



THE SOCIETAL BENEFITS OF COPPER

Introduction to The Societal Benefits of Copper

A new series of copper messages and supporting materials, created by the ICA Global Communications Team

The International Copper Association and the copper industry are fortunate to have at our disposal the best and most powerful messages ever regarding copper and the copper industry. The Societal Benefits of Copper series is designed to position copper as a *material* that addresses sustainable development. This series will serve to position the *copper industry* as a key contributor in meeting many of society's greatest challenges. We ask you, our members, to work in partnership with the ICA and take every opportunity to promote these very powerful and important messages when you are communicating about copper. These messages will provide both your internal and external stakeholders with a positive, strong and accurate perception about copper and a good understanding of the importance of copper in their lives. We are confident that you will find this series an effective part of your outreach efforts. If you have any questions or concerns, please contact a member of the ICA Global Communications Team.

AQUACULTURE EXPANDS GLOBAL FOOD SUPPLY

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Executive Summary

- Aquaculture is the only means to meet the projected growth in fish consumption of approximately 40 million tonnes per year by 2030 because nearly 75 percent of the world's fisheries are fully exploited. This is a 25 percent increase from 1974 when the UN's Food & Agriculture Organization (FAO) began collecting this data.
- The \$43 billion marine aquaculture industry produces 21 million tonnes of seafood products annually.
- In an attempt to quickly meet the needs of the global population, many aquaculture farms were not designed to be environmentally friendly, and other farms ignored the natural habitat during their construction and operation. These projects have resulted in biological, chemical and nutrient pollution that threaten the collapse of the industry. An environmentally friendly fish farm offers significant advantages.
- Copper-alloy nets are corrosion resistant. Their natural ability to stay clean prevents them from clogging with organic matter, improving water circulation and leading to healthier fish, higher yields, lower costs and reduced environmental impact as a result of increased water flow.
- The strength of copper alloys aids in fish development. Predators such as seals and sharks cannot reach the fish.
- Copper-alloy mesh is successfully used in Australia, Chile and Japan.

- Development activities and trials of improved copper-alloy materials, mesh forms and aquaculture system configurations are underway in China, Korea, Panama, Scotland, South Africa, Turkey, and the U.S.
- Target market applications for copper-alloy-based systems are marine aquaculture, but more specifically marine fin-fish production. The value of the world aquaculture market is more than \$100 billion, and fin fish account for approximately 60 percent the market value.
- If copper were to reach *100 percent market uptake*, the impact would be about 130k tonnes per year from retrofit of existing cages (about 70 percent or 90k tonnes) and new market growth (about 30 percent or 40k tonnes). However, initial market uptake will be closer to the 10 percent range.
- Copper and its alloys are 100 percent recyclable, unlike other net materials such as nylon and coated nylon. Copper-alloy nets will not corrode or degrade, so they last longer than other net materials.

The Story

Growing Population Requires More Protein

As the global population continues to grow, so does the demand for protein, especially meat and fish. In fact, demands on the aquaculture industry are outpacing population growth, and the world is struggling to have supply meet the demand.

People have relied on the world's oceans, seas and rivers for fish for thousands of years. However, this resource, critical to man and other species, cannot be depended on moving forward. According to the United Nations, overfishing is a problem in both developed and non-developed countries. The UN's Food and Agriculture Organization (FAO) estimates that for major marine fish stocks, or groups of stocks for which information was available, 47 – 50 percent are fully exploited, 15 – 18 percent are overexploited, and 9 – 10 percent are depleted or are recovering from depletion. This means nearly 75 percent of the world's fisheries are fully exploited or worse. This frightening reality poses an environmental and economic challenge that aquaculture can uniquely solve.

Aquaculture is the farming of aquatic organisms such as fish, shellfish and plants and can be land or open ocean based. The health and growth of fish are actively managed to improve production and profitability.

The \$43 billion marine aquaculture industry produces 21 million tonnes of seafood products annually. Aquaculture supplies almost half of the world's demand for fish. It is the only means to meet the projected growth in fish consumption of approximately 40 million tonnes per year by 2030. The global aquaculture industry has grown by at least 10 percent per year since 1980, and since 2008 it accounts for more than 50 percent of global seafood consumption. Predictions show this percentage increasing dramatically over the next few decades.

The use of copper alloys in aquaculture helps promote a clean energy economy. From decreased CO₂ emissions to increased fish mortality, copper alloys promote "green" living and help fish farmers realize greater cost savings.

Copper Promotes Sustainable Environment

Copper is an essential micro-nutrient, helping achieve good health and development in all organisms. Due to its natural metallurgical and biological properties, copper alloys are excellent materials for both surface and submersible marine aquaculture enclosures for near- and off-shore sites.

According to Rodrigo Sanchez, general manager of EcoSea Farming S.A., a business focused on developing copper solutions from aquaculture, “Unlike other net materials such as nylon and coated nylon, copper and its alloys are 100 percent recyclable. Copper-alloy nets have a minimal corrosion rate, less than 2 percent per year, making their lifespan longer than other net materials. Copper-alloy mesh lasts for five years or more, depending on conditions.” The reuse of copper materials saves about 95 percent of the embodied energy that would otherwise be wasted. Embodied energy is defined as the energy required for procuring raw materials, manufacture, transport, construction, maintenance and repair.

Copper mesh is not coated or covered in an antifouling paint that wears or corrodes over time nor will it leach like an antimicrobial substance in the surface layer of paint. Carol Powell, international metallurgist and marine specialist, notes, “Copper alloys naturally offer high corrosion resistance in aquatic environments. Bare metal placed in sea water oxidizes to form a complex and protective surface patina that inhibits further corrosion.” This resistance to corrosion is the primary reason copper alloys are attractive for long-term uses in aquaculture.

Because microorganisms and algae do not grow on copper or copper alloys, they will not clog with organic matter. Mesh/net changes are unnecessary and maintenance (net cleaning) is greatly reduced, thus promoting a cleaner and healthier environment.

Copper alloys contribute to the reduction of CO₂ emissions compared to conventional technology. Recycled material is used in initial production of copper-alloy mesh, further reducing CO₂ emissions compared with traditional polymer nets. In addition, the extended lifespan of copper mesh translates into fewer greenhouse gases because the transportation involved with constructing, installing and removing nets is required less frequently.

Copper = Increased Savings

Fish farming requires extensive capital expenditures, so any increase in profit and decrease in expenses is welcome. Copper-alloy meshes stay naturally clean. Nylon nets require cleaning weekly or after several months. This naturally ability to stay clean prevents them from clogging with organic matter, improving water circulation and leading to healthier fish and cleaner oceans. This also means divers do not need to go underwater to clean the nets, resulting in less stress on the fish, reduced operations costs, and increased net profit. Net cleaning is extremely stressful and disruptive for fish. Stress-induced fish mortality is often as high as 10 percent, an expensive byproduct of routine maintenance for the fish farmer. In addition, aquaculture diving can be dangerous for divers due to high risk weather conditions, low visibility, chemicals used to keep the fish healthy, etc. Copper-alloy nets decrease this risk. They require fewer diving hours and improve the security of workers.

Growth of organic matter adds enormous weight to submerged netting. Some reports mention two hundredfold increases in weight. An example would be two thousand pounds of unwanted organisms stuck to a 10-pound fish net. This extra burden often results in net breakage and additional maintenance costs. When the netting is cleaned, these unwanted organisms and algae may come to shore, potentially posing risks to the land environments.

Traditional net cleaners leave removed organic matter drifting in the ocean; some of it floats away and some sinks to the bottom. Nets that are cleaned less frequently often create large black spots representing decaying matter on the bottom of the ocean when they are finally cleaned and suddenly release a large amount of organic matter into the environment.

Nets can be removed from the ocean for cleaning, but this process presents a range of expenses, from moving the fish from one net to another and added labor costs to reduction in net lifespan due to aggressive cleaning procedures.

Clean copper-alloy mesh helps cages resist waves and currents, allowing them to keep their shape. Larger cage volumes prevent fish overcrowding and maintain high oxidation levels, improving yields and inhibiting parasites and pathogens from growing and infecting fish. This reduces the need for added antibiotics and anti-fouling chemicals. Feeding costs can be reduced by 15 percent or more.

High-strength copper-alloy mesh resists predator attacks and reduces escapes of farmed fish. Predators such as seals and sharks cannot reach the fish, so more fish reach maturity and can be harvested.

Copper's Market Potential

Today copper-alloy mesh is successfully used in Japan, Australia and Chile, and global use continues to expand. Development activities and trials of improved copper-alloy materials, mesh forms and aquaculture system configurations are underway in Panama, China, Turkey, South Africa, Korea, , Scotland and the U.S.

Copper-alloy based systems are targeted for marine aquaculture, specifically marine fin fish production. Marine fin-fish production was 4.9 million tonnes in 2008, for a value of \$20 billion. The copper market opportunity on an annual basis is about 130k tonnes per year from retrofit of existing cages (about 70 percent or 90k tonnes) and new market growth (about 30 percent or 40k tonnes) for marine fin fish as well as shrimp and other crustaceans/mollusks.

Solutions for Aquaculture Challenges

High-strength and corrosion-resistant copper-alloy meshes are compatible with cages commonly used in the marine aquaculture industry, allowing for rapid implementation at existing cultivation centers. In the future, the strength and durability of copper-alloy meshes may allow nets to be installed further offshore, reducing fish waste in in-shore environments. Moving offshore also allows water to flow more freely through the nets, leading to healthier fish. Copper-alloy nets offer an effective and efficient solution to the current and future challenges facing the aquaculture industry.

Copper Represents a Responsible Solution

The world is changing at an ever-quickening pace. Population growth coupled with the modernization and increasing affluence of third-world countries means increased demand for protein sources. Farmed fish convert feed more efficiently than farmed animals, better positioning aquaculture to support growing protein demand for a growing population. To date, over exploitation of the world's fish stocks prevents oceans and rivers from providing the amount of fish required to meet population needs. Innovative aquaculture techniques, such as the use of copper-alloy nets, can improve global harvest numbers. Feed conversion rates (FCR) are lower for ocean farmed fish versus farmed animals. FCR is the amount of food (in kilograms) needed to grow 1 kg of animal mass. For example, the FCR for ocean farmed fish is 1.5:1, while the FCR for chicken is 2:1, the FCR for pork is 5:1, and the FCR for beef is 10:1. Recyclable copper-alloy nets provide a responsible solution and promote a sustainable environment.