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Aquaculture 101

A brief story and introduction to NOVA

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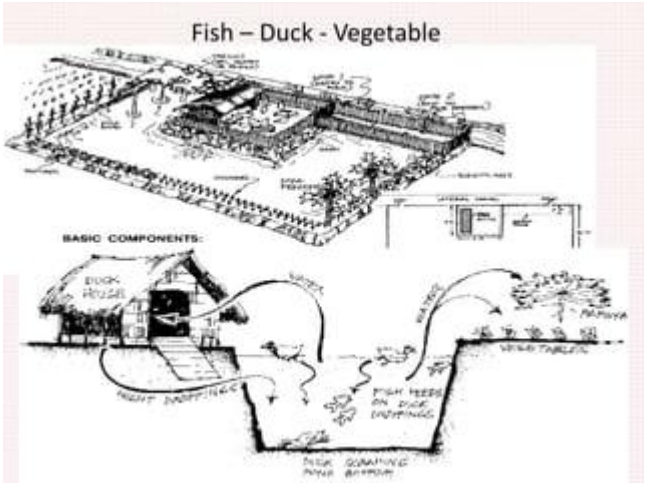
Origins of Aquaculture

6000 BC: Australia > channel and dams to capture of eels to have



1500 BC: China > common Carp trapped in lakes and fed silkworm nymph

500 BC: Romans > Oyster porduction

Origins of Aquaculture

Renaissance era: Wealthy families had pounds with carps in their own houses

Floating houses in Vietnam

1730s: Germany > aquaculture as we know nowadays salmonids

1871: National Fish Hatchery USA (salmon eggs)

A bit of salmon feed history

- Until the end of the 1980s, dry feed for salmon and trout in freshwater was produced by pelleting. The dry raw materials were mixed, ground and conditioned using steam - and the pelletized.
- Pelleting offers many advantages when feed is to be produced with a low fat content (in addition, the conditioner and pellet press are relatively inexpensive to purchase and have a high capacity).

BUT: the biggest problem with pelleted feed is that it is not able to absorb enough fat to satisfy the salmon's need for energy.

A bit of salmon feed history

- For a period, a lot of soft feed was therefore used (made from ground fatty fish, binding flour with gelatinized starch, vitamins and minerals – e.g., GellyFeed). The fish liked this feed - although it was of poor technical quality (and there was a large accumulation of uneaten feed under the cages leding to an anaerobic environment, production of the toxic gas H_2S and poor fish health).
- These challenges were then solved by using an extruder (resulting in much better physical quality), and by using a "vacuum coater" afterwards (ensuring high fat absorption in the extruded pellet). The first extruded salmon feed was launched in 1983 by Skretting…

SKRETTING
a Nutreco company

Strategies

- Hand feeding
  - Used on small fish to check the activity and appetite.
  - Usually the first 6-8 weeks.
  - standard in “the old days”

Photo: from Skretting

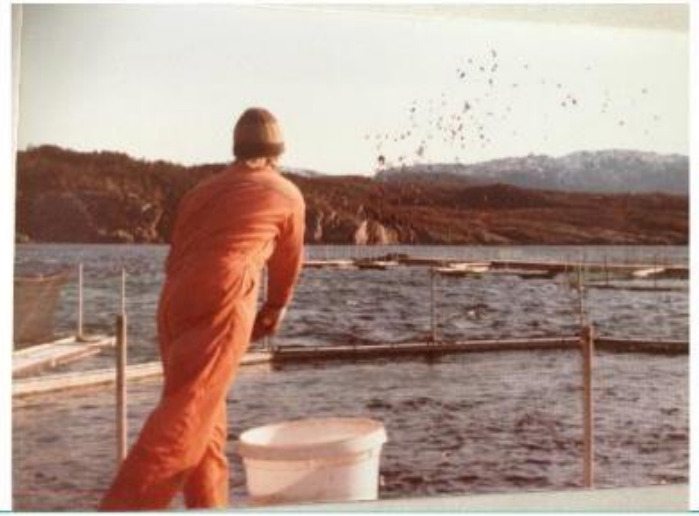


Photo: from Olai Einen

Why make a pellet?

- Distribute an eatable particle that contain everything the fish need
- Each gram should reach the fish - durability
- Avoid destroying nutrients
  - Vitamins and viability in the process
  - Highly digestible proteins

- Improving performance of nutrient with low nutritional value
  - Increase digestibility of proteins
  - Increase digestibility of starch
- Physical demands (must “stick together” and not leak nutrients (e.g. oil))

Feed-raft and feed equipment

- At the fish farms the feed is stored in the feed raft, in silo.
- Under the silo there is mechanism that is dosing the feed.
- A lot of the feed systems use air pressure to get the feed out to the fish.

Fish farming today:

Current state of Aquaculture

Current state of Aquaculture

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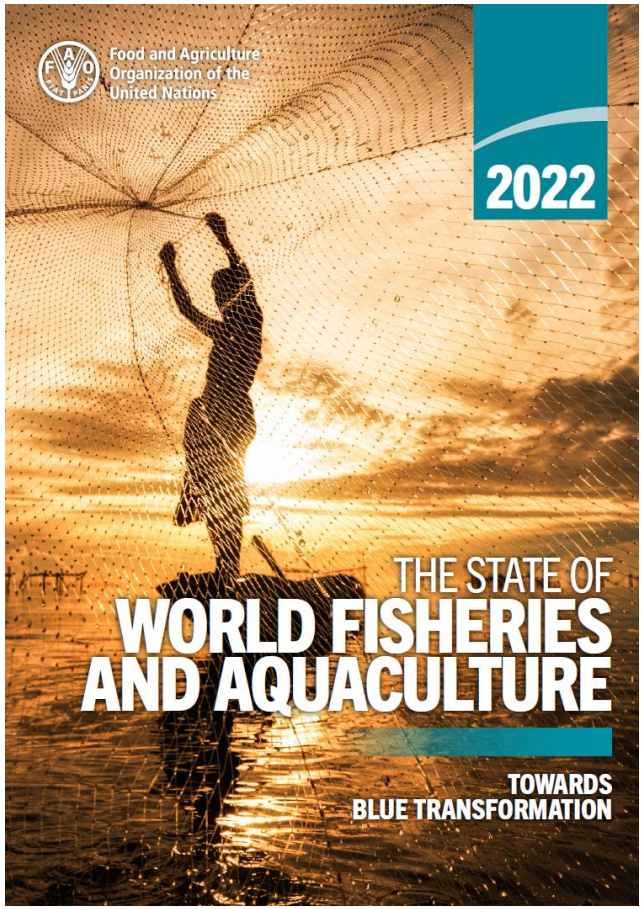

FAO. 2022. *The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation*. Rome, FAO. https://doi.org/10.4060/cc0461en

FAO. 2024. *The State of World Fisheries and Aquaculture 2024. Blue Transformation in action*. Rome. https://doi.org/10.4060/cd0683en

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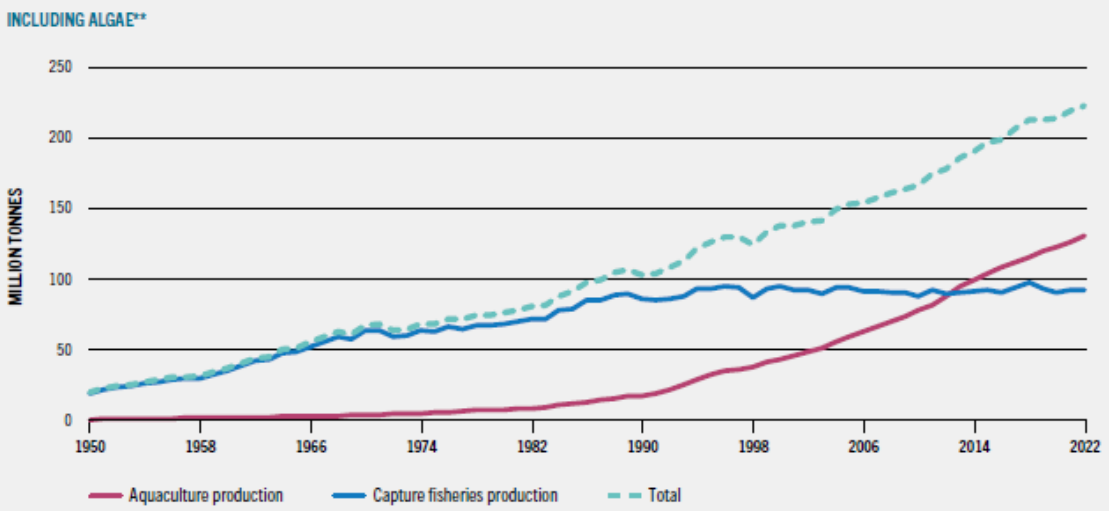
FIGURE 3 WORLD FISHERIES AND AQUACULTURE PRODUCTION



NOTES: Aquatic animals excluding aquatic mammals, crocodiles, alligators, caimans, aquatic products (corals, pearls, shells and sponges) and algae. Data expressed in live weight equivalent for aquatic animals and wet weight for algae. * Aquatic animals. ** Aquatic animals and algae.

FIGURE 7 WORLD AQUACULTURE PRODUCTION, 1990–2022

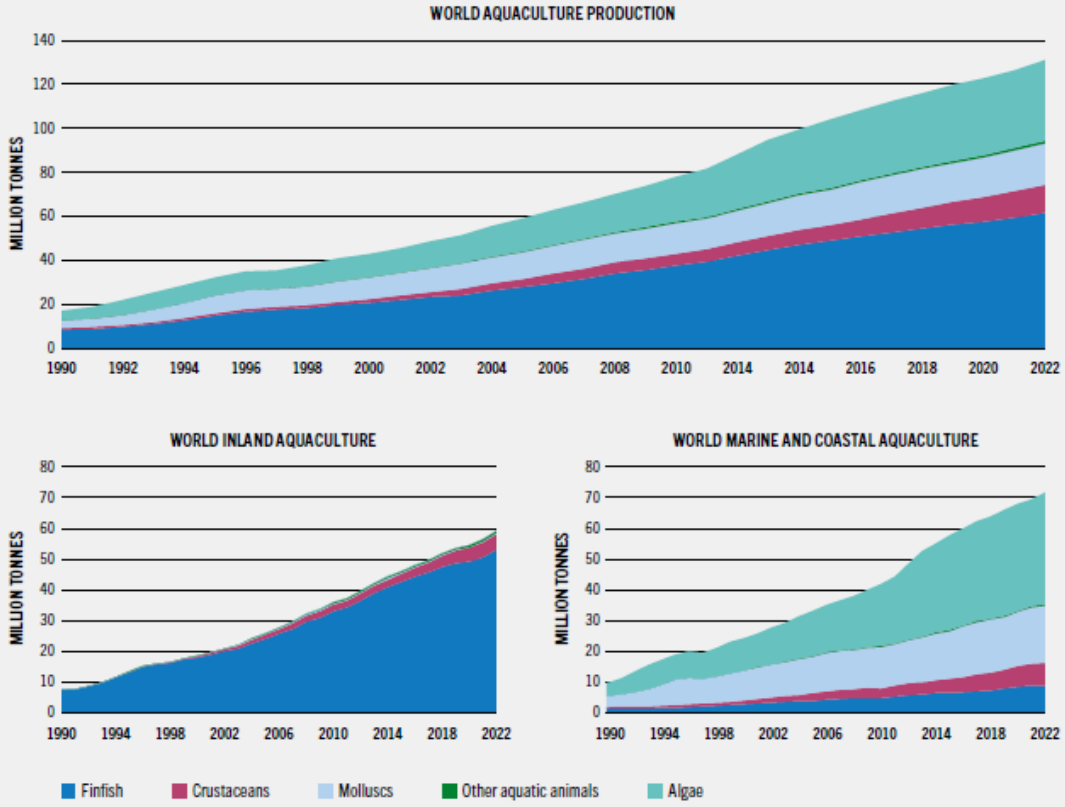


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FIGURE 1 WORLD FISHERIES AND AQUACULTURE PRODUCTION OF AQUATIC ANIMALS

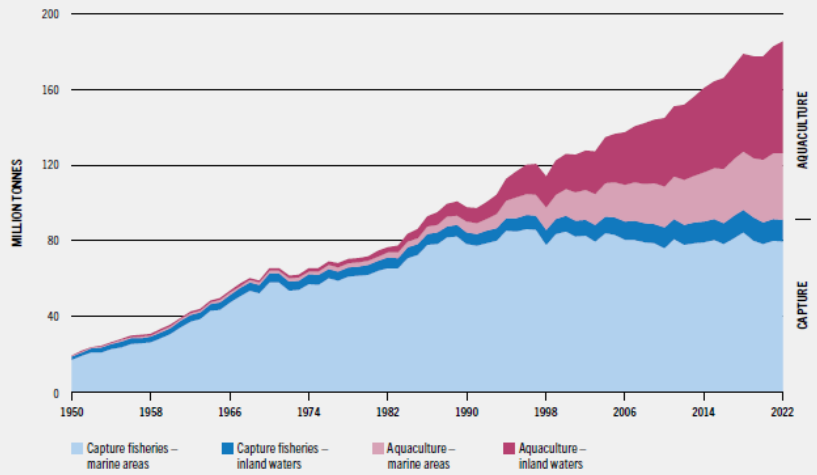
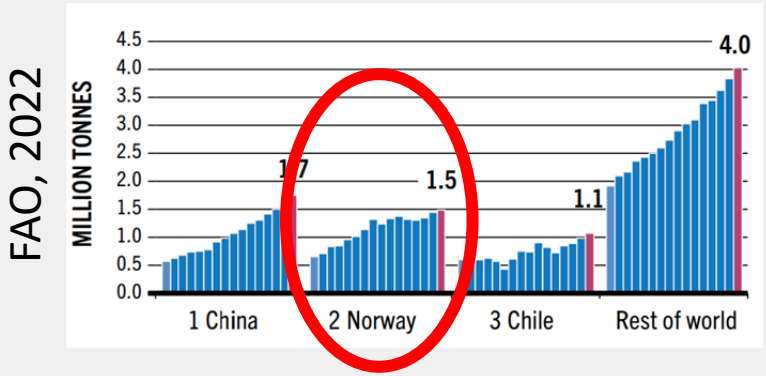


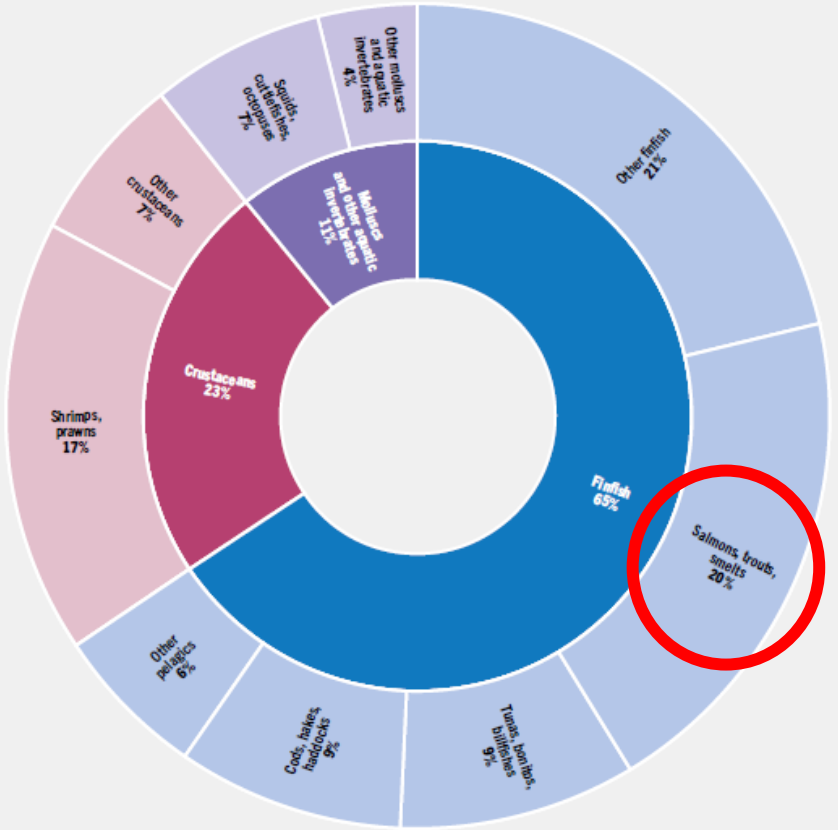
FIGURE 15 PRODUCTION DISTRIBUTION OF SELECTED MAIN SPECIES GROUPS AND TYPE OF AQUACULTURE, 2005–2020

WORLD MARINE AND COASTAL AQUACULTURE PRODUCTION OF FINFISH BY MAJOR PRODUCERS



FAO, 2022

FIGURE 50 SHARE OF MAIN GROUPS OF SPECIES IN EXPORTS OF AQUATIC ANIMAL PRODUCTS BY VALUE, 2022



NOTE: Shares may not add up to 100 percent due to rounding.

SOURCE: Preliminary data. Final data available here: FAO. 2024. Global aquatic trade statistics. https://www.fao.org/fishery/en/collection/global_commodity_prod. Licence: CC-BY-4.0.

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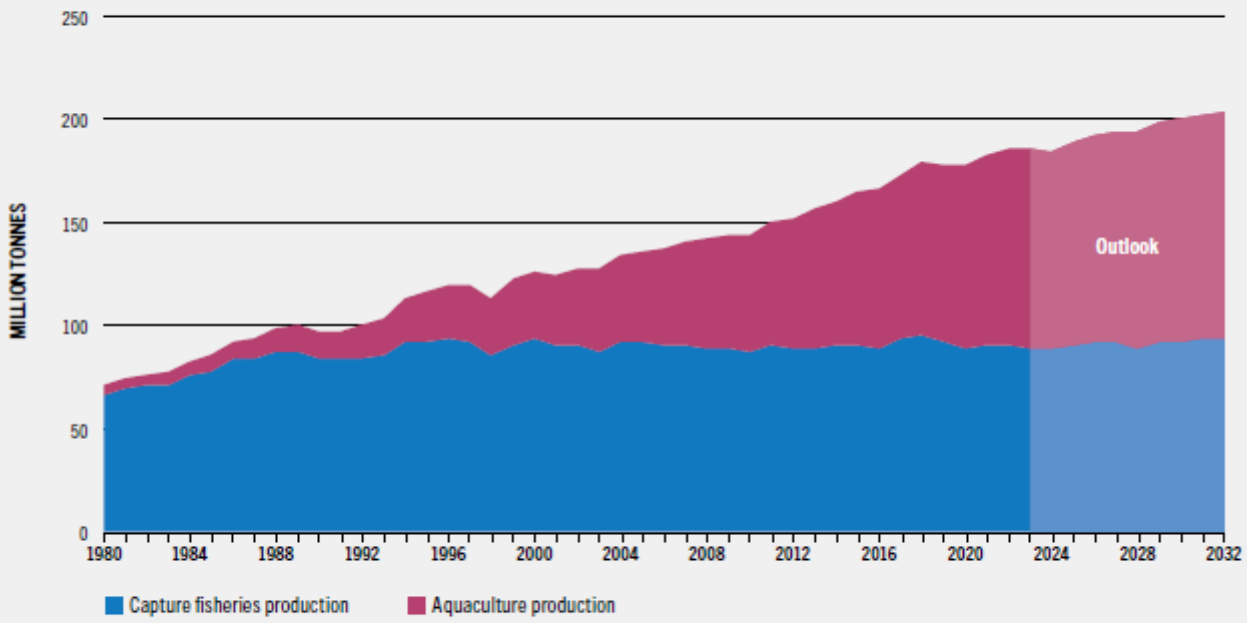
FIGURE 64 WORLD FISHERIES AND AQUACULTURE PRODUCTION OF AQUATIC ANIMALS, 1980–2032



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SOURCE: FAO estimates.

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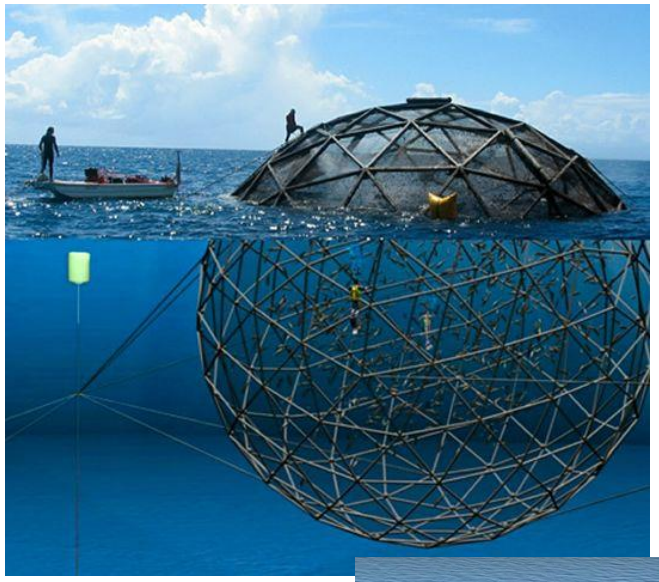

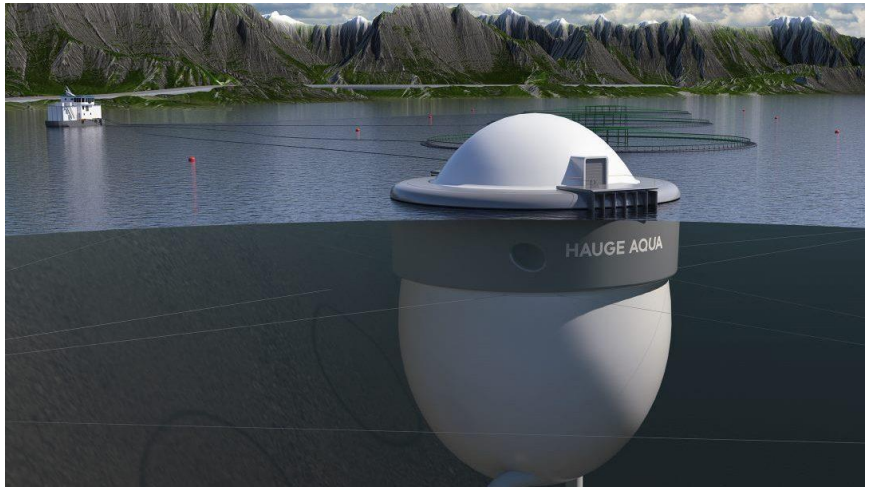

Problems of Aquaculture

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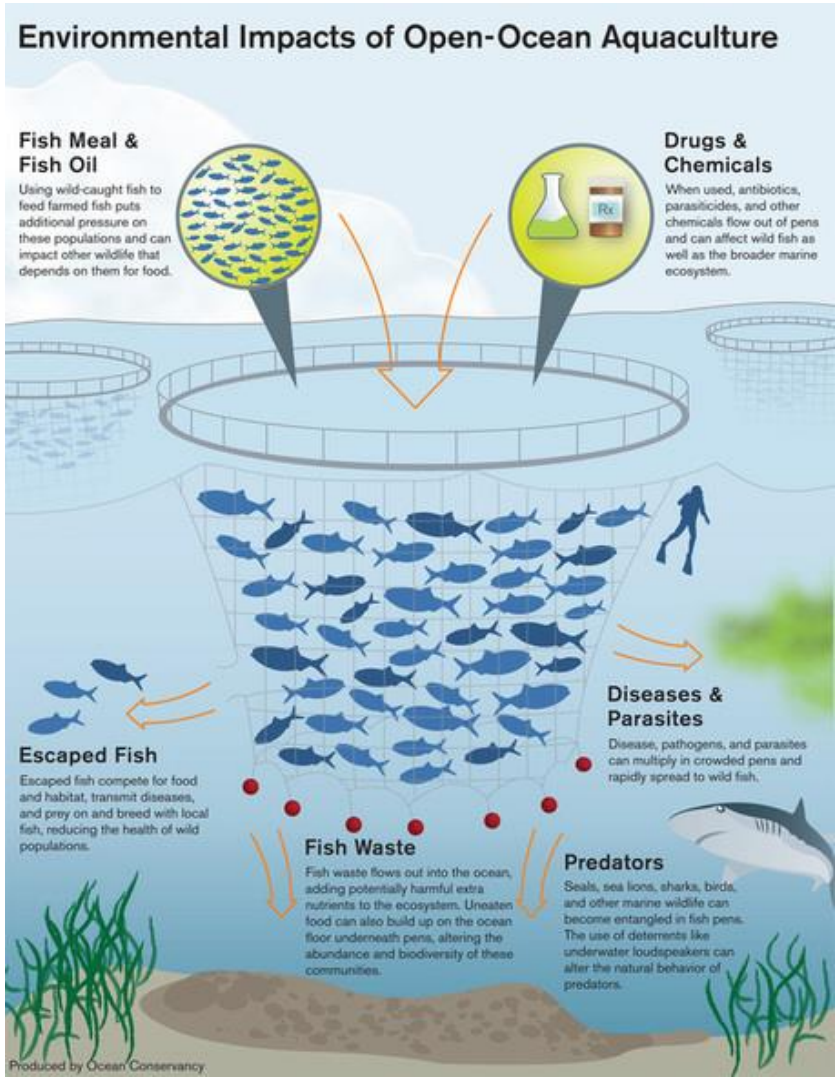

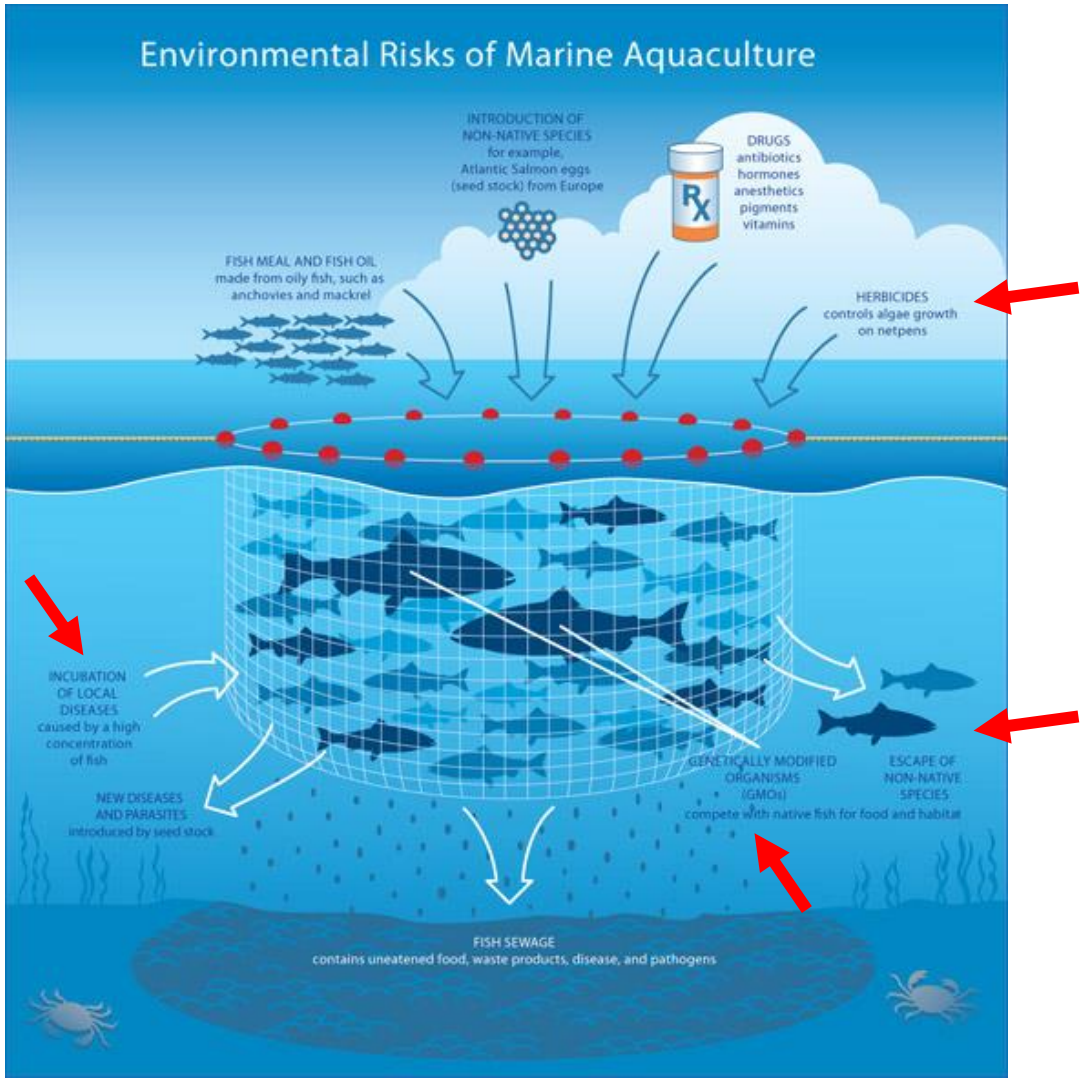

Integrated Aquaculture

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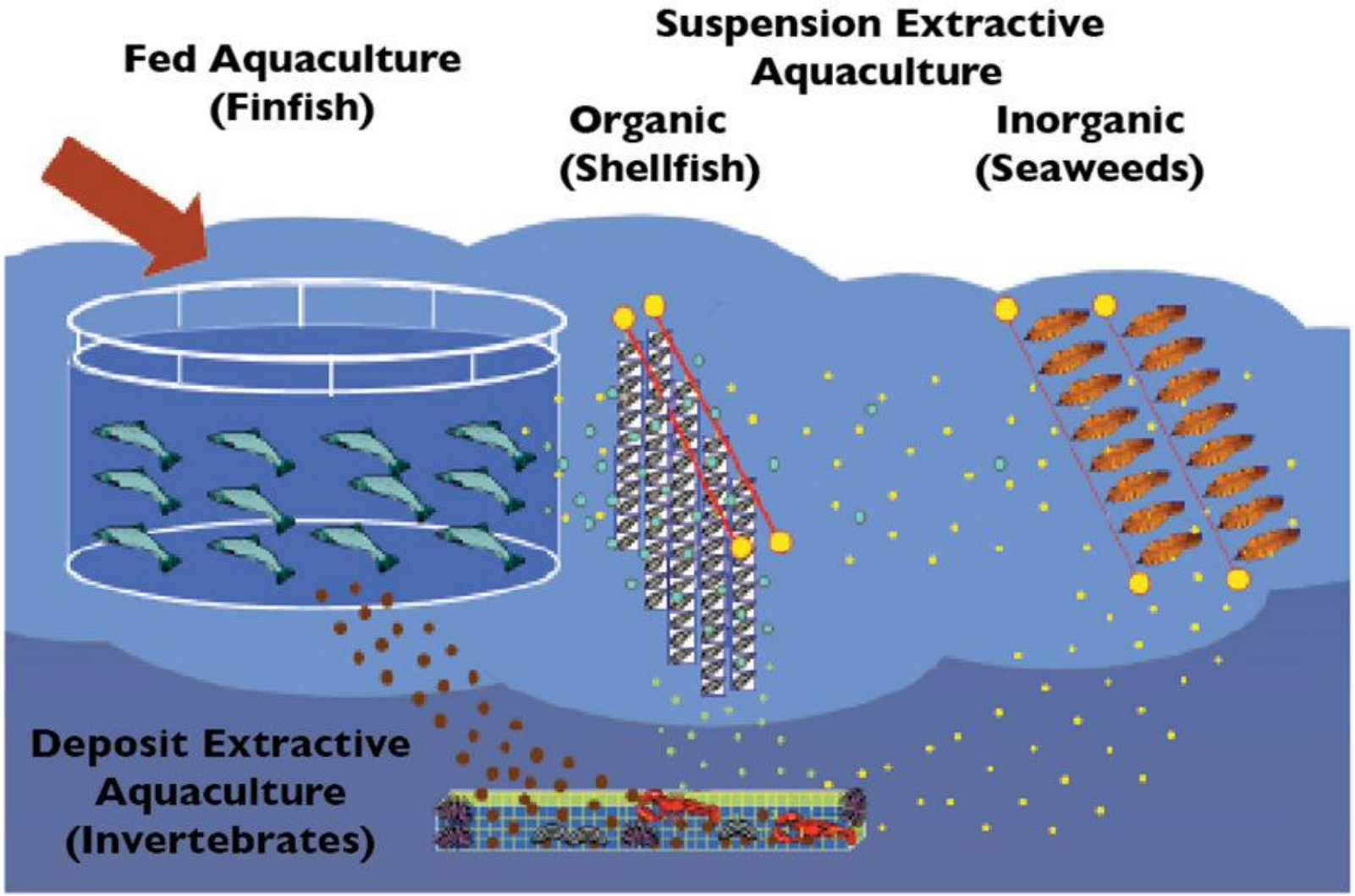

Problems of Aquaculture (Norway)

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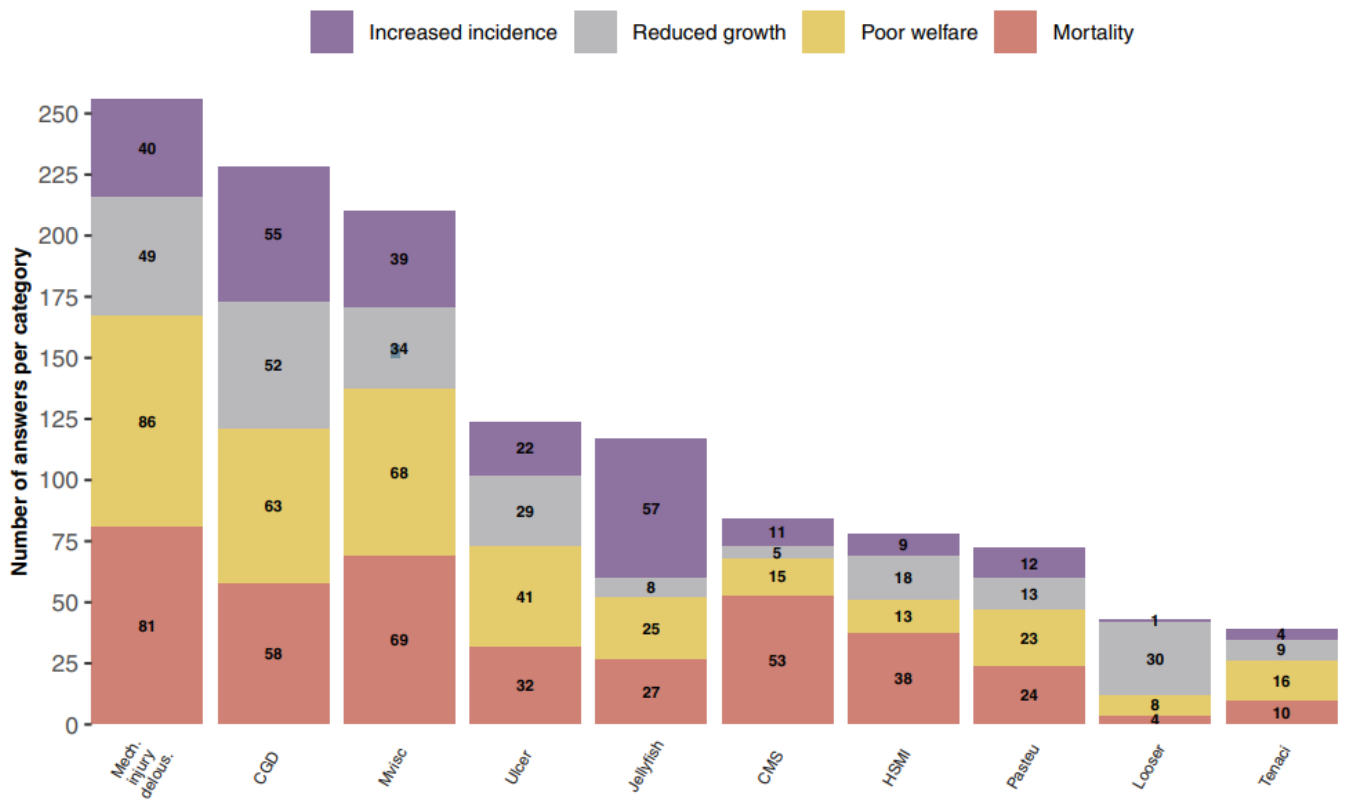

Figure The 10 most important fish health problems of salmon in ongrowing facilities (sea water sites).

Abbreviations:
Mech injury delouse = mechanical damage related to delousing
CGP = gill disease complex/multifactorial
Mvisc = infection with Moritella viscosa (classic winter ulcers)
ulcer = ulcers unspecified cause
CMS = cardiomyopathy syndrome
HSMI = heart and skeletal muscle inflammation
Past = infection with Pasteurella sp. (pasteurellosis)
Looser = runted fish, runt syndrome, emaciation
Tenaci = infection with Tenacibaculum spp. (non-classical winter ulcers)

Problems of Aquaculture (Norway)

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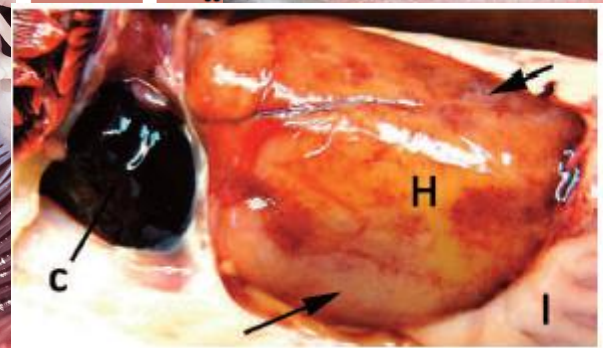

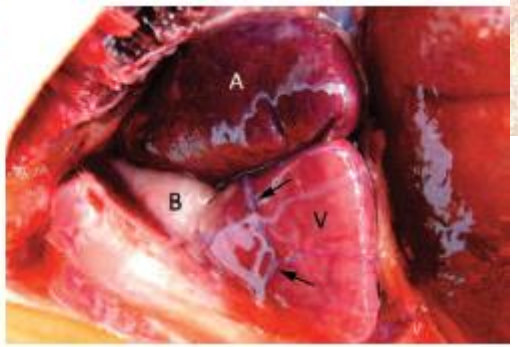

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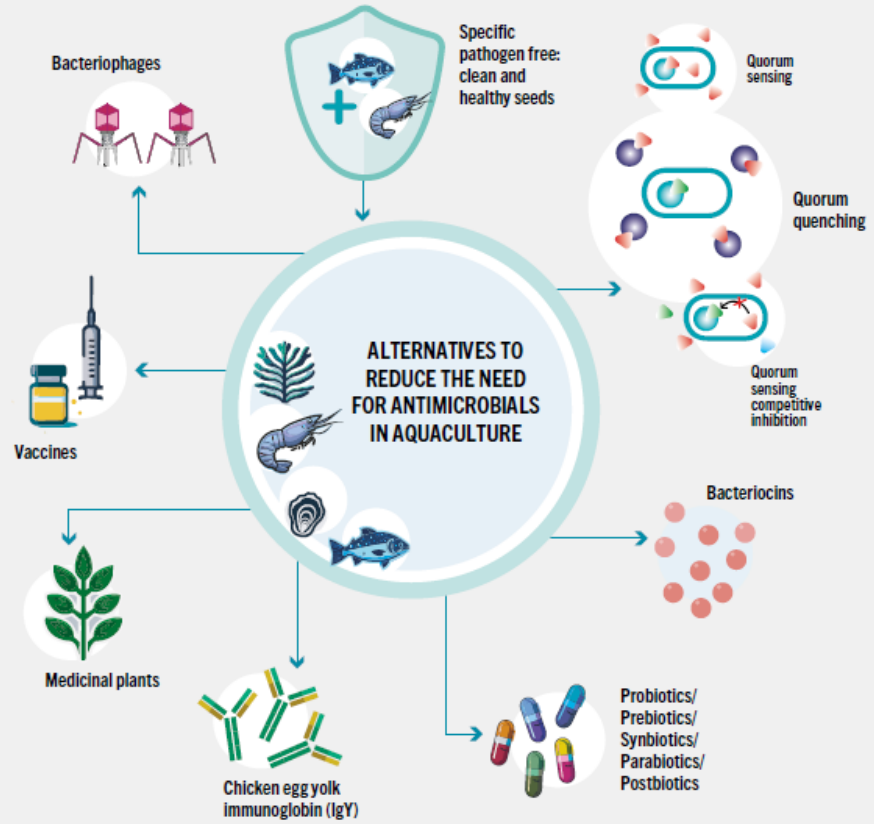
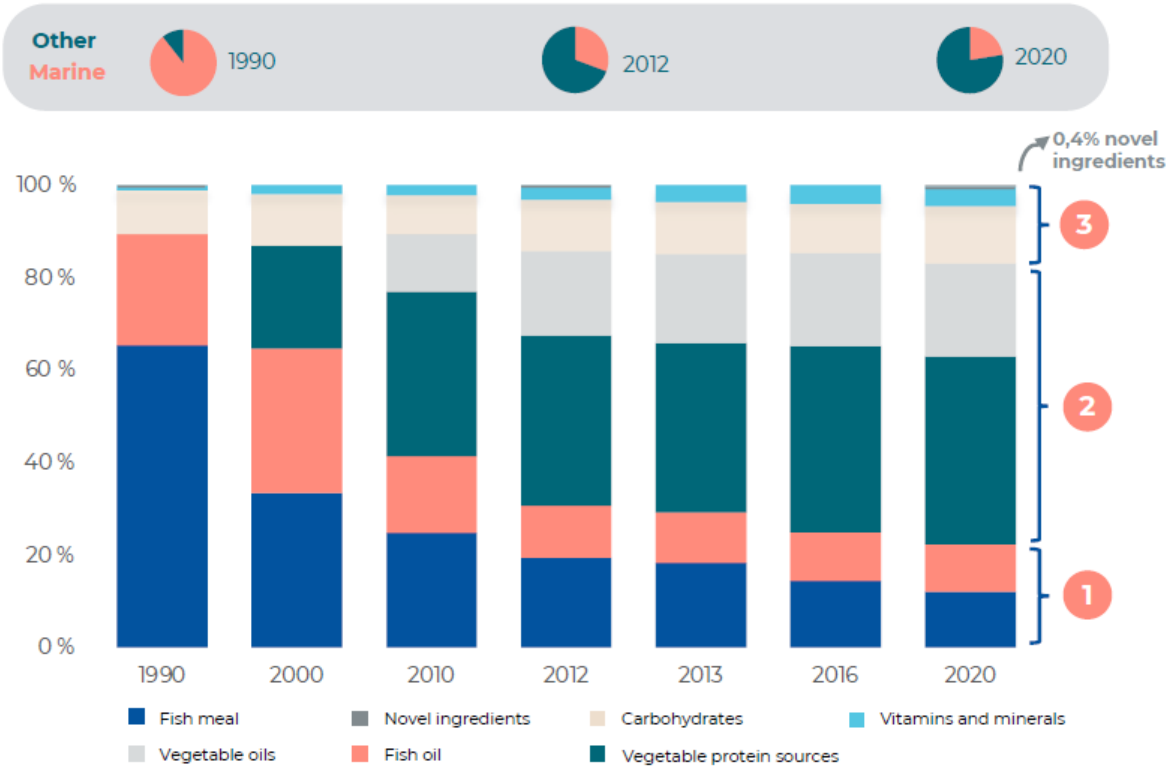
BOX 14 (Continued)

ALTERNATIVES TO REDUCE THE NEED FOR ANTIMICROBIALS



SOURCE: Adapted from Bondad-Reantaso, M.G., MacKinnon, B., Karunasagar, I., Fridman, S., Alday-Sanz, V., Brun, E., Le Groumellec, M. *et al.* 2023. Review of alternatives to antibiotic use in aquaculture. *Reviews in Aquaculture*, 15(4): 1421–1451. https://doi.org/10.1111/raq.12786

Ingredients used in Norwegian salmon feed (% of total ingredients)



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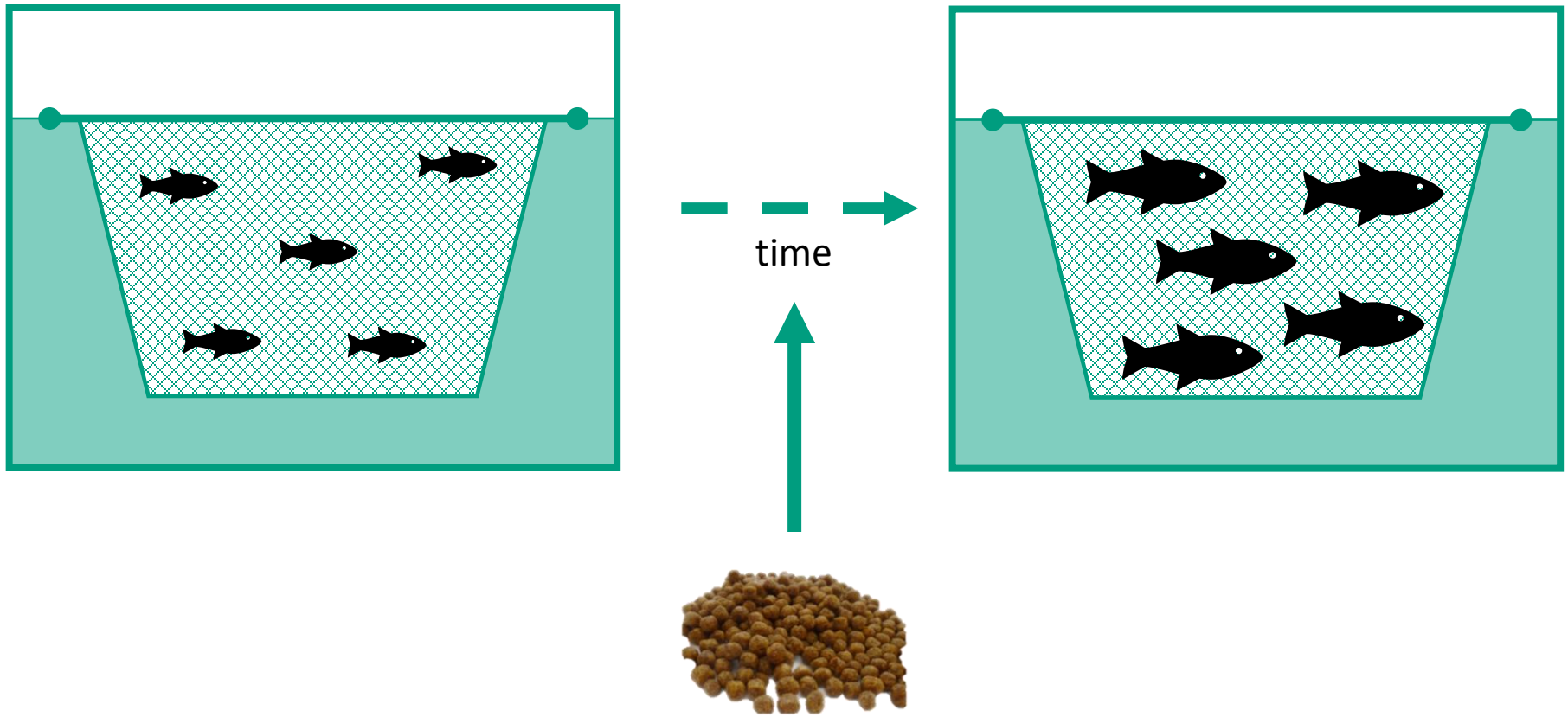
Aquaculture main goal



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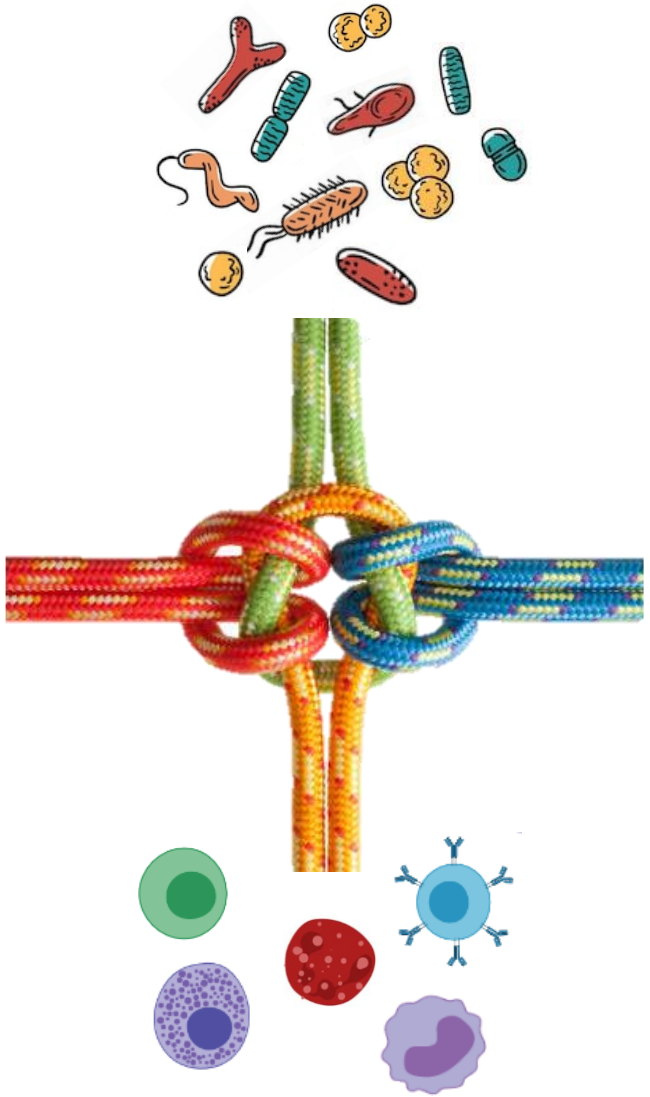

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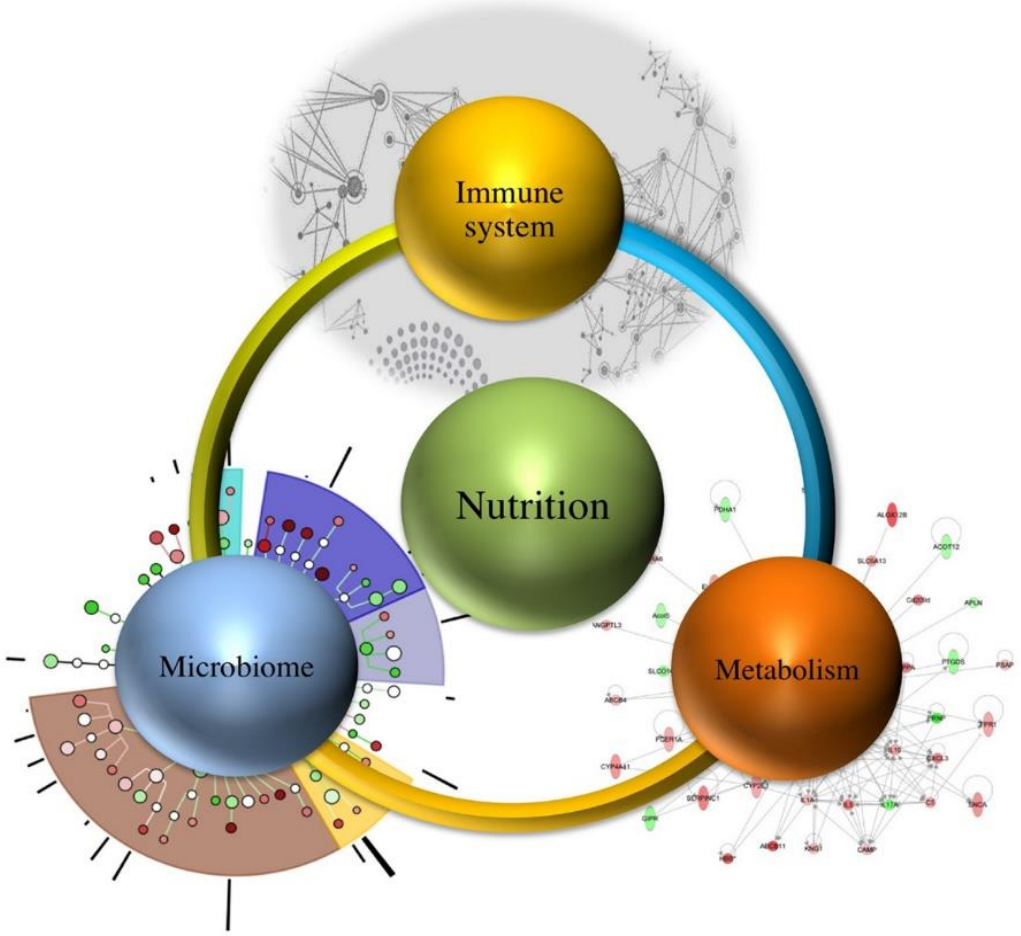

Verma *et al*. **2016**, Frontiers in Nutriton