Grain 10 : Sustainable production systems

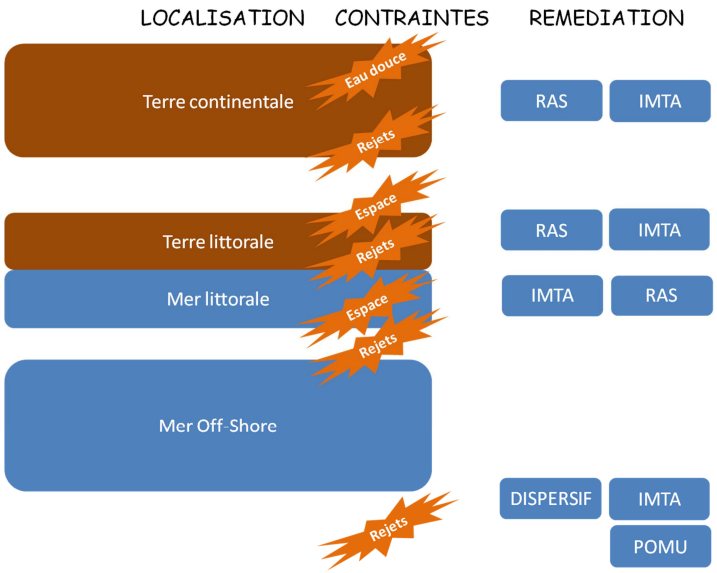
Responsibles : Myriam CALLIER, Denis Covès et Jean-Paul Blancheton

INTRODUCTION (1,5 mn)

To ensure the sustainable development of aquaculture in its three components, environmental, economic and social, it is necessary to develop new aquaculture practices to manage more effectively inputs (nutrients, energy ...), and better valorise the outputs (flow of nutrients and organic matter ...) in order to reduce environmental impacts and increase the efficiency of production systems.

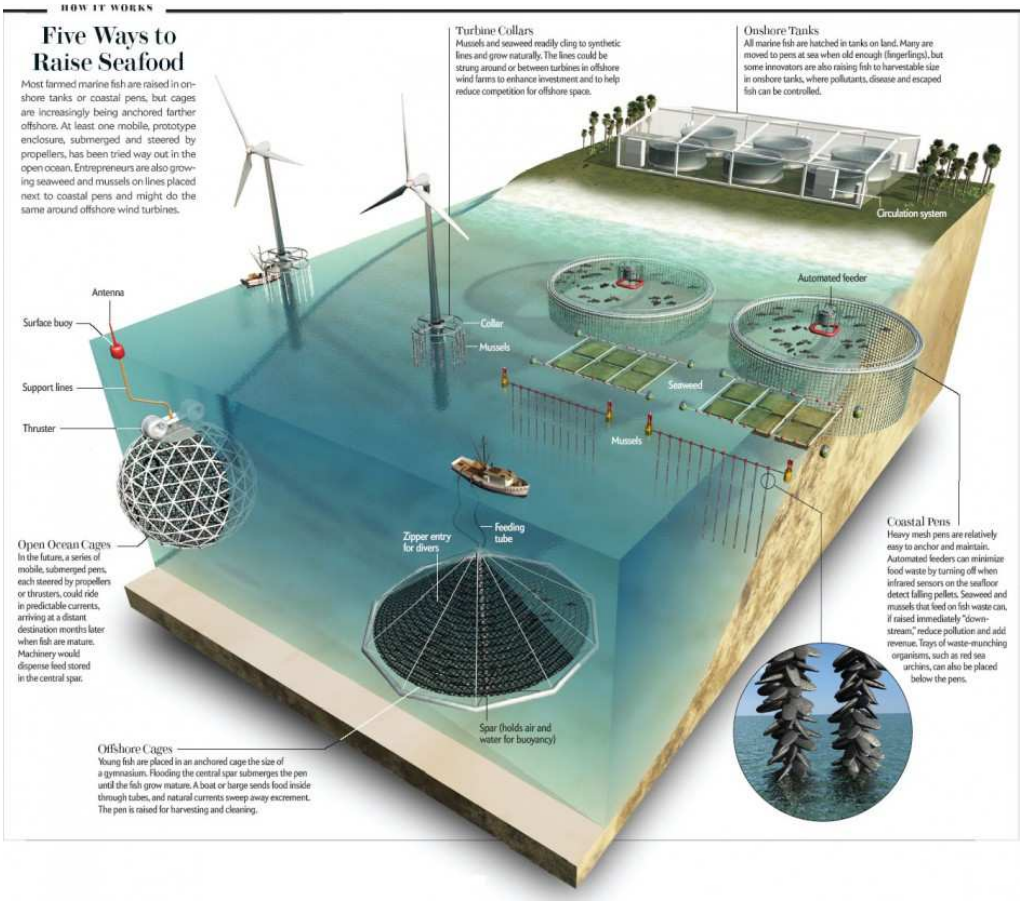
The continental fish farming faces conflicts mainly related to fresh water use and must evolve towards systems limiting the intake water needs and effluent emissions. The development of marine fish farming is limited by the lack of available sites due to over exploitation of coastal areas leading to conflicts for space.

To continue its development, aquaculture must move away from the coast (which implies the development of new production systems that can adapt to offshore constraints) or develop on land, develop environmentally friendly solutions and combine these approaches in a sustainable way.



What are the existing solutions?

This module introduces the operating principle of three production systems offshore systems, recirculating aquaculture systems (RAS) and multi- trophic integrated systems (including aquaponics in freshwater). How can these production systems improve the sustainability of aquaculture? What are their advantages and limitations?



1- Offshore (1mn)

Interview 1 Denis COVES

Offshore aquaculture can remove the barriers linked to space availability and move away from conflicting areas. By moving away from the coast, the depth and water currents increase and allow better dispersion of solid waste and a better dilution of dissolved effluents in the water column, thus minimizing their impacts on the environment"

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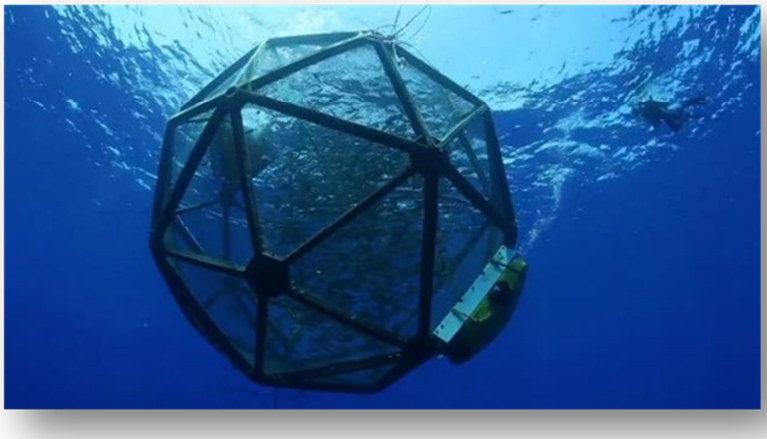

2-Système en recirculation (1mn)

Interview de Jean-Paul BLANCHETON

Intensive recirculating systems use less water and space. These systems allow:
- to consider the requirements of fish with respect to the water quality for optimal fish welfare,
- To treat and valorize waste products in order to limit their impact on the environment. Different types of recirculated systems are possible, depending on the environment and the type of fish product. The economic viability of recirculating systems was demonstrated for broodstock and early stages of marine species and for the growth of freshwater species. In recent years, recirculating systems, with low investment and operating costs, are developed for freshwater and marine species of lower added value.

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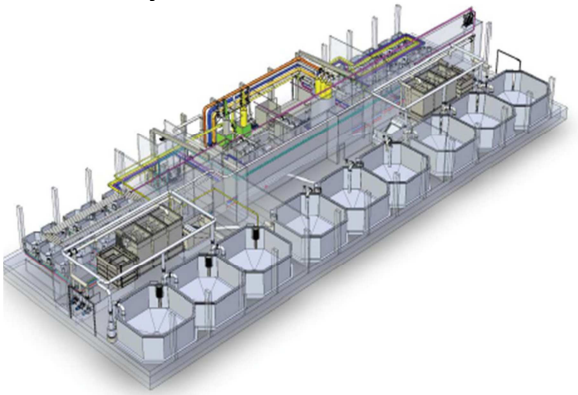
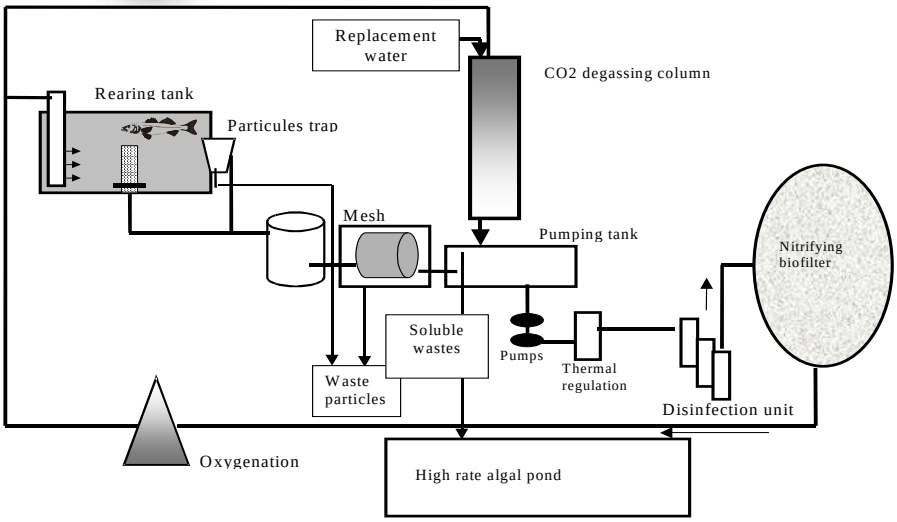
All recirculated systems are organized according to the same scheme. The water from rearing tanks is first filtered mechanically to remove suspended solids. The water then passes through a biofilter where ammonia is oxidized by nitrification. The configuration and management of the biological filter are critical with respect to the effectiveness of nitrification and maintenance of a stable physical-chemical and biological environment. Removal of carbon dioxide from the respiration of the fish is ensured by degassing. When necessary, oxygen is injected directly into the rearing tanks water.

FILM d'un système RAS à Salses





3. IMTA (1mn) (incluant l'aquaponie)

Interview de Myriam Callier

One of the aquaculture improvement pathways is the development of integrated multi-trophic systems (IMTA). The principle of IMTA is to combine the cultivation of species of different trophic levels (ie different diets). For example, fed species (eg fish) can be associated to autotroph species (algae, plants) that feed on inorganic waste (nutrients). Organic wastes - composed of fish faeces or non-ingested feed - can be consumed by heterotrophic species (molluscs, crustaceans, for example). "extractive" species provide bioremediation services by reducing the input of organic and inorganic materials into the environment and produce valuable

biomass. Recent studies have shown that the culture of deposit-feeders (invertebrates and benthic fish) improves the quality of the sediments under fish cages. By feeding on organic waste, such consumers contribute directly to recycling the material organically and through their bioturbation activities, enhance the mineralization of organic matter (diffusion and penetration of oxygen in the sediments) by stimulating microbial activity. In IMTA systems, the combined activity of autotrophic and heterotrophic species can reduce the flux of carbon, nitrogen and phosphorus released into the ecosystem.

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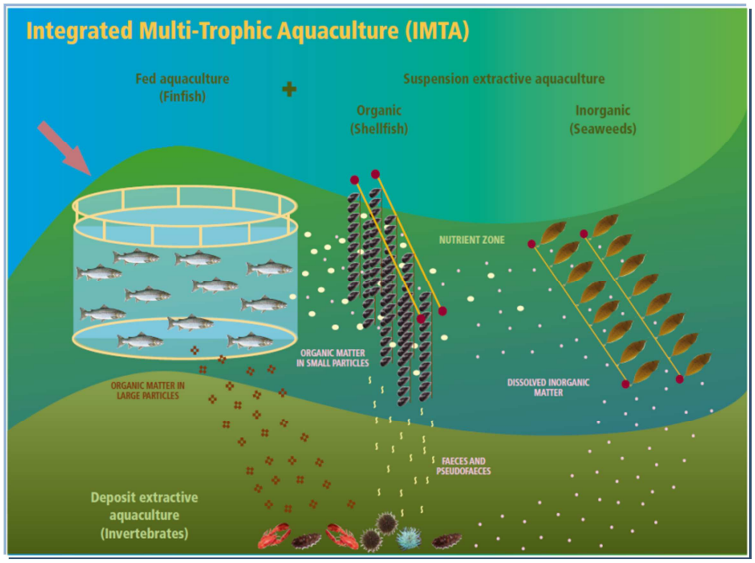

Studies have shown for example, that 60-85% nitrogen and 50-90% phosphorus can be recycled in IMTA systems, while in intensive monoculture, fish retains only 14-30 % nitrogen and 20-42 % phosphorus provided by the feed. Integrations have been proposed in temperate and tropical waters, such as in Canada, with system combining salmon (Salmo salar), macroalgae(Saccharina latissima) and mussels (Mytilus edulis).

Limits: multi-trophic systems can be complex and many factors can influence their effectiveness (selected species, biomass ratio and scale, hydrodynamics, trophic relationship etc. ..).

4. Le futur: Vers de nouveaux espaces et une intégration avec d'autres activités (valorisation des nutriments +énergie, économie circulaire)

"It is time to think about the possibility of implementing offshore sites where integrated aquaculture, with low environmental impact, could be developed (fish, crustaceans, algae and shellfish). Aquaculture production as well as fisheries by-catch could be valorize on "factory ship" platform. The transition from coastal aquaculture to offshore aquaculture lead to challenges: to design technological innovation, produce and deploy aquaculture structures and equipment adapted to the open sea. Fisheries and aquaculture could not meet these challenges alone but could benefit from the development of *multi-use offshore platform* and their services (living areas, communication, autonomy energy and fresh water, site security, storage capacity and integrated processing site). "

	8. Les systèmes de production durables
Gros plans	Différentes parties du système aquaponique (La Canourgue) RAS (Salses) Ulves, polychètes (Palavas) Valorisation rejets + énergie solaire (Beaurepaire)
Interview	Catherine Lejolivet (AQUAPONIE)- La Canourgue Pisciculteur (Salse) Pisciculteur (Beaurepaire) JP Blancheton, Denis COVES, Myriam CALLIER (Palavas) Thomas Lockart (Offshore multi-usages)
Insertion d'images existantes (vidéos ou photos)	Images IMTA Canada Photos (à trouver)