inorganic extractive seaweed and aquatic plants, and organic extractive animals must be develop-
med in a more evenly distributed manner throughout the world.

It is time to make the Blue Revolution green and apply agronomic principles to make aquacultural environments and “aquatic fields”, i.e., it is time for the Turquoise Revolution and aquaconomy. Humans will soon not be able to think of marine agriculture without natural solutions for securing their food and many derived products. They will have to turn increas-

Conclusion
The recognition and implementation of NTCs would give a fair price to extractive aquaculture species. They could be used as financial incentive tools to encourage single-species aquaculturists to contemplate IMTA as a viable aqua-
cultural option to their current practices. Beyond Nutrient Biomitigation
Seaweeds can be cultivated without the addition of fertilizers and agrochem-
cal, especially in an IMTA setting, where the fucoid aquaculture component provides the nutrients. Seaweed cultura-
tion does not require more arable soil and transformation of land for agricultural activities with accompanying loss of some ecosystem services. If appropriately designed, it can be seen as engineering new habitats and harboring thriving com-
munities, and can be used for habitat res-
toration. Moreover, it does not need irri-
tation, on a planet where access to water of appropriate quality is becoming more and more an issue.

As photosynthetic organisms, sea-

eweds are the only aquaculture compo-
nent with a net production of oxygen. All other fed and organic extractive compo-

dents are oxygen consumers. Hence, sea-

eweds contribute to the avoidance of coastal hypoxia. While performing photosynthesis, seaweeds also absorb carbon dioxide and hence participate in carbon sequestration, even if in a transitory manner. Conse-

quently, they could be a significant player in the evolution of climate change, slow-

ing down global warming, especially if their cultivation is increased and spread througho-

tout the world. By sequestering carbon dioxide and increasing PH in sea-

water, seaweeds could also play a signifi-
cant role in reducing ocean acidification.

Integrated Sequential Biofery
For too long, the products of fisheries and aquaculture have been processed according to a simple scheme: one species/ one process/one product. Seaweeds remain a relatively untapped resource with a huge potential. With careful planning at the time of harvesting and sequential processing, more than one product can be manu-
factured from seaweeds.

Seaweeds are prime candidates for the integrated sequential biofery (ISB) approach. On one hand, they can yield a wide range of bio-based, high-value compounds: edible food, food and feed ingre-
dients, biopolymers, fine and bulk chemi-

cals, agrochemicals, cosmetics, bioactive, pharmaceuticals, nutraceuticals and botanicals. On the other hand, lower valued bioproducts – biofuels, biogas, biokohls and other biomaterials – can also be generated from seaweeds.

Over the last decade, the Canadian Integrated Multi-Trophic Aquaculture Network at the University of New Brunsw-

wick has adopted this ISBN diversifica-
tion strategy with an industrial partner, Cooke Aquaculture Inc., in Atlantic Canada. IMTA kelps recapture some of the inorganic dissolved nutrients from fish farms, and the partners are develop-

ing markets for kelp use in human con-

sumption, cosmetics, fish feed and bio-


clear, production, along with.coellaborating and organic certification.

Human activities have altered the concentra-
tions of gases and other compounds in the atmosphere. Acid rain typically does not heavily affect aquaculture opera-
tions. However, the use of agricultural limestone can buffer water against the impacts of acid rain at facilities that use stream water. Due to higher carbon dioxide concentrations in the atmosphere, the amount of carbon dioxide that will dissolve in ocean water has increased. Decreased PH can thin the shells of some molluscan shellfish and reduce survival.

Acid-base relationships are important in aquatic water quality, because they influence PH and concentrations of carbon dioxide and alkalinity. As a general rule, most types of aquacul-
ture can be conducted best in waters that are slightly basic with PH of 7.5 to 8.5. In ponds, waters should have sufficient total alkalinity to buffer against PH change during periods of rapid phototropism photosynthesis.

Acid Rain
Since the mid-1970s, there has been concern over contami-
nation of the atmosphere with sulfur dioxide and nitrogen oxides. Global emissions of sulfur dioxide by human activities increased from about 55 mmt in 1950 to over 120 mmt in 1975. Nitrous oxide emissions were less than those of sulfur dioxide during that period, but they increased at a similar rate. In the atmosphere, sulfur dioxide and nitrogen oxides are oxid-
ed to sulfatic acid and nitric acid, respectively, and reach the earth as dry fallout or precipitation – the acid rain phenomenon. Because it is saturated with carbon dioxide, rainfall naturally is acidic with a PH of around 5.6. In and around heavily popu-
lated and highly industrialized areas, rainfall can have an average PH between 4.0 and 4.5, and rainwater from individual storms can be even more acidic.

Pollution factors such as acid rain and higher atmospheric carbon dioxide concentration are leading to reduced PH levels in ocean and surface waters, which negatively affects fish and shellfish.

Acid Rain can lessen alkalinity and lower PH. Declines in PH of one to two units have been observed in some lakes in the eastern United States and Canada, and adverse effects on fish health, reproduction, survival and growth have been noted.

Effects In Aquaculture
There has not been much concern about the effects of acidic rain in pond aquaculture. In areas where surface waters are suscep-
tible to acidification by acid rain, the application of agricultural limestone traditionally has been used to increase total alkalinity. This treatment buffers water against the impacts of acid rain. Trout hatcheries and farms supplied by stream water can be impacted by acid rain. Following heavy rainfall, the PH of water in some streams of the eastern U.S. can drop drastically. At some trout farms, inflow must be treated after heavy rains with lime to avoid the negative effects of low PH on fish. Acid rain is not con-
sidered a threat to the ocean, because ocean water is well buffered. News media coverage of acid rain subsided in recent years. Although this was partly because concentration of air pollution control measures lessened the total quantities of sulfur and nitrogen oxides emitted, it was mainly because attention shifted to the possible effects of increasing emissions of carbon dioxide and other greenhouse gases into the atmosphere on the world’s climate. Of course, with the emergence of China and India as major industrialized nations with improving economies during the past two decades, emissions of sulfur and nitrogen oxides are again on the increase.

Greenhouse Gases
There is no doubt that human activities have increased atmo-
spheric concentrations of greenhouse gases. Atmospheric carbon dioxide concentration was 280 ppm at the beginning of the industrial revolution in the mid-1700s. The average annual atmospheric carbon dioxide concentration measured at the refer-
ence station in Hawaii, USA, increased from 316 ppm in 1959 to 396 ppm in 2013. During the first 200 years of the industrial-
ized era, the carbon dioxide concentration in the atmosphere increased by 36 ppm – it rose 80 ppm in the past 50 years. The possible effects of increasing in carbon dioxide and other greenhouse gases on global climate change and sea level are
many streams in the area are increasing in pH, and the alkalinity of some rivers has doubled since the 1960s. The reason given is increased weathering of soils and mineral formations by acidic rain, especially in areas with limestone formations. However, this explanation does not make sense, because the input of acidity in rainfall should neutralize alkalinity.

Possibly the cause is increased weathering of carbonate and silicate minerals by the greater carbon dioxide concentration. For example, the equilibrium concentration for total alkalinity in a container of pure water containing solid calcium carbonate and open to the atmosphere has been reported as 55 mg/L at 320 ppm atmospheric carbon dioxide. The equilibrium alkalinity should increase to about 70 mg/L at present atmospheric carbon dioxide concentrations – an increase similar to that observed in some streams.

The author has worked for many years with ponds on the E. W. Shell Fisheries Station at Auburn University that are filled by rainfall should neutralize alkalinity.

A decrease in ocean pH will increase the solubility of calcium carbonate minerals such as aragonite and calcite, which comprise the shells of many marine organisms. There already are reports of thinning of shells that could eventually threaten their existence and the biodiversity of the ocean. Of course, molluscan shellfish aquaculture will be negatively affected by ocean acidification, it is definitely occurring.

Shell Fisheries Center at Auburn University that are filled by water from a small stream draining a catchment with acidic soils of the Piedmont Plateau. In the early 1970s, the stream consistently had a total alkalinity of 14-18 mg/L. Today, the stream has an alkalinity of 25-35 mg/L. As there are no limestone formations on the catchment of the stream, the source of increased alkalinity apparently is weathering of silicate minerals. Reports about alkalization of streams in the eastern U.S. and elsewhere consider it an undesirable phenomenon. Increasing alkalinity usually would not be detrimental to aquaculture. For example, at the E. W. Shell Fisheries Station, ponds traditionally have required limestone applications at one- to three-year intervals to maintain acceptable alkalinity. The increase in alkalinity apparently is weathering of silicate minerals by the greater carbon dioxide concentration. For an explanation does not make sense, because the input of acidity in rainfall, especially in areas with limestone formations. However, this explanation does not make sense, because the input of acidity in rainfall should neutralize alkalinity.

Highly publicized and politicized. Although we hear less about pollution predictions elsewhere consider it an undesirable phenomenon. Increasing alkalinity apparently is weathering of silicate minerals. For example, the equilibrium concentration for total alkalinity in a container of pure water containing solid calcium carbonate and open to the atmosphere has been reported as 55 mg/L at 320 ppm atmospheric carbon dioxide. The equilibrium alkalinity should increase to about 70 mg/L at present atmospheric carbon dioxide concentrations – an increase similar to that observed in some streams.

Carbon dioxide is acidic in water, and raising its concentration decreases pH. The pH of the ocean declined from about 8.12 in the late 1980s to 8.09 in 2008. This decline is expected to continue as atmospheric carbon dioxide rises.

While in ocean pH will increase the solubility of calcium carbonate minerals such as aragonite and calcite, which comprise the shells of many marine organisms. There already are reports of thinning of shells that could eventually threaten their existence and the biodiversity of the ocean. Of course, molluscan shellfish aquaculture will be negatively affected by ocean acidification, it is definitely occurring.

Carbon dioxide is acidic in water, and raising its concentration decreases pH. The pH of the ocean declined from about 8.12 in the late 1980s to 8.09 in 2008. This decline is expected to continue as atmospheric carbon dioxide rises.

Many streams in the area are increasing in pH, and the alkalinity of some rivers has doubled since the 1960s. The reason given is increased weathering of soils and mineral formations by acidic rain, especially in areas with limestone formations. However, this explanation does not make sense, because the input of acidity in rainfall should neutralize alkalinity.

Summary:

Although the characteristics of shrimp postlarvae have changed over time, the standard method used to identify their size has not. Usually, the “size” of postlarvae is considered their chronological age after completing the metamorphosis period. However, length and weight – as well as their mathematical relationship – are of vital importance in aquaculture science. After an analysis of biometric data for 480 postlarvae from different culture systems, the authors agreed that weight is more relevant than age in the expression of postlarval size.

Whenever someone asks a shrimp farmer, what is the size of your shrimp, the answer usually comes back as the weight of the animals (e.g., g, 15 g, 20 g). Why, then, is the size of shrimp postlarvae described in age (e.g., P.L.10, P.L.15, P.L.20)?

Usually, the “size” of postlarvae in the market is considered their chronological age after completing the metamorphosis period. A P.L.10, for example, is an animal that went through complete metamorphosis (involving nauplii, copepod, mysis stages) and has been a postlarva for 10 days. At this point, the animal has completed its morphological and physiological development, and the standard larval-rearing process would be finished.

Changes In Commercial Postlarvae

Factors such as species adaptation, genetic improvement, diversification and modernization in production have led to significant advances in the Pacific white shrimp, Litopenaeus vannamei. In general, farmers who works with this product is looking for stronger seedstock, which can reach up to 30 days. In general, the farmer who works with this product is looking for stronger seedstock, which can bring more tolerance of stocking management and higher weight gain during the first days in the pond. The latter is of huge importance to farmers affected by white spot syndrome and those producers who don’t have nursery facilities at their farms. To provide some perspective on this market, Aquatec Aquacultura Ltda. launched its P.L.10 product in January 2009. Since then, it has sold more than 1.5 billion P.L.10 and 500 million P.L.15. Does chronological age provide the best information on shrimp postlarvae to farmers? Size and weight are also important in aquaculture science.

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effectively supplying an increasing regional demand.

Products like the P.L.20 reflect the importance in aquaculture science. As pioneers in the marketing of P.L.20 in Brazil with 25 years of experience selling P.L.20 weighing from 19 to 45 mg, which is the same as saying 53–22 P.L./g. Same age, but different sizes/weights. Which is better for the farmer: older or bigger?

Facing so many changes, questions continue to arise: Should we continue to identify postlarvae merely by chronological age? Does this provide the most important information to shrimp farmers?

Aiming to better understand the growth pattern of “older” postlarvae and the influence of three culture systems on their development, the authors analyzed biometric data for 480 P.L.15 to P.L.22 postlarvae from Aquatec’s Speedline® HB121 lineage collected between February 2013 and February 2014.

Growth: P.L.15 To P.L.22

Figure 1 shows the growth curve for P.L.15 to P.L.22, on which a breakpoint for weight gain appears at P.L.17. Figure 2 shows the growth curve on length and information on the variance coefficient, illustrating uniformity along with growth. As indicated on the second curve, uniformity decreases as age increases. In addition, the gains in length are smaller than the gains in weight, confirming the idea that at this stage, animals are more in a process of weight gain than physiological development.

The next step was to cross the information above with different seasons and cultures systems, analyzing the influence of these factors on the animals’ performance. This study used the Fulton’s condition factor, a measure of fish health that assumes the standard weight of a fish is proportional to the cube of its length.

Seasonal Effects

In the graphs of the parameters analyzed during five, three-month periods between February 2013 and March 2014, greater differences are observed among ages in weight than in length. On the other hand, the similarity of the condition factors along the seasons for all ages is remarkable. They all present an average decrease of 18% in the second trimester, followed by recovery during the next three trimesters of 4, 22 and 5%.

The average historical climate data for each trimester is also plotted in Figure 3. The months with maximum precipitation and minimum temperatures are identified by the red rectangle.

Effects Of Culture System

To study the effects of the culture system, the data was divided into three systems, as shown in Table 1. It is important to emphasize that the results from each system is a sum of effects from the rear- ing environment and rearing facility (type of tank, aeration system; water entrance, drainage and movement) plus management (which includes as main differentials the preparation and maintenance of the tank and water, along with feeding). It is also important to consider the order in which the authors worked with each system, presented on the table. The changes from one system to another came due to production demand, but also while searching for improvement of the zootechnical results and production line efficiency.

Comparing the three systems (now considering days of hatchery and no longer age, Figure 4), the animals cultivated in greenhouse-covered tanks had the best performance. To verify the conditions under which the animals where reaching this higher productivity, the condition factor was calculated for each hatchery day for the three systems, with the greenhouse tanks still having the best results.

Randomly selecting a fixed weight of 20 mg under the greenhouse tank system, this weight could be reached in 23 days, while it took 25 and 27 days under the raceway and tank systems, respectively, for shrimp to reach 20 mg. This means that with changes and adaptations in infrastructure and management, it was possible to “gain” four days of production while maintaining average survivals near 100%. This makes the initial question even more intriguing: Is age, by itself, enough to identify the animals we stock in grow-out ponds?

New Concept To Consider

This study showed there can be P.L.15, weighing from 19 to 45 mg, which is the same as saying 53–22 P.L./g. Same age, but different sizes/weights. Which is better for the farmer: older or bigger?

As pioneers in the marketing of P.L.20 in Brazil with 25 years of experience selling marine shrimp postlarvae, Aquaquacultura Ltda. believes that after the research and practical experience of 80-90% of the time, learning that “older” postlarvae are more relevant by weight than by chronological age. Based on this concept, the company has been selling new “jumbo” postlarvae since March 2013.

The shrimp, which have an average weight of 16 mg and reflect a range of 50-80 animals/g, are all produced in greenhouse-covered tanks. Some of the shrimp have reached even higher average weights than the ones described in this article. The authors therefore believe this may be a new step for the Brazilian shrimp-farming industry that improves the relationship between hatcheries and farms.
How many chances do you get to address royalty? Rarely, in my case, so when offered the chance to highlight the importance of aquaculture (with specific reference to Latin America) to Prince Albert II of Monaco at the Monaco Blue Initiative in Santiago, Chile, I grabbed it with both hands.

Knowing that the audience was essentially anti-aquaculture was not especially easy for me, but as an industry, we should not be afraid of confronting issues. I believe the world needs to embrace aquaculture for many reasons, but especially for food security and nutrition. Millions are hungry, and children are dying daily due to malnutrition.

As I shared with the audience during my presentation in Monaco, I hear a lot of gloom and doom about the fish industry, but what is forgotten is that fish is the world’s most traded protein. The sector is twice the size of the coffee trade. It had an estimated export value of U.S. $136 billion last year. According to an article from the environmental think tank Earth Policy Institute, global production of farmed fish has overtaken the production of beef.

More than 120 million people in the world already depend directly on fisheries-related activities, which in turn support the livelihoods of over 1 billion people. While we can maintain wild fish harvests through strategic management and cutting out wasteful practices, however, wild fish cannot support the whole population. Farmed seafood will be pivotal in helping to supply food and jobs for the future.

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Healthy Food
Of course you already know fish is good for you. But just how good? An outstanding graph in a report on obtaining essential omega-3 fatty acids from fish published by the High-Level Panel of Experts to the United Nations Committee on World Food Security confirmed that the level of iron in beef is lower than in most fish, particularly small freshwater fish.

The knowledge on the health aspects of seafood just keeps coming. In light of the increasing evidence of neurodevelopmental benefits from eating fish, the U.S. Food and Drug Administration has revised its dietary recommendations to encourage pregnant women, breast-feeding mothers and young children to eat more of it – two to three servings a week. This is an important message that needs to be heeded by all governments that want to have healthy people with fewer chronic diseases, thus alleviating heavy health costs and underpinning better gross domestic product prospects.

1,000 Days Program
The 1,000-day program highlights the most important period of anyone’s life – the time from conception to the second birthday, which forms an essential window of opportunity to shape healthier and more prosperous futures. The right nutrition during this 1,000-day window can have profound impacts on a child’s ability to grow, learn and rise out of poverty. It can also shape a society’s long-term health, stability and prosperity.

In the real world for children under the age of 2, the consequences of undernutrition are particularly severe and often irreversible, and reach far into the future. During pregnancy, undernutrition can devastate the healthy growth and development of a child. Babies who are malnourished in the womb have a higher risk of dying in infancy and are more likely to
face lifelong cognitive and physical deficits, and chronic health problems. Eating more fish can help. But in Australia, the Meat and Livestock Association promoted advertising espousing that we were meant to be born eating red meat! While the Neanderthals ate lots of red meat, modern humans became modern by eating lots of oysters, mussels and fish. As revealed in “When the Sea Saved Humanity,” an article in Scientific American, when the number of breeding women and noting that the earth is 72% ocean, it was seafood and root vegetables that helped us survive, not red meat. As we move toward the future, and noting that the earth is 72% ocean, the same situation may return.

**Obesity And Seafood**

Seafood can help tackle the global obesity crisis, said health writer Martin Bowerman, author of “Lean Forever: The Scientific Secrets of Permanent Weight Loss.” Speaking at World Aquaculture Adelaide, Bowerman said fish provided more protein for comparably lower calorie intake than other meats, and this “calorie efficiency” was key to a high-protein weight-loss diet.

In “Don’t Miss the Bus,” a new book drawing on the latest findings in neuro-science from the University of California, it’s a list of a dozen “Gold Medal” food groups vital to maintaining brain health and preventing dementia and Alzheimer’s disease. The only whole animal products on the list are fish – specifically salmon, trout and sardines.

In a recent report prepared for Canada’s aquaculture industry, “How Higher Seafood Consumption Can Save Lives,” the authors quoted a study from the Harvard School of Public Health and the University of Washington that found older adults with high blood levels of fish-derived fatty acids lived, on average, 2.2 years longer than those with lower levels. Increasing levels of fish consumption to the recommended levels could save about 7,000 lives in Canada annually, the report concluded.

It is the position of the U.S. Academy of Nutrition and Dietetics that dietary fat for the healthy adult population should provide 20 to 35% of energy, with increased consumption of omega-3 polyunsaturated fatty acids and limited intake of saturated and trans fats. Two “long-chain” omega-3 fatty acids found in fish – eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) – are not made by the human body, meaning we need to get them from a dietary source. Many people get omega-3 fatty acids from plant sources like flax seeds and walnuts, although this type of “good” fat only partially converts to EPA and DHA in the body and doesn’t have the same amount of research behind it that omega-3s derived from fish do.

In Latin America, seafood consumption is below the world average, and in South America, Brazil had annual seafood consumption of less than 5 kg/capita until it embarked on a strong aquaculture program with tilapia that raised consumption to nearly 10 kg/capita. In Mexico, where seafood consumption has been on a downward spiral, plans and budgeting are put in place to promote seafood consumption alongside increasing aquaculture activity.

*Based on specifically training the workforce through the value chain.

**Fishmeal, Fish Oil**

There are two important points to make regarding fishmeal and fish oil. The first is that aquaculture is far from the biggest user of the products. That honor lies with land-based animals. The second is that evidence from the salmon industry shows that its investment in feed research over 20 years has enabled the quantity of fishmeal and fish oil to drop from around 89% of the feed to 32%, and more progress is expected in this area.

The anti-aquaculture lobby seems to be stuck in the past on these issues and either lacks current data or is stuck with antiquated concepts. Their emphasis often falls on feed issues regarding salmon and other carnivorous species. But the freshwater fish such as carp, tilapia and catfish that dominate global aquaculture production are herbivores species not reliant on fishmeal and fish oil.

Producing more from less is the consistent aim. Massive amounts of time, money and effort are going into feeds for the future. As an example, CSIRO Australia has perfected a prawn feed additive that results in 30% faster growth without using fish products. Several concepts getting attention include the use of proteins from worms, insects and algae in aquafeeds.

While all farmed animals need to be fed, aquaculture represents the most efficient method by which to convert feed to edible protein. Of course, species such as oysters and mussels do not need to be fed at all.

**Perspectives**

Seafood harvested from aquaculture is a complete nutrient package and the major source of animal proteins and micronutrients for many coastal populations. It is a renewable and sustainable source of polyunsaturated fatty acids for optimal brain development and the prevention of coronary heart disease, and an important source of vitamins generally scarce in rural diets. People should consume seafood weekly to comply with dietary guidelines.

I urge you to read the “Sustainable Fisheries and Aquaculture for Food Security and Nutrition” report just issued by the High Level Panel of Experts. Applying our collective “Licence to Fish,” we need to work together to maximize our use of the oceans and fully utilize the resources in sustainable growth. Working to assist the poorer nations and increasing food security and nutrition are essential elements of this work.

Indian aquaculture

Indian aquaculture has truly attained world standards. The Second largest aquaculture producer in the world is creating new strides through its adoption of diversification efforts and organic production methods. The vast natural resources of India offers great potential to develop aquaculture in a sustainable manner following Good Aquaculture Practices.
Sea bream aquaculture in the Mediterranean Sea faces various constraints that include increasing supply in fully developed markets, the effects of financial crises in many consumer countries and the difficulties of negotiating with concentrated retailers. The authors studied the value chain for sea bream in Spain as it relates to competition between different producing countries and its impact on the prices of local traders.

Study Setup
The prices for sea bream at ex-farm, wholesale and retail levels have been collected weekly for sea bream from 2009 to 2013 by Spain’s Ministry of Agriculture and Food through the Observatory of Food. Prices for Spain’s imports from Greece and Turkey were obtained from the European Commission’s Eurostat trade database. Integration among the price series was analyzed using the Johansen test, a procedure for testing cointegration of several time series. The limited sample size of the available data did not allow conducting a single model. Instead, two separate models were used to illustrate horizontal and vertical price integration.

The first model studied price competition among Greece, Turkey and Spain, the three largest producers of sea bream. The second model studied transmission across ex-farm, wholesale and retail levels. One limitation of this partial analysis was the small sample size that results were conclusive for rejecting issues of market power, but could not conclude whether any agent in the value chain was acting like a cartel.

Results
The model involving the prices of imports from Greece and Turkey and the Spanish ex-farm prices resulted in one cointegrating vector (Table 1). This implied that the three origins compete in the same undifferentiated market. Subsequent tests indicated that Greek prices were endogenous, meaning that price changes for Greek sea bream followed the rest of the market changes and were caused by the prices of Turkey and Spain.

The prices of Turkish imports and domestic Spanish ex-farm product were related to each other, with Turkey acting as price leader. However, Spanish prices were found to be exogenous, caused by variables not included in the model, such as long-term contracts with local retailers or other institutions. Ultimately, changes in the prices of any of the three competitors were replicated by the other two in a perfectly delineated market. The model assessing price transmission along the Spanish value chain also found one cointegrating vector (Table 2). In this case, it confirmed that shifts in ex-farm price reached the retail level, suggesting that no actors exerted definitive market power. Furthermore, ex-farm and retail prices were found to be endogenous.

Summary:
Work by the authors analyzed price competition for farmed sea bream from Greece, Turkey and Spain across the value chain. They found that sea bream from the three origins competed in an undifferentiated market, where price changes by one competitor were replicated by the others. The ex-farm prices of sea bream in Spain were partially affected by international competition, but retailers adjusted pricing according to farmers’ costs and also responded to consumer demand. All levels of the value chain adjusted prices to changes at the wholesale level.

In Spain, all levels of the sea bream value chain adjusted their prices to changes in the wholesale level, whether for domestic or imported fish.
and can be explained by the links among them and the wholesale level. The prices at the wholesale level, instead, were exogenous and affected by causes not included in this model. Domestic ex-farm prices were related to retail prices, but they did not seem to affect wholesale prices.

To clarify the relationships among the different price series, paired causation tests were performed crossing domestic and import prices. When the prices of Turkish imports were substituted for domestic ex-farm prices, one cointegrating vector was found (Table 3). Once again, wholesale prices were exogenous, affecting both Turkish and retail prices. This meant that Turkish exporters were adopting the prices of Spanish wholesalers, and Spanish retailers adapted their prices as the wholesale price changed.

**Perspectives**

The ex-farm prices of sea bream in Spain are partially affected by international competition led by Turkish imports and by the prices set by wholesalers. Despite this, there is still a place for negotiation and trade agreements, as well as the possibility of effective differentiation, since a significant part of their variation is not explained by international competitors.

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**Table 1. Price integration across Greece, Turkey and Spain.**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Eigenvalue</th>
<th>Trace</th>
<th>P Value</th>
<th>L-max</th>
<th>P Value</th>
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**Table 2. Price integration across ex-farm, wholesale and retail prices in Spain.**

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**Table 3. Price integration across Turkish imports, wholesale and retail prices in Spain.**

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<td>0.795</td>
<td>0.260</td>
</tr>
</tbody>
</table>

Spanish farmers’ prices also interact with the retail level in a bidirectional relation indicating perfect price transmission between agents. Retailers accommodate the prices of sea bream according to changes in farmers’ costs, and also respond to the levels of consumer demand. No evidence was found that retailers exerted power over farmers has been found, or that farmers behaved as a cartel.

While the results in assessing the exercise of market power at any level of the value chain were not conclusive, there was evidence that Spanish wholesalers could exercise a degree of negotiation. While totally independent of the behavior of the other actors, wholesale prices for sea bream affected all other observed prices. All levels of the value chain adjusted their prices to changes in the wholesale level, whether for domestic or imported sea bream.
Value Chain Analysis Helps Overcome Gender Barriers In Aquaculture

By the middle of this century, global population is expected to reach 9.6 billion, and food production must keep pace. The current and expected growth of aquaculture across the globe will continue to require innovation and adaptation, especially in the emerging markets of developing countries. Successful aquaculture supply chains require access to market information, reliable transportation, good communication and relationships, and increasingly, access to technology.

Value chain analysis (VCA) is a tool used to improve efficiency and equity in aquaculture markets. Value chains are complex, and VCA studies in aquaculture look at both economic and social elements of the value chain, focusing on where value can be added. This increases transparency and opens up opportunities for economic improvements to quality, processing, safety and value-added products.

Attention is also paid to who is involved along the chain, the intricate relationships between linkages and how individuals and groups stand to benefit or be harming from a given policy, change in management or technology. With a more thorough understanding of all reference points along the aquaculture value chain, opportunities arise for improved performance of the entire aquaculture sector.

Gender Integration

Both women and men are vital to the viability of the aquaculture industry in developing countries. Thus, gender integration is essential for the successful growth of the sector. Women are involved in aquaculture from pond to plate, playing significant roles in global food production and ensuring the nutritional well-being of households. Understanding value chains can help uncover where women are involved and how they can benefit or be harmed by interventions along the chain.

In developing countries, women produce over half the food, bear most of the responsibility for household food security and increasingly contribute to the household through income-generating activities. In recent years, women’s involvement in aquaculture activities has expanded to meet increasing global food production demands. However, their roles are often limited by lack of access to economic opportunities, education, capital and technology.

Typically, women are not equally represented along value chains. Rather, they tend to be concentrated in high-risk and low-power positions in the middle.

AquaFish Research

The AquaFish Innovation Lab (AquaFish), headquartered at Oregon State University in Oregon, USA, has conducted research using VCA as a tool to increase income and nutrition for small-scale fish farmers through improved market participation and efficiency. Integrating women into the aquaculture value chain is part of a systems approach to improve the economic and social benefits of aquaculture.

AquaFish work in Africa and Asia has identified some of the underlying barriers to women’s participation and begun to develop strategies for overcoming them.

From 2009 to 2012, AquaFish conducted a VCA and consumer preference study to ascertain the roles of women in aquaculture in Kenya and Ghana. In Kenya, the goal was to identify the primary constraints to participation for women in tilapia and catfish aquaculture. Major actors in the value chain included input suppliers, suppliers of juvenile seed fish, fish farmers and fish marketers. Women represented the majority of wild fish marketers and also the majority of wild and farmed fish consumers.

From response to dwindling wild fish stocks and the resulting economic impacts, project partners held a workshop for women wild fish traders in Mumbia,

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Drying seaweed on a new rack. Photo courtesy of Kevin Fitzsimmons.
required, these groups will have better access to opportunities and technologies in processing and sanitation for personal protection and food safety.

Organization and communication play a critical role in efficient aquaculture markets. Therefore, access to market information and the nature of information flow have become key factors for maintaining competitiveness for men and women.

Aquafish researchers worked with the Kenyan government to examine women’s access to market information in the fishery sector and analyze mobile information networks for women fish marketers. This foundational work has become a model for research on market-based cell phone data in neighboring Uganda. Research planned through next year aims to improve test-based fish market and fingerling supply information to Ugandan markets and provide a new extension mechanism for broad-scale outreach to fish farmers.

Expanding Markets In Asia
Aquafish research conducted in the rural northeastern province of Aceh, Indonesia, from 2009 through 2013 combined VCA and technical training to success-fully introduce seaweed farming to communities recovering from a 2004 tsunami that devastated shrimp aquaculture in the area. Research efforts addressed the challenge of reestablishing shrimp aquaculture with a renewed focus on sustainability.

Training activities focused on best management practices for small-scale tambak ponds through seaweed and shrimp polyculture. An effort that started out as restoration assistance grew from cultivating Gracilaria seaweed for pond efficient removal to a broad VCA of the seaweed markets of Indonesia and a series of workshops to enhance the benefits of growing and selling seaweed.

Aquafish conducted a VCA of the seaweed market in Aceh in response to growing demand in the ports of Jakarta, Sulawesi and Surabaya, the major transshipment points of seaweed products. The study looked at the roles of key players in the industry, logistics, transaction flows between market levels and external market influences. The results suggested that communication about product quality, levels and adequate facilities for optimal drying were some of the major barriers for building successful relationships between rural farmers and professional buyers.

Organization and communication play a critical role in efficient aquaculture markets. Therefore, access to market information and the nature of information flow have become key factors for maintaining competitiveness for men and women.

In response, Aquafish partners reached over 220 farming families through nine workshops to teach men and women how to construct drying racks from local materials to maintain quality for processing. "This awareness, along with the early VCA efforts described in this article, inspired Aquafish’s leadership in the first globally focused meeting on gender equity in aquaculture value chains."

Gender Integration in Value Chains
Gender integration in value chains represents an important innovation in our understanding of the significant roles women play in the health of households, economies and aquaculture development. This awareness, along with the early VCA efforts described in this article, inspired Aquafish’s leadership in the first globally focused meeting on gender equity in aquaculture value chains.

Three special sessions on “Markets and Value Chains for Small Aquaculture and Fisheries Enterprises With a Focus on Gender” at the International Institute of Fisheries Economics and Trade Conference helped bring gender integration to the forefront of VCA. These sessions included 17 presentations, representing different streams of scholarship from around the globe, and deepening our understanding of the complex relationships that influence market performance for smallholder farmers, including value-added distribution, optimal institutional arrangements and policy approaches.

Common patterns emerged among the presenters, acknowledging gender concentration of less-educated, resource-poor women at the low value end of chains. Outcomes of this visionary global forum can be found at the Gender in Aquaculture and Fisheries website – http://genderaquaculture.org, and session proceedings are available on the Aquafish website at http://aquafishcorp.org/gendercon2014/page/proceedings. Based on participatory brainstorming, these sessions will contribute to the development of strategies to improve gender equity in aquaculture.

In 2008, the comprehensive farm bill that functioned as the main agricultural and food policy tool of the United States government moved responsibility for catfish inspection from the U.S. Food and Drug Administration (FDA) to the U.S. Department of Agriculture (USDA). However, there was some concern whether the bill actually removed all catfish inspection from the FDA. Therefore, both agencies had responsibility, but no catfish really received inspection.

Because of the confusion, the 2014 farm bill included language directing FDA and USDA’s Food Safety and Inspection Service (FSIS) to enter into memorandum of understanding (MOU) to improve interagency cooperation and prevent duplication of inspection services. The transition of catfish inspection from FDA to FSIS will cause major changes for domestic and international producers and processors. It is important that all producers and processors are informed and prepared for the changes.

A failure to understand and accommodate the proposed legislation could result in rule violations and a failure to have products accepted for import into the United States.

Substance Of Agreement
Enacted February 7, the 2014 farm bill called for the MOU to improve inter-agency cooperation on food safety and fraud prevention, and maximize the effectiveness of limited personnel and resources. The bill sought to ensure that inspections conducted by FSIS satisfy requirements under the Federal Food, Drug and Cosmetic Act, and inspections of shipments and processing facilities for Siluriformes fish – including commercial catfish, bau and Pangasius – by the agencies are as effective. The information resulting from examinations, testing and inspections is considered in making risk-based determinations and establishing inspection priorities.

In the memorandum, the department agreed to plan for the orderly, phased transition from FDA to FSIS of primary regulatory oversight of domestic and imported Siluriformes fish and fish products. The agencies will coordinate in issuing regulations and guidance and in conducting outreach specific to Siluriformes. They will also exchange information relevant to regulatory oversight and take advantage of the inspection capabilities of each other to achieve the maximum utilization of resources with regard to Siluriformes fish and fish products.

According to the MOU, FSIS will exercise primary regulatory oversight over Siluriformes fish products and inform...
FDA if an apparent violation is encountered involving other fish. FDA will continue to oversee all other fish and fish products, and inform FSIS regarding apparent violations involving Siluriformes.

Unless requested by FSIS to do so, FDA will not inspect domestic and foreign establishments that grow, slaughter or process Siluriformes fish. It will also not sample or analyze Siluriformes fish products bearing a USDA inspection legend or import mark.

**FSIS Implementation**

The transfer of inspections to USDA has significant impact on both domestic catfish producers and imported Siluriformes fish and fish products. In 2011, USDA’s FSIS published a proposed rule in the Federal Register whose main points will likely carry over to any new proposed rule.

The 2011 proposed rule said, “FSIS anticipates that moving the catfish industry from FDA’s regulatory regime to the FSIS inspection system will have some impact on the industry.”

Under the rule, all catfish-processing establishments are required to follow the regulations in Code of Federal Regulations (CFR) 9, part 416, for sanitation and meet the FSIS sanitation performance standards. FSIS will verify that HACCP plans comply with the requirements of part 417 and have been validated.

Verification activities by FSIS include marketplace sampling and rapid screening tests for chemical residues, organoleptic and other hands-on verifications, and reviews of monitoring records. FSIS will also verify the conditions under which catfish are raised and transported to the processor, both as a check on the effectiveness of the establishment’s HACCP plan and to provide additional reassurance that only safe, wholesome raw materials are processed for human food.

**Implementation Phases**

USDA proposed phasing in implementation for the regulation in four phases. Highlights of the phases are as follows.

**Phase 1**

FSIS will deploy inspection personnel to domestic catfish-processing establishments. The processors will be required to continue to comply with the requirements of 21 CFR, part 132, until the proposed FSIS sanitation procedures (under proposed 9 CFR, part 537) are in place.

**Phase 2**

Persons and firms covered by the record-keeping requirements in proposed 9 CFR 550.5 will have to register with FSIS.

**Phase 3**

Domestic and foreign establishments will be required to comply with the sanitation requirements in 9 CFR, part 416 (proposed 9 CFR, part 537).

**Phase 4**

The transitional measures will expire. FSIS will require that all establishments that produce catfish and catfish products comply with all provisions of the final catfish inspection regulations.

Foreign countries that export catfish products to the United States will be required to have catfish inspection programs equivalent to the U.S. inspection program and be listed in proposed 9 CFR, part 557.

**Perspectives**

All catfish and catfish product producers and processors affected by the transfer of regulatory oversight are encouraged to be aware of any proposed rule that may be published in the U.S. Federal Register. Ignoring this important change in regulations could have severe financial impacts on firms and countries.

Foreign countries that export catfish products to the United States will be required to have catfish inspection programs equivalent to the U.S. inspection program.

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Summary:
June volumes of shrimp imported to the United States were up 25.2% compared to the import levels a year ago. Peeled, cooked and breaded shrimp imports were all up YTD. Total salmon imports remain higher YTD. Peeled shrimp imports were up 25.6% in June, pushing YTD 10.7% with volumes significantly up from May to June. June volumes of shrimp imported to the United States were up 25.2% compared to the import levels a year ago. Peeled, cooked and breaded shrimp imports were all up YTD. Total salmon imports remain higher YTD. Peeled shrimp imports were up 25.6% in June, pushing YTD 10.7% with volumes significantly up from May to June. June's shrimp imports from Vietnam were up sharply – 77% from the import levels of a year ago. HLSO imports were far outpaced by imports of peeled and also cooked shrimp. Vietnam was on par with Thailand, which has been the leader in value-added processing, in imports of cooked shrimp through June. Anecdotal reports indicate Vietnamese imports have been heavy in 21-25 through 31-40 shrimp.

Shrimp Market
Imports of HLSO shrimp of 36-40 and larger counts from all areas were full steady to firm in mid-August, while smaller shrimp steadied after a weak period. Easy-peel shrimp also ranged full steady to firm. A full steady to firm bias persists for 26-30 and larger-count value-added shrimp, which is in line with the overall trend for larger-count shrimp.

Vietnam
June's shrimp imports from Vietnam were up sharply – 77% from the import levels of a year ago. HLSO imports were far outpaced by imports of peeled and also cooked shrimp. Vietnam was on par with Thailand, which has been the leader in value-added processing, in imports of cooked shrimp through June. Anecdotal reports indicate Vietnamese imports have been heavy in 21-25 through 31-40 shrimp.

Indonesia
Imports from Indonesia have been heavy. Through June, Indonesia was the leading supplier to the U.S. market, beating out India and Ecuador. Imports of HLSO (likely easy-peel concentrates) were up 25.6% compared to import levels a year ago. Current U.S. imports continue in those count sizes with relatively low costs. However, much of that product was under contract and has been having limited effect on the current spot market. Recently, as the spot market has firmed, farmers have been holding back on raw material delivery to processing plants. There was a brief period of increased offerings from packers of 16-20 and larger shrimp. Currently, replacement offerings from India are limited and not expected to ramp up again until September or October.

Ecuador
Shrimp imports from Ecuador appeared to be at record levels in June. Ecuador's shrimp production was higher, as exports to Europe and Asia from that country continued strongly along with those to the U.S.

The U.S. imports were mostly HLSO 26-30 count and smaller YTD, with the bulk in 31-40, 41-50 and 51-60 sizes. HLSO imports were 13.3% higher YTD. Peeled imports have also been significant – 30% higher YTD.

China
As typhoon Rammasun bore down on southern China, there was a rush to harvest shrimp, which led to reports of shrimp prices falling precipitously. Chinese authorities reported significant damage across the southern provinces of Guangdong, Hainan and Yunnan, and in the region of Guangxi, according to China's Ministry of Civil Affairs. At this writing, the effects on shrimp production and infrastructure were unclear.

There have been reports of continuing active sales of shrimp into Chinese processors, which may be needed to supplement the lack of the country's own raw material.

Salmon Trend Continues: Whole Fish Off, Fillets Up

June YTD imports of salmon to the United States continued the year with a 5.3% increase when compared to import levels from the same time last year (Table 2). Fresh whole fish had a YTD decrease of 19.7%. Fresh fillet imports remained higher, 18.8% up from 2013 YTD levels. Total month-to-month data was lower for June – down 11.3% when compared to May's imports. June imports were 4.1% higher than in June 2013, however.

Whole Fish
In June, YTD figures for imports of fresh whole salmon continued the year with a decrease of 19.7% below June 2013 YTD figures. Similarly, a monthly comparison revealed a decrease of
Whole Tilapia Imports Jump As Fresh Fillets Soften

Though the market for fillets has remained seasonally steady, the market for whole fish is seeing some of the seasonality. June’s YTD imports of fresh tilapia were down 35.5% from June 2013, but the recent increases in prices from China have trended lower. In addition, there have been some shifts in the position of traders, with the Chinese market staying generally steady and volume reported by the U.S. Department of Commerce, usually softens. Replacement costs, expressed by dividing value and volume reported by the U.S. Department of Commerce, reaching its highest level at U.S. $3.52/lb in June. The market has remained steady after the first five months of the year were over 11% greater when compared to the same period last year and the largest since 2008. The market has remained steady after the first five months of the year were over 11% greater when compared to the same period last year and the largest since 2008.

Frozen Whole Fish

Volumes of frozen whole tilapia imported to the United States increased over 50.0% from May to June, but were 8.5% lower than in June a year ago (Table 3). However, after four straight months of pricing falling under the three-year-average, imports in June managed to surpass this level. Still, year-to-date (YTD) cumulative imports were down 15.9% from 2013.

Fresh Fillets

June imports of fresh fillets declined from the previous month and when compared to the same month a year ago – and with prices below the three-year-average. Imports from Costa Rica, the second-largest supplier to the U.S., were 15.0% lower on a YTD basis. Shipments from Honduras and Mexico have increased 37.5 and 124.0%, respectively, year over year. Volume-wise, June’s YTD monthly average imports were down from last month, when imports reached a record high. The market has remained generally steady to about steady. This was seasonally normal, as consumption during the summer usually softens. Replacement costs, expressed by dividing value and volume reported by the U.S. Department of Commerce, reaching its highest level at U.S. $3.52/lb in June.

Frozen Fillets

June’s frozen tilapia fillet imports increased from the previous month and when compared to the same month a year ago. Historical data suggested this was seasonally normal. This year, the future is uncertain, given that the market currently holds a mixed undertone. Replacement costs have reached record highs over the last five months. On the other hand, inventories in the U.S. have been reported adequate to ample at times.

Either way, it is more than clear that carryover inventories from late 2013 contain high holding costs. Average import prices from China have been reaching record highs month after month since February, with YTD imports surpassing those from last year. Still, YTD imports are not at a record high, but are 13% higher than in 2013.

Catfish Decline But Still Strong, Pangasius Steadying

Channel Catfish

June’s YTD imports of channel catfish declined from May levels and when compared to those of the same month a year ago (Table 4). The seasonal pattern observed this year (after the first two months) looks very similar to that of last year, which historical data suggested was counter seasonal. On a YTD basis, catfish imports during the first five months of the year were over 11% greater when compared to the same period last year and the largest ever since 2008. The market has remained steady after firming up prior to the start of summer. The undertone is generally steady going forward.

Table 2. Snapshot of U.S. salmon imports, June 2014.

<table>
<thead>
<tr>
<th>Form</th>
<th>June 2014 (lb)</th>
<th>May 2014 (lb)</th>
<th>Change (Month)</th>
<th>June 2013 (lb)</th>
<th>Change (Year)</th>
<th>YTD 2014 (lb)</th>
<th>Change (Year)</th>
<th>YTD 2013 (lb)</th>
<th>Change (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh whole fish</td>
<td>13,781,754</td>
<td>15,620,062</td>
<td>-11.84%</td>
<td>15,562,298</td>
<td>-11.44%</td>
<td>83,487,885</td>
<td>-19.73%</td>
<td>104,007,260</td>
<td>-47.58%</td>
</tr>
<tr>
<td>Frozen whole fish</td>
<td>371,491</td>
<td>276,132</td>
<td>-48.84%</td>
<td>379,561</td>
<td>-30.90%</td>
<td>4,011,281</td>
<td>-27.45%</td>
<td>5,674,514</td>
<td>-29.60%</td>
</tr>
<tr>
<td>Fresh fillets</td>
<td>225,177,832</td>
<td>25,794,411</td>
<td>-12.70%</td>
<td>19,219,984</td>
<td>-71.65%</td>
<td>138,554,178</td>
<td>-40.45%</td>
<td>227,538,882</td>
<td>-39.71%</td>
</tr>
<tr>
<td>Frozen fillets</td>
<td>8,547,287</td>
<td>9,224,270</td>
<td>-6.98%</td>
<td>7,586,297</td>
<td>-8.05%</td>
<td>40,518,716</td>
<td>-27.38%</td>
<td>54,400,306</td>
<td>-32.74%</td>
</tr>
<tr>
<td>Total</td>
<td>447,816,364</td>
<td>80,418,675</td>
<td>-13.30%</td>
<td>24,929,940</td>
<td>-4.78%</td>
<td>245,225,620</td>
<td>0.50%</td>
<td>361,853,747</td>
<td>1.50%</td>
</tr>
</tbody>
</table>

Sources: Urner Barry foreign trade data. U.S. Department of Commerce.

Table 3. Snapshot of U.S. tilapia imports, June 2014.

<table>
<thead>
<tr>
<th>Form</th>
<th>June 2014 (lb)</th>
<th>May 2014 (lb)</th>
<th>Change (Month)</th>
<th>June 2013 (lb)</th>
<th>Change (Year)</th>
<th>YTD 2014 (lb)</th>
<th>Change (Year)</th>
<th>YTD 2013 (lb)</th>
<th>Change (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh tilapia</td>
<td>4,445,561</td>
<td>4,856,730</td>
<td>-8.46%</td>
<td>4,774,666</td>
<td>-4.58%</td>
<td>27,648,590</td>
<td>-13.72%</td>
<td>31,719,205</td>
<td>-12.84%</td>
</tr>
<tr>
<td>Frozen whole fish</td>
<td>7,098,717</td>
<td>7,458,799</td>
<td>5.66%</td>
<td>7,757,500</td>
<td>-8.49%</td>
<td>35,335,384</td>
<td>-11.16%</td>
<td>38,766,476</td>
<td>-10.52%</td>
</tr>
<tr>
<td>Fresh fillets</td>
<td>29,667,220</td>
<td>32,196,377</td>
<td>8.02%</td>
<td>23,866,569</td>
<td>-14.81%</td>
<td>159,669,495</td>
<td>-17.26%</td>
<td>193,583,416</td>
<td>-17.54%</td>
</tr>
<tr>
<td>Frozen fillets</td>
<td>41,241,599</td>
<td>43,629,906</td>
<td>6.47%</td>
<td>38,172,254</td>
<td>7.48%</td>
<td>224,897,477</td>
<td>11.22%</td>
<td>253,413,868</td>
<td>11.22%</td>
</tr>
<tr>
<td>Total</td>
<td>107,709,571</td>
<td>114,904,116</td>
<td>-6.26%</td>
<td>98,862,250</td>
<td>-4.28%</td>
<td>796,212</td>
<td>11.22%</td>
<td>877,402</td>
<td>11.22%</td>
</tr>
</tbody>
</table>

Sources: Urner Barry foreign trade data. U.S. Department of Commerce.

Table 4. Snapshot of U.S. catfish imports, June 2014.

<table>
<thead>
<tr>
<th>Form</th>
<th>June 2014 (lb)</th>
<th>May 2014 (lb)</th>
<th>Change (Month)</th>
<th>June 2013 (lb)</th>
<th>Change (Year)</th>
<th>YTD 2014 (lb)</th>
<th>Change (Year)</th>
<th>YTD 2013 (lb)</th>
<th>Change (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pangasius Channel catfish</td>
<td>12,807,674</td>
<td>11,425,261</td>
<td>-12.18%</td>
<td>11,281,891</td>
<td>-24.61%</td>
<td>38,067,995</td>
<td>-24.61%</td>
<td>41,823,315</td>
<td>-7.86%</td>
</tr>
<tr>
<td>Pangasius Frozen fillets</td>
<td>685,922</td>
<td>631,477</td>
<td>-8.49%</td>
<td>777,500</td>
<td>-11.71%</td>
<td>2,056,073</td>
<td>-33.79%</td>
<td>3,099,180</td>
<td>-33.79%</td>
</tr>
<tr>
<td>Total</td>
<td>13,493,596</td>
<td>11,869,739</td>
<td>-13.64%</td>
<td>12,059,391</td>
<td>-16.97%</td>
<td>40,124,068</td>
<td>-16.97%</td>
<td>44,922,495</td>
<td>-16.97%</td>
</tr>
</tbody>
</table>

Sources: Urner Barry foreign trade data. U.S. Department of Commerce.
innovation

Multi-Phase Shrimp Production In Sun-Driven Honduran Ponds

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Honduras-based Grupo Granjas Marinas (GGM), a fully integrated shrimp producer with facilities from intensive biofloc nurseries to large extensive pond systems, is fine tuning what nature already has to offer by more efficiently producing zoo-plankton biomass in multi-phase ponds systems. To date, it has converted 400 ha of old ponds with plans to build out an additional 700 ha in 2015.

Multi-Phase Inventory Management System

For GGM, productivity is the single most important factor affecting the bottom line. Its new low-density, high-cycle multi-phase inventory management system (MIMS) is improving productivity by increasing growth and survival rates with shorter growout cycles. With a three-phase system, shrimp inventories are transferred from smaller to larger areas as the shrimp grow, thereby using production area more efficiently without increasing stocking densities.

Traditionally, GGM used a two-phase system to raise small juveniles in nurseries before transferring them to growout ponds. But this limited the size of the juveniles due to the logistics involved in transporting live biomass great distances. What MIMS does differently is minimize the transfer distance with a patented transfer system that facilitates moving large juveniles with minimum stress.

MIMS is a three-phase system with a central nursery pond configuration for easy transfer of large juveniles, the key productivity driver. The first phase utilizes a 1,200-m²-capacity multi-purpose enclosed nursery for starting juvenile shrimp, as well as mass culture of rotifers and copepods to inoculate the central nursery ponds.

With an average survival of 74% in 350 ha of ponds harvested to date, MIMS has produced 15.0- to 16.0-g shrimp in eight weeks with an average survival of 74%.

Summary:

Honduras-based Grupo Granjas Marinas believes that large-scale production of rotifers and copepods and sequential pond inoculations, in combination with short shrimp growth cycles can significantly increase shrimp production while reducing dependency on other sources of protein in feeds. In its three-phase system with a central nursery pond, shrimp are transferred to larger areas as they grow, using production area efficiently without increasing densities. The multi-phase inventory management system has produced 15-g shrimp in eight weeks with an average survival of 74%.

Open pond aquaculture, where radiant light energy flows from the sun through a complex myriad of aquatic food webs to the final target animals, is a very efficient form of culture with significant untapped potential to improve efficiency beyond current levels by enhancing the conversion of free solar energy into second generation biomass producers. Natural food organisms rich in protein and other essential growth elements are very important food sources in ponds.

plankton biomass can be quickly produced to feed shrimp with positive implications for the economics and sustainability of the business.

Zooplankton Management

Grupo Granjas Marinas believes that zooplankton management through large-scale sequential inoculation strategies in combination with short shrimp growth cycles can significantly increase the energy conversion from the sun toward shrimp production while reducing dependency on other sources of protein in feeds.

Shrimp ponds are complex food webs in which energy is passed from one trophic level to the next. As we learn more about their functional ecologies, our interest is drawn toward the incredible growth and reproductive capacity of the secondary producers and their important roles in the energy flow through pond ecosystems. Although algae are the principal primary producers that convert solar energy into organic compounds, secondary production is where the real untapped opportunity lies, because algae play such an important role as carriers of energy to higher trophic levels.

With the superior growth seen in ponds with higher copepod counts, GGM is convinced that the natural protein produced in the ponds is nutritionally superior to that present in formulated feeds. More emphasis is now being placed on the quality and composition of the cereal grain and feed distribution system throughout the company’s facilities.

Biomass Management

The best candidates for secondary biomass production are rotifers and copepods, because they are capable of rapidly reproducing nutritious biomass and tend to dominate under GGM’s typical pond conditions. GGM’s biomass production methodology was initially developed at the shrimp hatchery in 40-m² raceways.

As green technology team now raises rotifers up to 80 rotifers/mL and copepods to 16 copepods/mL in eight, 600-m² raceways. Final copepod counts reach 10 billion/raceway before the inoculation of 7-ha nursery ponds and replication up to 250 billion. The standing biomass can reach about 544 kg/ha in seven days. The rotifer production can reach nearly 1,270 kg/ha in four days. The GGM team is working to affirm the large-scale inoculation technology.

Paola Ordóñez monitors rotifiers in 40-m² raceway tanks.
Optimizing Depuration Of Salmon In RAS

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Steven Summerfelt, Ph.D.
The Conservation Fund’s Freshwater Institute

Summary:
In a study to evaluate operating practices and system designs that could potentially enhance depuration of off-flavors from Atlantic salmon cultured in a semi-commercial-scale freshwater recirculating aquaculture system, disinfection with hydrogen peroxide before stocking and a lack of water aeration media resulted in fish with lower off-flavor (MIB and geosmin) concentrations. Other findings were that off-flavor concentrations varied widely among fish, and depuration systems should be as simple in design as possible.

Fish cultured within recirculating aquaculture systems (RAS) can bioaccumulate the off-flavor compounds geosmin and 2-methylisoborneol (MIB) in their flesh. These off-flavor compounds are produced by actinomycete bacteria associated with biosolids and biofilms that form on tank walls and the submerged surfaces of unit processes. These off-flavors are often described as “earthy” or “musty” by consumers, and if present at high enough concentrations can result in product that is unpalatable and unacceptable for the marketplace. Therefore, it is critical for RAS facilities to establish effective standard operating procedures to mitigate off-flavor and produce “on-flavor” fillets. At The Conservation Fund’s Freshwater Institute research facility, rainbow trout and Atlantic salmon are effectively purged for six days while held in clean partial-reuse systems flushed with odor-free, 12-14° C spring water.

Although depuration is arguably one of the most important steps for RAS food fish production, very little research has been devoted to optimizing standard operating procedures to mitigate off-flavors. Therefore, the authors recently conducted a study to evaluate operating practices and system design parameters that could potentially enhance depuration of off-flavors from Atlantic salmon cultured to harvest size of about 4 kg within a semi-commercial-scale freshwater RAS.

Key Design Parameters
The key system design parameter evaluated during the trial was the presence or absence of water aeration media within the gas transfer columns of each depuration system. This focus was based on anecdotal evidence that ineffective purging can occur in partial-reuse systems that contain biofilm-coated water aeration media. The high-surface-area media was suspected to harbor actinomycete bacteria and biofilms associated with off-flavor production, which could explain inadequate purging experiences.

Water aeration media is often used within RAS and partial-reuse systems to evenly distribute water to facilitate gas exchange such as carbon dioxide removal or oxygen addition during aeration. Such media is purposely designed with high specific surface area.

However, the increased surface area also provides significant substrate for the attachment and growth of bacterial biofilms. In addition, it creates a challenge for effective disinfection, because water tends to channel around layered media, thereby inhibiting complete contact of recirculated disinfectants with all surfaces.

With this in mind, the second variable evaluated during the study was the use of hydrogen peroxide to disinfect depuration systems prior to stocking fish. It was hypothesized that salmon depurated in systems disinfected with hydrogen peroxide and
void of water aeration media would purge more effectively in comparison to alternative treatments.

Depuration Study

The depuration study was conducted using 12 partial-reuse systems of 0.5-m$^3$ volume, each operated with a recycle rate of 95% on a flow basis. The systems were relatively simple in design, consisting of a circular single-drain tank, a water aeration column and a magnetic drive pump that recirculated the water. Four combinations of the two key treatments were evaluated by using three replicate systems per treatment. It is important to point out that rainbow trout were intensively cultured in the experimental depuration systems prior to the study to create biofilm-coated surfaces and a potential “worst case scenario” to purge off-flavors. One day prior to the study, the trout were removed, and the tanks were thoroughly brushed. However, the water aeration columns and media within them were not brushed or cleaned.

Six partial-reuse systems were disinfected with 250 mg/L hydrogen peroxide for one hour with no dilution. The peroxide was then flushed from these systems. The next day, 14 Atlantic salmon weighing 3 to 5 kg each were stocked into each experimental depuration system.

Off-Flavor Detection

The goal of depuration should be that all fish have undetectable off-flavor concentrations prior to final harvest. Based on the range of off-flavor compound concentrations measured during this study, tasting only one fish is likely not a representative method to determine market suitability. RAS producers might consider filtering three to five fish and conducting an on-site flavor evaluation with trained panelists before the product is considered on-flavor and ready for market.

It is important to point out that the geosmin and MIB concentrations measured during this trial were possibly below the average human sensory detection thresholds for Atlantic salmon, which have been preliminarily reported in literature as greater than 900 ng/kg for MIB and 400-500 ng/kg for geosmin. More research is needed to specifically define these detection thresholds.

Perspectives

The findings from this study indicated that water aeration media with high specific surface area should not be used within depuration systems unless it is removed between each lot of fish and thoroughly washed, cleaned and disinfected. The absence of the media within depuration systems should not present a problem relative to carbon dioxide removal, because the aeration columns still function without packing, though at a lower gas-transfer rate. However, this is mostly offset in depuration systems, because fish produce less carbon dioxide and use less oxygen when they are kept off feed.

Results

The results of the study matched the hypothesis that salmon depurated in disinfect systems void of water aeration media purged more effectively than fish depurated using alternative treatments. Figure 1 illustrates that Atlantic salmon held in disinfected systems without the media depurated faster and had lower MIB concentrations throughout the depuration period compared to other treatment combinations. Conversely, salmon depurated in systems that were not disinfected and contained water aeration media released off-flavor at a slower rate and contained the highest concentrations of MIB.

Similar results occurred relative to the depuration of geosmin (Figure 2). From days 0 to 6, salmon held in pre-disinfected systems and void of water aeration media depurated faster and had lower geosmin concentrations compared to other treatment combinations. Conversely, salmon depurated in systems that were not disinfected and contained aeration media released geosmin at a slower rate and contained the highest geosmin concentrations within fish. There was no significant difference in geosmin between days 6 and 10 for this treatment, indicating reduction of geosmin might have reached a low threshold.

Another key finding from the study was that off-flavor concentrations within individual Atlantic salmon varied widely. For example, the range of MIB concentration for salmon purged within disinfected systems void of media was 74-226 ng/kg. Interestingly, salmon depurated in these systems had the tightest MIB concentrations compared to other treatment combinations.

Off-Flavor Detection

The goal of depuration should be that all fish have undetectable off-flavor concentrations prior to final harvest. Based on the range of off-flavor compound concentrations measured during this study, tasting only one fish is likely not a representative method to determine market suitability. RAS producers might consider filtering three to five fish and conducting an on-site flavor evaluation with trained panelists before the product is considered on-flavor and ready for market.
Variable-speed pumps have been around for many years, however, only recently has the use of variable-speed applications expanded into the aquaculture industry. Variable-speed pumps are in continuous service, as they are in many aquaculture applications. In fact, reducing a pump’s motor speed by 15% can reduce the energy consumed by the pump motor by 33%. However, variable-speed pumps cannot maintain constant flow when conditions in the system “upstream” of the pump change, such as a filter becoming clogged or a valve setting being changed.

Constant Flow

Have you ever wanted to operate a system at a constant flow rate when the system head downstream of the pump changes over time? For example, when a media filter clogs with waste solids from an aquaculture operation, the pressure builds, and the flow is reduced. In many cases, the operator will either need to

Components that add oxygen to the water of fish culture systems can also benefit from constant flow control. Depending on their sizes and configurations, these systems have optimized oxygen gas flow and water flow rates at specific pressures.

An example of one configuration is the pressurized packed column shown in Figure 1. A pump with Constant Flow Technology™ and a solenoid gas control valve can be controlled by a PLC with real-time oxygen measurement to provide near-ideal performance, all while maintaining the minimum flow rates required for the process.

Summary:

By minimizing the speed of a pump to achieve only the required output, significant energy savings can be achieved in a pumping system. Controlling the speed of a pump motor with a variable-frequency drive to maintain output more efficiently than controlling the pump’s flow with a valve. New variable-speed pumps fitted with a small “backpack” variable-frequency drive can maintain a set flow rate even when system operating conditions change upstream.
Operational Risk Management Tool Applied To Offshore Aquaculture

Summary:
Aquaculture managers must regularly make decisions that affect efficiency, competitiveness and economic performance. Although qualified managers can make excellent decisions, human nature potentially limits their results. To overcome this limitation when evaluating all possible strategies for maximized performance, firms can apply optimization tools. For example, a particle swarm optimization algorithm can be implemented to assist in determining strategies that maximize gross margins and minimize operational risk in both day-to-day and longer-term strategic decisions.

Nowadays in aquaculture production, managing the uncertainty of costs is more complicated than determining what they are. For a given set of production factors, why do we not always get the same results? The uncertainty over the outcome of the production process is called operational risk. During the farming process, the courses taken by events can result in different levels of production. The volatility of the results can be used as an indicator for measuring operational risk. So the difference between the best and the worst results shows the level of exposure to uncertainty.

Aquaculture Factors
Offshore aquaculture production involves a large number of factors whose evolution cannot be controlled by companies, or their control is costly or not cost effective. Such factors include weather conditions, water parameters like salinity or oxygen levels, feed prices and diseases. However, there is another factor – management – that firms can influence to reduce their uncertainty. Aquaculture management, particularly involving decisions about operational strategy, does not often receive the same attention management gets in other sectors. Yet aquaculture managers must regularly make decisions that affect efficiency, competitiveness and economic performance. Decisions on stocking and harvesting times, ration sizes, types of feed, or even the location of production facilities are under the responsibility of managers.

Potential Risks
Uncertainty over the outcome of the production process is a risk that affects different areas of activity. When a strategy does not evolve as expected, the company may be unable to supply the agreed quantity of fish to its customers, or it may not have the money needed to meet the repayment of a loan. These imbalances have a high cost for the company in terms of both economics and reputation.

One way to reduce the level of uncertainty associated with decisions is to employ qualified managers who not only...
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Table 1. Operational risks at sample sea bream mariculture facilities.

<table>
<thead>
<tr>
<th>Location</th>
<th>Units</th>
<th>Best Operational Plan</th>
<th>Worst Operational Plan</th>
<th>Operational Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canary Islands</td>
<td>5</td>
<td>U.S. $355.75/m³</td>
<td>U.S. $181.80/m³</td>
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<tr>
<td>Eastern Spain</td>
<td>4</td>
<td>U.S. $160.43/m³</td>
<td>U.S. $185.69/m³</td>
<td>15.76%</td>
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</table>

east coast. There are significant differences in water temperature between these locations. The production conditions considered a time horizon of five years, maximum biomass density of 20 kg/m³, 5% interest rate, maximum delay of 60 days between harvest and restocking, harvest weight of 300 to 700 g, and weight range for fingerlings of 3 to 10 g.

The results in Table 1 show how the higher average water temperature in the Canary Islands would generate faster growth and higher returns. However, the operational risk in the Canary Islands is higher due to the greater number of potential operational strategies that increase uncertainty about the gross margin.

If a manager chose a production strategy based on knowledge and experience, the economic result would likely fall between the worst and best strategies obtained by the algorithm. However, if a manager uses this type of approach, the result will be the production strategy that allows achieving the maximum economic return given the conditions of production. This removes the risk arising from the uncertainty associated with manager’s decisions.

Perspectives
Aquaculture production management is an activity that depends on human knowledge and rationality. Determining optimal stocking and harvesting strategies allows managers to maximize profits and eliminate operational risks. Artificial intelligence techniques such as PSO are a tool to optimize the results, minimize the costs and eliminate the uncertainty of aquaculture enterprises. These new methodologies open a future line of work in operational risk analysis in aquaculture.

The development of tools like a decision support system would allow managers to take decisions taking into account multiple aspects that affect the growing process, even if they do not have an expert knowledge of the same. Additionally, such systems would support the fast and efficient processing of large volumes of data. Greater capacity to address changes in the environment allows aquaculture companies to be more competitive and adapt to the rapid changes in markets.
Report: Aquaculture Reduces Poverty In Bangladesh

Impacts on Fish Consumption in Bangladesh. Data gathered over a 10-year period provides important evidence for the need to invest in the sector to help alleviate poverty and hunger.

By analyzing fish consumption in Bangladesh between 2000 and 2010, the peer-reviewed report shows that growth in aquaculture has led to greater consumption among poor consumers in Bangladesh. In a country where malnutrition costs an estimated U.S. $1 billion a year in economic productivity, fish are an important, low-cost source of high-quality protein and nutrients.

It had previously been thought the benefits of aquaculture were derived mainly from increased employment. Co-authors Kazi Ali Toufique and Ben Belton note that while aquaculture has increased, the wild fish supply has diminished. Policies are needed that support both sectors in parallel.

WorldFish is an international, non-profit research organization committed to reducing poverty and hunger through fisheries and aquaculture. For more, visit www.worldfishcenter.org or contact Toby Johnson at t.johnson@cgiar.org, +60-175-124-606.

Preferred Freezer Services Opens New Facilities In U.S.

Preferred Freezer Services, a global leader in advanced design and engineered temperature-controlled warehouses, has added new facilities in Florida and California, USA.

The new Miami-area warehouse is the company’s fourth cold storage facility in Florida and the 13th in the United States. The new facility has over 254,000 m³ of storage capacity, an 1,850-m² dock area, an oversized truck yard and a 24/7 online information system. Located close to major roadways, it can perform on-site inspections and offers packing and labeling services.

The new 23,225-m² facility in San Leandro, California, is Preferred Freezer’s seventh in the state. It has 424,750 m³ of storage capacity, an oversized truck yard space and 23 dock doors with levelers. The cold storage warehouse offers three different temperature zones, providing cold chain distributors the opportunity to store a wide range of products under one roof.

For more information, visit www.preferredfreezer.com or contact Dan DiDonato at +1-973-820-4040.

I. Chiu Liao Receives Awards From Japan

Dr. I. Chiu Liao was honored in June with a citation and medal from the Japanese government in recognition of his efforts to promote aquaculture exchanges between Japan and Taiwan.

An academician at Taiwan’s top research institution, Liao received the citation from the Japanese Representative to Taiwan, Sumio Tanii, and was later awarded the Order of the Rising Sun by Japanese Deputy Representative Izuu Hanuki.

In 1968, Liao developed the world’s first farming techniques for giant tiger prawns, which helped boost Taiwan’s production for local consumption as well as export. Liao made significant contributions to Taiwan’s prawn industry in the 1970s and 1980s, and shared his experiences with Japanese experts.

Liao also played an important role in the artificial breeding of mullet in 1969, complete life cycle of mullet in 1976 and complete culture of milkfish in 1978. These breakthroughs established artificial breeding techniques and resulted in the rapid development of mullet and milkfish cultures.

Liao received a Lifetime Achievement Award from the Global Aquaculture Alliance in 2012.

Cargill Launches New Tool To Battle EMS

Cargill Animal Nutrition has launched a new EMS Risk Tool to help customers determine the best farm management programs to manage the risks of early mortality syndrome (EMS) at their shrimp farms.

With this tool, Cargill can identify the main risk factors for individual farms and provide tailored recommendations to help reduce the severity of the disease and promote shrimp survival. The tool assesses risk based on available knowledge of the varied factors associated with the disease, including seed quality, genetics, sanitary practices, environmental and farm management, shrimp nutrition and shrimp health.

“This tool is the next step in our journey to mitigate the effects of EMS,” said Ryan Lane, Cargill’s global aquaculture technology director. “Helping shrimp producers manage risks of diseases like EMS will lead to better farming practices.”

In combination with strong biosecurity, studies have shown that high-quality hatchery and farm feeds are better at delivering nutrients to young fish and shrimp. Cargill’s products include Lignalife®, Aquaxcel® and Purina® and Cargill® feeds.

For more information, visit www.cargill.com.

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Corporate membership is required to serve on GAA’s board of directors. Qualify for discounts at GAA’s annual GOAL conferences and save on advertising, too. Visit www.gaalliance.org/about/joiningaa.php for more information on corporate dues and benefits.

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* Governing membership dues are based on annual seafood sales.
** Association membership is for trade organizations and groups only. Registration discounts apply only to designated representatives of the group.

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