Sustainable aquaculture in artificial ecosystems

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BACKGROUND

Overfishing is one of the biggest threats to the oceans and their sensitive ecosystems. If we want to preserve marine ecosystems, change is needed, which is why efficient and innovative management solutions are required. One proposed solution are aquacultures, which covers controlled farming of aquatic organisms such as fish, crustaceans, snails and aquatic plants. [1]

Figure 1: Aquacultures in Norway / Source: Otto Olsen [2]

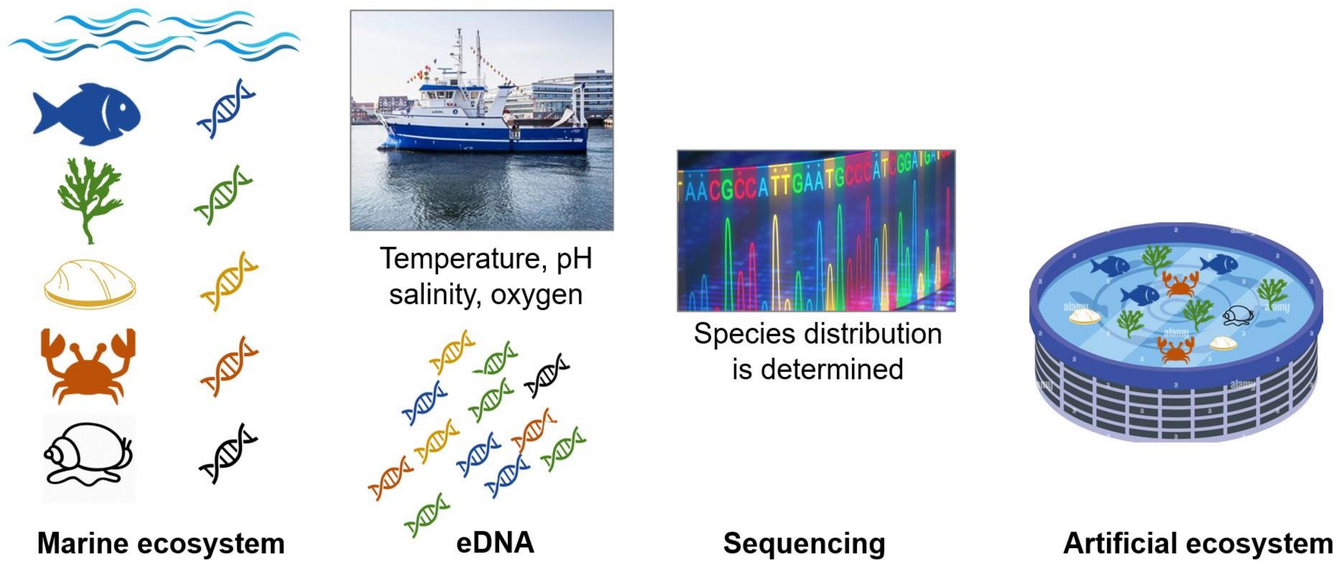

Figure 3: Schematic overview of analyzes and setup of artificial ecosystems.
Source: Karolin Janina Demtröder, 2022

PURPOSE OF THE PROJECT

The project is a design proposal for setting up aquaculture systems in which different organisms live in symbiosis. The purpose of this is to develop a symbiotic aquaculture system where breeding and conservation are combined such that the system becomes self-sufficient without medication and reduced water pollution. It is therefore investigated which methods can be used to determine the species composition and the conditions under which the organisms live in natural balance.

METHOD

1) **Water quality parameters**

   Water samples are collected at five different sites in four replicates and analyzed using **CTD probe** on the research vessel Aurora. Measures are taken on parameters such as salinity, temperature, oxygen and pH.

2) **Genomic analysis**

   All organisms leave traces in the form of DNA fragments that spread in the environment. These are called **environmental DNA (eDNA).** Water samples are filtered to concentrate eDNA. (Figure 2)

3) **eDNA metabarcoding**

   eDNA is amplified using specific primers and fragments are analyzed using NGS sequencing and bioinformatics assays. (Figure 2)

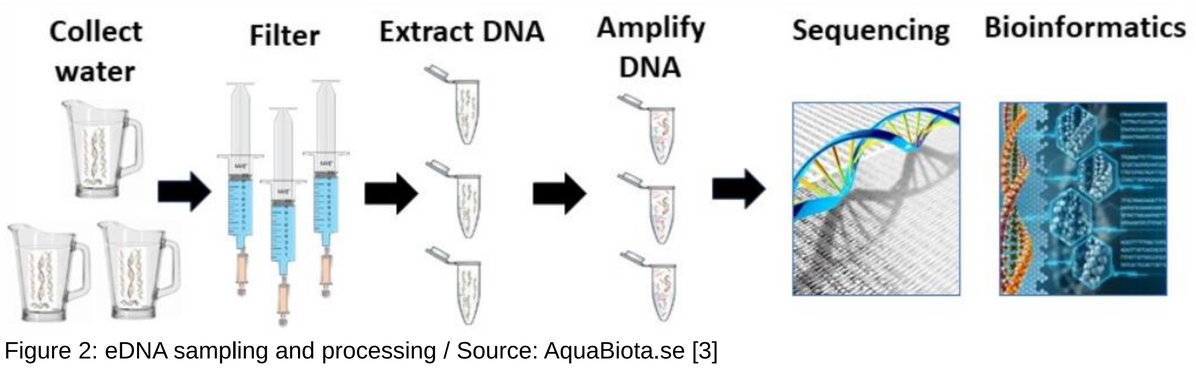

Figure 2: eDNA sampling and processing / Source: AquaBiota.se [3]

APPROACH

A) Setting up a smaller artificial ecosystem

- Data from the eDNA analyzes lead to a species list, which is used to generate an image of the composition of the ecosystem in which the sample was taken.
- The species composition is determined.
- Then an artificial ecosystem can be set up according to this specific species composition (Figure 3)

B) Optimization of biological composition and quality parameters

C) Monitoring of the artificial ecosystem

- Ongoing analyzes of water quality parameters and eDNA distribution.
- Stability of the biological population.

PERSPECTIVE

A successful artificial ecosystem could be transferred to a larger system, which could also be monitored using biological parameters, where eDNA is used as a biomonitoring tool. Finally, farmed fish are added to the artificial ecosystem, combining farming and conservation.

Primary goals:

- secure fish stocks and increase food security
- contribute to the sustainable development of the aquaculture sector

Secondary goals:

- to preserve the unique biodiversity of the natural marine ecosystem with many different species and biotopes
- to preserve the sea as a complete ecosystem (less pollution, less destruction)

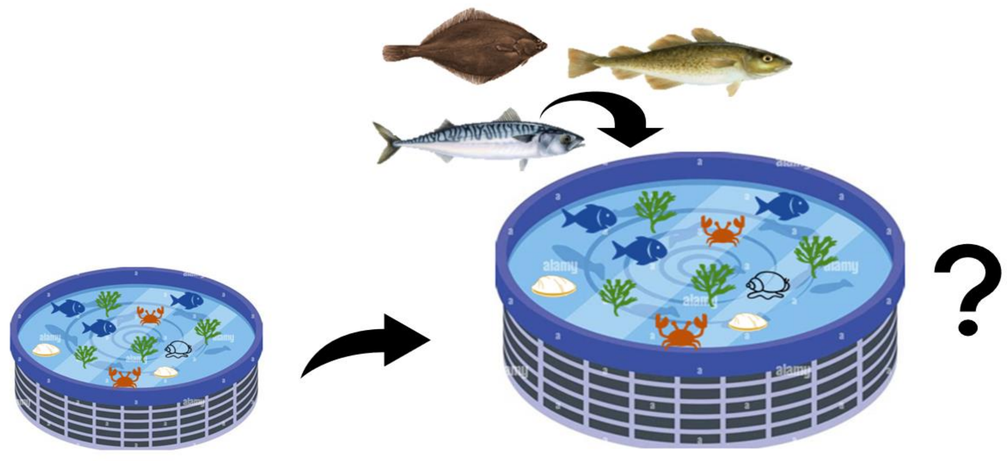

Figure 4: Optimization for larger systems with farmed fish. Source: Karolin Janina Demtröder, 2022

CONCLUSION

This project provides the opportunity to set up a successful artificial ecosystem with a specific species composition of e.g., mussels, fish and algae using eDNA analyzes. The quality aspects are continuously monitored, whereby both the composition and the conditions are checked. This project has great potential to contribute to a sustainable expansion of aquaculture production in Denmark, as it provides the opportunity to ensure nutritious food for the growing population.

ACKNWOLEDGMENTS

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REFERENCES

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[2] Akvakultur: https://oo.no/industrier/akvakultur/

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