

Seven Principles of Ecological Aquaculture: *A Guide for the Blue Revolution*

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Cite as: Costa-Pierce, B.A. 2022. *Seven Principles of Ecological Aquaculture: A Guide for the Blue Revolution*. Ecological Aquaculture Foundation, Maine, USA and Pico, PORTUGAL <https://oceanfoods.org>

Ecological aquaculture, the production of aquatic proteins essential to human health and wellness, is an integral part of our common planetary wisdom and cultural heritage...an essential part of our past and a vital part of our future evolution as a sophisticated species living in Peace with the Earth's invaluable aquatic ecosystems.

Ecological aquaculture is an alternative model of aquaculture development that uses ecology as the paradigm for the development of aquaculture (Costa-Pierce 2002, 2003, 2010, 2021a; FAO, 2010).

The development of ecological aquaculture relies upon findings from an array of progressive, transdisciplinary wisdom coming from the fields of ecosystems design, systems ecology, ecological engineering, industrial ecology, agroecology, and social ecology.

Ecological aquaculture farms are “aquaculture ecosystems” designed to deliver both economic and social profit.

Ecological aquaculture incorporates at the outset — *and not as an afterthought* — careful planning for not only the sustainable production of aquatic foods but also for innovation (Culver and Castle, 2008), community development, and the wider social, economic, and environmental contexts of aquaculture at diverse scales, both large and small, at commercial, school, and homeowner scales both locally and globally (Soto et al., 2008; FAO, 2010).

There are 7 principles of ecological aquaculture —

<p>1. Ecological aquaculture systems are “aquaculture ecosystems” that mimic the form and functions of natural ecosystems.</p>

Ecological aquaculture farms are designed, farming ecosystems. Sophisticated site planning occurs so that farms “fit with nature and society” and do not displace or disrupt invaluable natural aquatic ecosystems, conservation areas, or socially invaluable or iconic human systems. If localized displacement or degradation does occur, active support of innovative, collaborative research and development programs for ecosystems redesign, relocation, rehabilitation, and enhancement efforts are initiated and supported by the ecological aquaculture farms throughout the life of their farming operations. Ecological aquaculture is a vital part of restoration aquaculture (The Nature Conservancy, 2021).

2. Ecological aquaculture is integrated with communities to maximize not only local but also regional economic and social multiplier effects in order to provide maximal job creation and training and create “aquaculture communities” that are an essential part of vibrant, working waterfronts.

Ecological aquaculture operations export to earn profits but also promote and market products locally to contribute to the development of society. Ecological aquaculture operations are committed to building the “culture” of aquaculture in order that “aquaculture communities” can develop and evolve as a source of innovation, education, and local pride. Aquaculture development as a means of community development can result in numerous, innovative economic and social multiplier effects such as aquaculture tourism, restaurants, and financial services, and the marketing of “sustainable seafoods” that are branded as valuable local and bioregional brands.

3. Ecological aquaculture results in economic profits by practicing trophic efficiency to ensure that aquaculture is humanity’s most efficient protein producer.

Non-fed, shellfish and seaweed (“sea vegetable”) aquaculture are preferred choices for ecological aquaculture developments. In fed ecological aquaculture, fish meals/oils are not used as either the major protein or energy sources; rather they are included in animal diets to solve issues of diet palatability or to insure high DHA & EPA levels only. If used in diets, fish meals and oils originate from certified, sustainable fishmeal/oil fisheries only. Fed aquaculture ecosystems rely on protein and oil sources from sustainable agricultural sources and seafood processing wastes and include science innovations such as the development of fungal, bacterial, and detrital foods (“bioflocs”) to feed cultured, aquatic organisms.

4. Ecological aquaculture results in social profit by integrating aquaculture developments into global fisheries, food, and poverty alleviation programs.

Ecological aquaculture is part of the global movement to support the United Nations Sustainable Development Goals (SDGs) to eliminate extreme hunger and starvation (SDG #2 and Millennium and Sustainable Development Goal #1) by being a part of comprehensive plans for sustainable fisheries for poverty alleviation (SDG #14). Ecological aquaculture uses alternative feeds to support programs to deliver more of the world’s feed fisheries (sardines, anchovies, mackerels, herrings, etc.) away from use as terrestrial animal and aquaculture feeds to foods for the world’s poor.

5. Ecological aquaculture practices nutrient management by using ecosystems design, reuse and recycling, and does not discharge any nutrient or chemical pollution causing irreversible damage to natural aquatic or terrestrial ecosystems.

No harmful metals, chemicals, or pharmaceuticals potentially harmful to long-term human or ecosystem health are used in the ecological aquaculture production processes. Ecological aquaculture farms are either certified or have “sustainability strategic and implementation plans” in place to develop comprehensive, full cycle reuse and recycling systems for all farming operations.

6. Ecological aquaculture uses native species/strains and does not contribute to "biological" pollution.

*Escapes from aquaculture systems and aquarium operations have severely impacted aquatic ecosystems worldwide. Exotic species/strains can be a good choice only if long-term scientific research and monitoring data indicate that exotic escapes are unlikely to establish; or the use of **native** species in aquaculture puts at risk native, indigenous, genetic diversity; or, exotics are widely established and have been shown that they do not have irreversible ecological or social impacts. Ecological aquaculture operations ensure that innovative engineering and complete escapement technologies are used; that control and recovery procedures are in place; that active research and development programs provide alternatives and new options; and that complete, transparent, public documentation and information is widely available.*

7. Ecological aquaculture is a global partner, producing information for the world, avoiding the proprietary.

Ecological aquaculture farms are aquaculture ecosystems that go far beyond "meeting the regulations". They are sites of innovation, collaboration, and leadership development. Successful leadership development triggers innovation leading to more productive and efficient aquaculture-related technologies and more socially and ecologically appropriate legislation and regulations. Ecological aquaculture farms are outstanding community citizens and models of stewardship (Costa-Pierce, 2008, 2021b).

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