AQUACULTURE MARINE SCIENCE

Advancements in Global Aquaculture and Fisheries Science: A Technical Analysis of ICFAS and ICFA Developments

Published: July 25, 2026 | Index ID: #878

The global demand for high-quality aquatic protein has placed unprecedented pressure on natural marine ecosystems, necessitating a paradigm shift from traditional capture fisheries to sophisticated, technology-driven aquaculture. The **7th International Conference for Fisheries and Aquatic Sciences (ICFAS 7)** and the **7th International Conference on Aquaculture and Fisheries (ICFA)** represent pivotal milestones in this transition. These gatherings of scientists, policymakers, and industry leaders serve as the primary mechanisms for disseminating research on fish welfare, antibiotic reduction, and the implementation of **Recirculating Aquaculture Systems (RAS)**. As we move deeper into the decade, the integration of innovation with sustainability has become the central theme of the industry, particularly as stakeholders navigate the operational challenges of a post-pandemic 'new normal'.

The Conceptual Framework of Modern Aquatic Sciences

Aquaculture is defined by the **National Oceanic and Atmospheric Administration (NOAA)** as the breeding, rearing, and harvesting of fish, shellfish, algae, and other organisms in all types of water environments. However, the modern definition has expanded to include the entire value chain, from genetic selection and hatchery management to processing and distribution. At the heart of current discourse is the **7th International Symposium on Cage Aquaculture**, which emphasizes the transition from coastal, shallow-water pens to offshore, high-energy environment systems.

The Multidisciplinary Nature of Fisheries Science

Fisheries science is no longer a isolated biological study; it is a synthesis of several core disciplines:

- Ichthyology and Physiology: Understanding the biological requirements and stress responses of aquatic species.
- Hydrodynamics and Engineering: Designing cages and systems that can withstand extreme weather conditions.
- Pathology and Immunology: Developing non-antibiotic treatments and vaccines to manage diseases in high-density environments.
- Environmental Chemistry: Monitoring nitrogen cycles, dissolved oxygen (DO), and pH levels to maintain optimal growth conditions.

Technical Analysis: Recent Trends in Aquaculture Innovation

The theme of "Recent Trends in Aquaculture Innovation" has dominated recent symposia. This focus is driven by the need to optimize the **Feed Conversion Ratio (FCR)** and minimize the environmental footprint of aquatic farming. One of the most significant technical shifts identified in the proceedings of **ICFAS 2023** in Iloilo City is the move toward **Precision Aquaculture (PA)**.

1. Smart Monitoring and IoT Integration

Precision aquaculture utilizes a network of sensors and AI-driven algorithms to monitor biomass in real-time. Key technical components include:

- Acoustic Sensors: Used to detect feeding activity, allowing for automated feeding systems that reduce waste.
- Computer Vision: High-definition underwater cameras combined with machine learning models to estimate individual fish weight and detect early signs of skin lesions or parasites like sea lice.
- Automated Water Quality Systems: Systems that automatically adjust aeration or flow rates based on sensor data for ammonia (NH_3) and nitrate (NO_3) levels.

2. Advancements in Fish Nutrition and Feed Formulation

Feed represents approximately 50-70% of the operational costs in aquaculture. Research presented at the **7th International Conference on Aquaculture & Fisheries** highlights the development of sustainable alternatives to fishmeal and fish oil. These include **Insect-based proteins (e.g., Black Soldier Fly larvae)**, **Single-Cell Proteins (SCP)**derived from fermentation, and microalgae rich in Omega-3 fatty acids. The goal is to create a circular bioeconomy where agricultural waste is converted into high-value aquatic feed.

Comparison of Traditional vs. Innovative Production Systems

The following table provides a comparative analysis of traditional pond culture versus the modern systems discussed at **ICFA 2022** and **ICFAS 7**.

Feature	Traditional Pond Culture	Recirculating Aquaculture (RAS)	Offshore Cage Aquaculture
Water Usage	High (Flow-through)	Minimal (90-99% recycled)	High (Natural exchange)
Environmental Control	Limited/Passive	Total Control	Partial Control
Biosecurity	Low (Exposure to wild pathogens)	High (Controlled entry)	Moderate (Isolation)
Waste Management	Difficult (Effluent discharge)	Highly Efficient (Solid waste capture)	Dispersive (Current dependent)
Initial CapEx	Low to Moderate	Very High	High (Engineering heavy)

Mechanical Principles of Cage Aquaculture

The **7th International Symposium on Cage Aquaculture in Asia (CAA7)** specifically addressed the mechanical stressors on submersible cages. The structural integrity of these systems relies on the **Morison Equation**, which calculates the wave and current forces acting on the cage netting and support structures. Engineers must balance the flexibility of the net (to prevent tearing) with the rigidity of the collar (to maintain volume for the fish).

Managing Fisheries and Aquaculture Under the 'New Normal'

The **ICFA 2021**conference, held virtually, introduced the concept of 'Managing Fisheries Under the New Normal.' This involves a three-pronged approach to resilience:

1. Digitalization of the Supply Chain: Implementing blockchain technology for end-to-end traceability, ensuring that seafood is sourced sustainably and legally.
2. Hybrid Operational Models: Combining remote monitoring with minimal on-site labor to maintain production during lockdowns or labor shortages.
3. Biosecurity Diversification: Moving away from monoculture toward Integrated Multi-Trophic Aquaculture (IMTA), where waste from one species (e.g., finfish) serves as nutrients for another (e.g., seaweed or mollusks).

Mathematical Modeling for Sustainable Yield

To prevent overfishing, fisheries management utilizes the **Maximum Sustainable Yield (MSY)**model. The surplus production model is often expressed as:

$dB/dt = rB(1 - B/K) - H$

Where: **B** = Biomass**r** = Intrinsic growth rate**K** = Carrying capacity**H** = Harvest rate

Researchers at the **International Conference for Fisheries and Aquatic Sciences**utilize these models to advise governments on seasonal closures and quota systems, ensuring that 'Fisheries for the Future' remains a reachable goal rather than just a slogan.

Practical Implementation: Step-by-Step Biofloc Technology (BFT) Setup

Biofloc technology is a sustainable method identified in the **7th International Conference on Aquaculture fisheries**as a solution for intensive farming with limited water exchange. Below is a high-level technical procedure for BFT implementation:

Phase 1: Tank Preparation and Inoculation

- Water Sterilization: Treat water with chlorine to eliminate pathogens, followed by neutralization.
- Carbon-to-Nitrogen (C:N) Ratio Adjustment: Maintain a C:N ratio of 15:1 or 20:1 by adding carbon sources like molasses or wheat flour. This promotes the growth of heterotrophic bacteria.
- Aeration: Ensure high-intensity aeration (at least 28-30 bubbles per minute per cubic meter) to keep the bioflocs in suspension.

Phase 2: Monitoring the Nitrogen Cycle

- Ammonia Spike: Expect an initial rise in Total Ammonia Nitrogen (TAN).
- Nitrite Peak: As Nitrosomonas bacteria develop, ammonia converts to nitrite.
- Stabilization: The cycle stabilizes when heterotrophic bacteria consume the nitrogenous waste directly, forming the 'floc' which also serves as a high-protein feed supplement for the species.

Troubleshooting and Operational Challenges in Modern Fisheries

Even with advanced technology, aquatic systems are prone to specific failure modes. Case studies from the **Archives of the International Conference** series suggest the following troubleshooting protocols:

1. Hypoxia and Oxygen Sag

Symptoms: Fish gasping at the surface, reduced feeding activity.**Solution:**Increase mechanical aeration immediately. Check for organic matter buildup on the pond bottom (sludge). Reduce feeding for 24-48 hours to lower biological oxygen demand (BOD).

2. Antibiotic Resistance and Fish Welfare

The **7th International Conference** stressed the dangers of prophylactic antibiotic use. Over-reliance leads to **Antimicrobial Resistance (AMR)**. **Solution:** Implement **Probiotic Therapy**. Introducing beneficial bacteria like *Bacillus subtilis* into the water or feed out-competes pathogenic bacteria like *Vibrio* through competitive exclusion.

3. Structural Fatigue in Cage Systems

Symptoms: Mooring line fraying, collar deformation.**Solution:**Monthly underwater drone (ROV) inspections. Use of high-density polyethylene (HDPE) materials which offer a superior balance of buoyancy and tensile strength compared to traditional wood or steel frames.

Broader Implications for Global Food Security

The synthesis of findings from the **ICFAS 7** in Iloilo City and the various **ICFA**sessions indicates that the future of aquatic sciences lies in the intersection of biology and data. The shift toward 'Fisheries for the Future' is not merely an environmental imperative but an economic one. As climate change alters ocean temperatures and acidity, the ability to transition production to controlled environments like RAS or resilient offshore cages will determine the stability of the global food supply.

Furthermore, the emphasis on fish welfare and antibiotic-free production aligns with growing consumer demand for ethical and healthy food sources. By adopting the technical workflows and theoretical frameworks established during these international conferences, the industry can achieve a balance between high-intensity production and ecological stewardship. The move toward a 'new normal' requires a commitment to continuous innovation, rigorous scientific validation, and international cooperation among scientists, technicians, and stakeholders. As we look toward the 10th and 11th iterations of these conferences, the focus will likely shift even further toward autonomous systems and carbon-neutral aquaculture, cementing the role of fisheries science as a pillar of 21st-century sustainability.

Tags: #ICFAS 7 #Aquaculture Innovation #Fisheries Management #Cage Aquaculture #Sustainable Seafood