Projekt: **The use of concrete as bio receptive material for artificial reefs: implications for marine habitat restoration and coastal protection**

Supervisors: Wolfgang Kunther / Jon Christian Svendsen
Contact: wolku@byg.dtu.dk / jos@aqua.dtu.dk

Background / Motivation

In many parts of the world, marine reef ecosystems have degraded in recent decades, with severe implications for the associated marine life and fisheries. Deteriorating marine reefs may also threaten human settlements in low-lying coastal regions and contributes to the redistribution of sediment along sandy coasts. Increasingly, reefs are therefore restored to recover the ecosystem services and enhance coastal protection. Further information is provided here and here. In addition, artificial reefs are created specifically to improve local and regional fisheries. Installing marine reefs requires engineering solutions that are socially, biologically and technically meaningful.



Objective:

In Denmark mostly granite, a material with little porosity, is used for the restoration of reefs. In this project, the use of a material that requires no import of granite is in the focus of investigation with respect to the benefit of a porous material to shorten the time of acceptance in the ecosystem. Geological calcium carbonate sources are used in cement production, which is used in combination with water as the glue in concrete. During its life-time, concrete takes up CO_2 from its surroundings and forms again $CaCO_3$. This process is on land unwanted as it threatens the structural integrity of steel-reinforced structures. However, this capability may facilitate the settlement of marine ecosystems, which is further supported by the property of concrete to be shaped in almost any form. Ideal forms and surfaces for various types of colonization (e.g. species of macro algae) are largely unknown, but may have the potential to improve reef restoration projects.

Topics to work on:

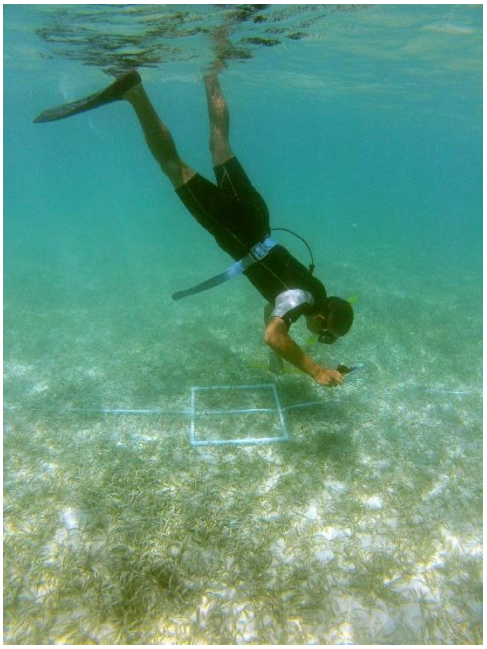
Reef restoration and the development of artificial reefs that provide important marine habitats and act as coastal protection offer an interesting engineering prospect in times of global warming, degrading reefs, collapsing fish stocks and rising seawater levels. Here, we focus on:

Restoring marine reefs and similar habitats

- Restore reef ecosystem services
- Identify optimal materials, surfaces and shapes to shorten the time of acceptance in the ecosystem to:
    - Minimize coastal erosion while protecting biological diversity and enhancing fisheries.
    - Use foundations of offshore wind mills and platforms to create reefs and support biological diversity and fisheries (e.g. scour protection).
    - Use harbors to enhance the survival and growth of juvenile fish and other organisms (e.g. Biohut).
- Biological sampling carried out using:
    - Snorkeling surveys
    - Baited and unbaited underwater cameras (e.g. BRUVS)
    - Remotely operated underwater vehicle (ROV; Trident)
    - Fish telemetry (electronic transmitters)

Using the Trident ROV (drone) to assess underwater habitats

Implanting a telemetry transmitter into the body cavity of endangered fish.

 Snorkel surveying benthic vegetation

Material Science / Concrete Technology

- bio-acceptance factors
    - Benefits of concrete use compared to granite, a material with little porosity.
    - Benefits of different cement types
    - Benefits of different surface textures
    - Influence of porosity differences

 An Example for surface texturing of a concrete element

- Durability related topics
    - carbonation and leaching
- laboratory vs. field exposure conditions

External funding / collaboration partners necessary for:

- Field studies / International collaborations

Sted: København og omegn
Virksomhed/organisation: DTU Byg / DTU Aqua
ECTS-point: 15 - 35
Type: Bachelor degree project, Master degree project
Skal have taget:. **Preferably**, you have attended DTU course 11561 for experimental work with concrete.