Aquaculture, closed containment technologies and energy consumption

Closed containment technologies offer a major step forward in fish farming practices. Providing a physical barrier between wild and farmed fish, closed tanks can eliminate, or greatly reduce many of the negative impacts of out-dated net-cage salmon farming. Having proven to be a technically feasible way to grow salmon, various closed systems are currently being tested to demonstrate viability at a commercial scale.

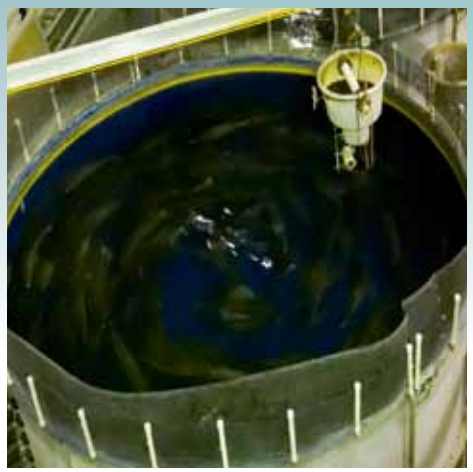
A criticism leveled against closed tanks is that they require a large amount of energy, making them ecologically unacceptable due to concerns around increased carbon footprint. It is true that closed containment systems require more *obvious* direct energy than net-cages. But if the root of this criticism is the total **ecological acceptability** of salmon aquaculture technology, then we must examine more than just energy use to determine the sustainability of salmon farming practices. In doing so, the overall environmental impacts of salmon aquaculture affirm closed containment as the more sustainable technology.

To judge the weight of the energy claim, we must understand:

- why closed containment systems are reputed to require more energy than net-cages;
- the complete picture of environmental impacts associated with salmon aquaculture technologies; and
- how closed containment systems and net-cages stack against each other in terms of overall sustainability.

PUTTING THE ENERGY CLAIM INTO PERSPECTIVE:

The larger energy 'footprint' of closed containment systems is due to the need to artificially replicate the services provided to the net-cage industry by the marine environment at no cost to industry. These services include the regulation of water quality and the dispersal of waste into our oceans. Ocean currents and tidal action provide a constant supply of fresh seawater and dissolved oxygen to net-cage farmed



Atlantic salmon raised in closed containment tank at the Fresh Water Institute. Photo: Andrew S. Wright

salmon, and simultaneously flush waste products from the cages into our marine waters.

But while use of this renewable energy source is *portrayed* by industry as beneficial from a sustainability perspective, this practice in the open ocean creates a significant environmental footprint. The benthic habitat (ocean bottom) directly below or near net-cage salmon farms is smothered with waste, algal blooms can result from excessive nutrient loads, and disease and sea lice are amplified by the concentration of fish growing in net-cages and can pass through the nets to marine species such as juvenile wild salmon.

So yes, net-cages do use less energy for water circulation and oxygen supply because they tap into naturally occurring services provided by the marine environment at **no cost to the industry**. But there is a significant cost borne by the marine ecosystem, local communities, and other marine-based businesses such as commercial fishing that rely on healthy, productive oceans.

WEIGHING THE ENVIRONMENTAL IMPACTS:

The intractable environmental issues associated with open net-cage operations such as disease, escapes, pollution, and predator impacts do not have effective solutions, nor are there any on the horizon.

better salmon

Formed in 2001, the *Coastal Alliance for Aquaculture Reform* (CAAR) is a coalition of five member groups working to ensure salmon farming in British Columbia is safe for wild salmon, marine ecosystems, coastal communities and human health.

CAAR Members:

David Suzuki Foundation

Georgia Strait Alliance

Living Oceans Society

T. Buck Suzuki Foundation

Watershed Watch Salmon Society

www.farmedanddangerous.org

wild salmon
the foundation of coastal life

ENVIRONMENTAL IMPACTS OF SALMON AQUACULTURE AND THEIR POTENTIAL SOLUTIONS:

Salmon Aquaculture Impacts/Problems	Open Net-Cage Practices	Closed Containment Practices
Sea lice infestation/ infection of juvenile wild salmon	Pesticides and other chemical treatments are used in the marine environment in an attempt to control sea lice meanwhile juvenile wild salmon continue to be infected with sea lice.	Closed systems reduce or eliminate the interaction between farmed and wild fish and the spread of sea lice to juvenile wild salmon.
Spread of disease to wild fish	Costly vaccines are administered in hatcheries. Antibiotics are administered in the marine environment.	Closed systems eliminate or reduce the spread of disease between farmed and wild fish.
Sea louse, viral and bacterial resistance to chemical/antibiotic treatments	Expand arsenal of chemical treatments, parasiticides and antibiotic options or reduce frequency of chemical treatments.	Closed systems eliminate or reduce the need for chemical/ antibiotic treatments due to a solid wall barrier between farmed fish and the marine environment.
Marine mammal deaths	Protective netting that can entangle and drown marine mammals; marine predators are shot.	Closed systems eliminate interactions between farmed salmon and marine predators.
Waste build up on the ocean floor	Reliance on dilution and dispersal therefore waste flows freely from net-cage operations into the marine environment. Recent studies show waste stream tends to hold in mass and can drift long distances.[1]	Solid waste can be recovered, treated as well as composted and sold/used as fertilizer. Potential for waste to be used in closed-loop aquaponic operations. Water can be recycled depending on system in use.
Escapes	Industry sets a target of zero escapes. Human errors, storm damage and predator damage result in thousands, or hundreds of thousands of escaped farmed salmon almost every year.	Closed systems eliminate the risk of farmed salmon escapes.
Depletion of wild fish to produce feed	Use of trimmings and offal in feed; plant-based as partial replacement to fishmeal and oil.	Use of trimmings and offal in feed; plant-based alternatives to fishmeal and oil. Closed systems can use significantly less feed during shorter growing periods due to controlled and improved growing conditions.
Energy use	Ocean currents and tidal action provide the service of oxygenating water and removing waste at the expense of a healthy marine environment.	Make use of renewable energy sources; work towards improved system design. Anaerobic digesters could be used for power production.

Practice has minimal environmental impact Practice has environmental impact with potential to improve Practice has negative environmental impact

These issues are highly complex, involving a number of variables which makes it difficult to identify solutions because you cannot isolate or control for everything. For instance, developed resistance to antibiotics and therapeutant treatments is increasingly common; the round up and removal of escapes is so difficult that a 10% capture rate is considered a success by industry;[2] and the act of killing predators does nothing to address the underlying problem.

For more information on each impact see: *www.farmedanddangerous.org/salmon-farming-problems*

When it comes to environmental concerns associated with closed containment aquaculture, solutions are already available. *Fully* closed systems *eliminate* the possibility of marine mammal deaths resulting from interactions with farmed salmon; escapes and subsequent problems related to invasive alien species; and the transfer of diseases between wild and farmed salmon. Furthermore, depending on the technology used, they *eliminate or greatly reduce* the need for chemical treatments, solid waste accumulation in the marine environment, algae blooms, and water column pollution.

Further solutions are also on the horizon. For example:

- How energy is generated makes a big difference. Studies have shown that a change from fossil fuels to cleaner forms of energy translates into a fourfold reduction of climate change and acidification impacts.[3] All proposed closed containment projects for B.C. intend to use hydroelectricity or geothermal electricity for power, which has the potential to be a cleaner source of power, depending on size and location.
- Improvements to system designs and proposed changes to water treatment can decrease energy demand.[4]
- Research dollars are being directed to the pursuit of plant-based alternatives to fish meal and oil.

Ultimately, we must consider the *overall* environmental impact of various aquaculture technologies. No production technology addresses the underlying problem of raising carnivorous fish reliant on feed derived from industrial fisheries for forage fish species such as Peruvian anchovita or North Sea capelin. But if the industry continues rearing salmon, closed containment technology is clearly on a more responsible path for salmon aquaculture.

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[1] February 2011. – Subhas K. Venayagamoorthy, Hyeyun Ku, Oliver B. Fringer, Alice Chiu, Rosamond L. Naylor and Jeffrey R. Koseff. *Numerical modeling of aquaculture dissolved waste transport in a coastal embayment.*

[2] Backman, Clare, Director of Sustainability for Marine Harvest Canada. "Escaped salmon pose threat to wild stock." Globe and Mail, 1 July 2008.

[3] Aubin et al. 2009

[4] D'Orbcastel et al., 2009c

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