Mariculture Systems, Integrated Land-Based

Glossary

Detritivores (also known as saprophages) They are heterotrophs that obtain nutrients by consuming detritus (decomposing organic matter).

Halophyte Salt-loving plants that can be grown at higher salinities than most traditional crop plants.

IMTA The Integrated Multi-Trophic Aquaculture System (IMTA) is an aquaculture practice in which excretions of one or more organisms are utilized by other cultured organisms from different trophic (nutritional) levels within the system.

Land-based and offshore mariculture systems Two methods of seawater aquaculture (mariculture); the former on land and the latter in the ocean.

Polyculture An aquaculture practice which involves culture of two or more species from the same or different trophic levels in the same water reservoir.

RAS Recirculated Aquaculture System (RAS) is an aquaculture practice for the rearing of aquatic organisms wherein 90% or more of the water is recycled within the system.

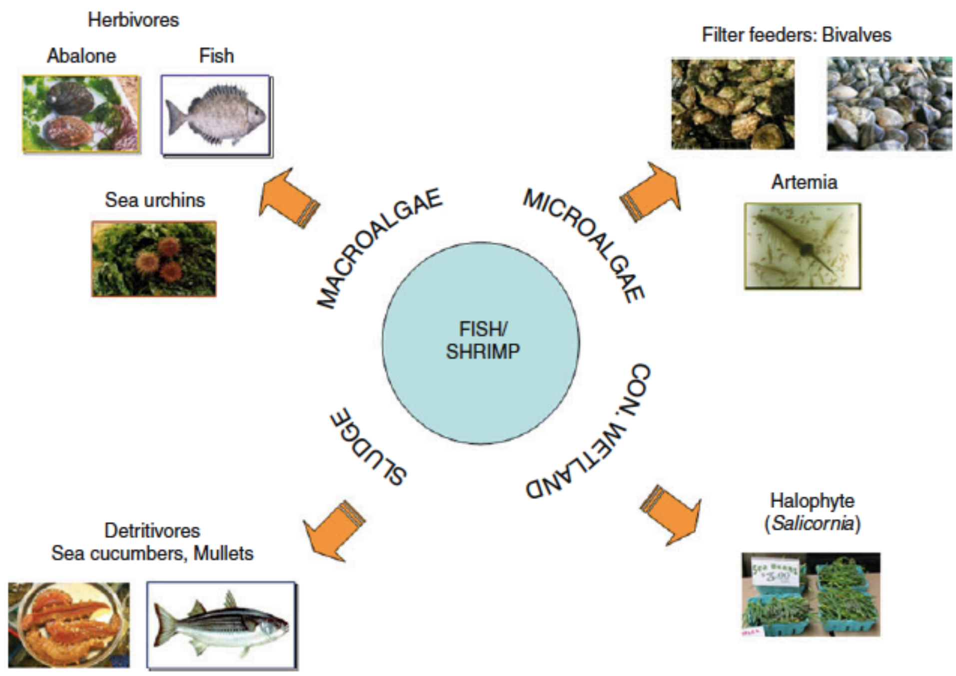
Sludge Solid/particulate waste that includes, among other components, feces, uneaten feed, algae and bacteria, which sinks to the bottom of aquaculture water reservoirs.

Definition of Subject

The Integrated Multi-Trophic Aquaculture System (IMTA) is an aquaculture practice in which excretions of one or more organisms are utilized by other cultured organisms from different trophic (nutritional) levels. IMTA systems are distinct from polyculture systems, which involve two or more species from the same or different trophic levels in the same water

reservoir. In a typical IMTA, the various species are
cultured in separate spatial entities, permitting intensification
and optimization of production. The IMTA concept has been increasingly adopted in modern day aquaculture, including land-based and offshore mariculture.

In land-based IMTA systems, seawater is pumped from the sea to fish or shrimp ponds. A pelleted diet is the only source of nutrients for the animals in the
system. Nutrient-rich effluent water from these ponds can take three directions: microalgae ponds, macroalgae ponds, and constructed wetlands with halophyte plants. The microalgae can be utilized by filter feeders such as Artemia or/and bivalves. The macroalgae can be utilized by macroalgivores such as abalone or sea urchins, and detritus can be utilized by
detritivores such as mullets, sea cucumbers, or polychaete
worms.



Mariculture Systems, Integrated Land-Based. Figure 1
Schematic design of land-based IMTA systems (con. = constructed)

The concept of polyculture and IMTA systems is not new.

Such systems of different species of fish, or combinations of invertebrates and fish, have been existing in ancient Egypt and China for thousands of years. Artificial enclosures
or natural ponds in tidal zones were generally used.

Extensive traditional IMTA and polyculture systems are still practiced today in various parts of Asia in fresh and salt water. Rice and fish are cultured together in China. Earthen ponds, in association with wild or agricultural plants, are used on a wide scale in fish and shrimp farming in China, Indonesia, Taiwan, Thailand, Japan, Vietnam, India, the Philippines, and Ecuador. In Europe, ducks, fish, and crayfish have been raised together in freshwater ponds. This type of extensive production has proven sustainable, because it utilizes organisms that feed on different levels of the food web, and maintains a clean environment.

The traditional IMTA and polyculture systems are more environmentally friendly than modern intensive mono-aquaculture systems. These systems utilize fewer resources and do not pollute surrounding waters with waste products, because they generally sustain relatively low stocking densities and do not employ fertilizers.
Most of them rely on natural production of food.
This concept has increasingly been adopted for modern aquaculture, including land-based and sea-cage mariculture. With dramatic increases in global human population, food demand, and overfishing problems, traditional extensive aquaculture cannot satisfy present demand, and much less so the projected future demand, for sea products.
Modern intensive monoculture systems require high levels of resources and produce undesirable wastes. They are dedicated to a few expensive species and do not generate a large amount of food. Intensive aquaculture uses extensive amounts of resources such as water, feeds, fertilizers, chemicals, and energy, while discharging fecal material, uneaten feed, excretions, and drugs into the environment. In turn, this creates eutrophication of the water, has deleterious effects on marine life, increases the risks of antibiotic resistance in organisms, has an adverse effect on biodiversity, and contributes to habitat destruction.
The economic success of intensive monoculture in sea cages or land-based facilities has much to do with the fact that, even today, pollution of the environment involves little or no monetary outlay or penalty for the growers. In most countries, aquaculture does not yet include the cost of effluent treatment. However, in the industrialized nations, this age is coming to a timely end and in Europe, there are already laws and regulations requiring

effluent treatment and imposing fines for noncompliance. In some countries, this cost can be as high as €0.5–1 kg^{-1} feed, resulting in an expense of €250,000–350,000 per annum for medium-scale RAS (Recirculating Aquaculture System) farms (250 t/year).

Awareness is growing among scientists, industry, the public, and politicians that technologies disregarding environmental impact are neither sustainable nor acceptable.

The concept of IMTA systems is generic and can be applied to cold, warm, and temperate waters, in intensive, semi-intensive, and extensive systems, in sea cages
or land-based facilities, in fresh water in land-based facilities or lakes, and all of the above in closed, semiclosed, or flow-through systems.