MSc and BSc projects or special courses:

Marine biology projects at the Technical University of Denmark (DTU Aqua) in 2018 - 2019

General information

Students are welcome to join ongoing research projects or start their own independent project. Students are expected to collect, analyse and interpret data and produce a manuscript draft that describes the study findings. All projects are designed to produce data for a peer reviewed publication that students will either first-author or co-author. Students are welcome to work in groups. Projects may be expanded, or combined, in case a single project (see below) provides insufficient work for a complete student project. In addition, most projects are flexible and could be modified (e.g. scope reduction) to meet student needs.

The work location is the Technical University of Denmark campus, north of Copenhagen in Denmark. Student guidance at the university covers study planning, data collection/acquisition, statistical analyses, results presentation and writing of thesis/manuscript. In addition to the student guidance, the university offers a study location (desk, PC, access to library, software etc.), laboratory space, transportation, research equipment (boats, underwater cameras etc.) and a friendly and international work environment. Depending on the project, direct financial support may be available. The university will ensure that students learn how to carry out a research project and report the findings.

Atlantic cod (Gadus morhua) captured by underwater video near Sønderborg in Denmark. (see project 2 below)
PROJECT 1: Annual migration of adult turbot (*Psetta maxima*) and implications for marine fisheries

**Aim:**
The aim of this project is to understand the spatial ecology of adult turbot to inform fisheries management. Specifically, the aim is to determine if adult turbot perform emigration from a shallow fjord during 2017-2019 or if the fish exhibit residency and therefore spawn locally. The latter may benefit future turbot recruitment in the fjord.

**Background:**
Turbot is a valued species by commercial and recreational fisheries and have been stocked in several locations in Denmark. The stocking has yielded increased catches of turbot, but the long term outcome of the stocking activities is largely unknown. For example, is turbot spawning near the stocking locations and therefore contributing to future turbot recruitment? Previous studies have indicated that some turbot may perform winter or spring emigrations and may leave stocking locations prior to spawning. It is therefore important to know if stocked turbot exhibit residency, because this behaviour would enable future recruitment in the stocking area.

**Content:**
The project will map turbot migration in the Roskilde Fjord near Copenhagen using acoustic telemetry. Tiny transmitters have been surgically implanted into the body cavity of adult turbot such that the individual fish can be tracked using acoustic receivers. Stationary acoustic receivers are positioned in the fjord to detect the movements of the fish. The student will assist the field work where data are retrieved from the acoustic receivers and then carry out analyses of the data to reveal the movements of the tagged fish. Fish were tagged in the spring of 2017 and preliminary analyses have already demonstrated movements of the fish. Several environmental variables are measured and may be used to explain the movements of the fish (e.g. water temperature).

![An adult turbot tagged with a transmitter inserted into the body cavity and then tracked using stationary acoustic receivers.](image-url)

**Duration:**
Data collection is expected to take 2-3 months, followed by analyses of the data taking 2-3 months and then 2-3 months for write-up.

**Contact:**
Jon C. Svendsen: jos@aqua.dtu.dk
PROJECT 2: The effects of cobble reefs on fish abundance and diversity: implications for marine fisheries and conservation of harbour porpoises

Aim:
The aim of this study is to examine to what extent cobble reefs affect abundance and diversity of fish and harbour porpoises (*Phocoena phocoena*) in coastal areas. The project will reveal if cobble reefs benefit marine fisheries and conservation of harbour porpoise.

Background:
Cobble is extracted in coastal areas in Denmark, but the effects of the extraction on fish abundance and diversity are unknown. While many coastal fish populations have been in decline in recent years, the possible relationship between cobble extraction and declining fish populations remains uncertain. Using underwater video footage, this project examines fish abundance and diversity on natural cobble reefs, artificial cobble reefs and on sandy sea beds.

Content:
Collection of data will involve field work where fish abundance and diversity are quantified using underwater GoPro cameras positioned on the sea bed. Camera deployment will involve baited and unbaited cameras. Data collection will cover three types of areas: 1) control areas with sandy sea beds, 2) areas with natural cobble reefs, and 3) areas with artificial cobble reefs. The study design will be based on the Before-After-Control-Impact (BACI) approach. Specifically, the study will test the hypotheses that 1) Atlantic herring (*C. harengus*) utilize cobble reefs for spawning and that 2) artificial cobble reefs may facilitate Atlantic herring spawning activities. Because Atlantic herring is an important prey species for many larger species, cobble reefs may support several trophic levels in the marine environment. In addition to the underwater video recording, abundance of harbour porpoise is measured in the three study areas. These data are collected using automatic listening stations that record sounds produced by harbour porpoise.

Atlantic herring (*Clupea harengus*) is an important prey species for Atlantic cod (*Gadus morhua*) and harbour porpoise (*Phocoena phocoena*) and may utilize cobble reefs for spawning.

Duration:
Data collection will take 2-4 months. Data analysis and write-up are expected to take approximately 4-6 months in total. Baseline data (i.e. without artificial reefs established) have already been collected and the student will have access to those data. The baseline data will be combined with data collected after the artificial reefs are established.

Contact:
Jon C. Svendsen: jos@aqua.dtu.dk
**PROJECT 3: Restoration of marine boulder reefs: addressing the single large or several small (SLOSS) debate in relation to marine habitat restoration.**

**Aim:**
The aim is to identify types of restored boulder reefs that maximize fish abundance and diversity. Specifically, the project will compare fish abundance and diversity in two types of restored boulder reefs: 1) a single large boulder reef, and 2) several small boulder reefs. Equivalent amounts of boulders are used for the two designs. It is hypothesized that several small boulder reefs host the highest fish abundance and diversity per unit boulder.

**Background:**
Human impact on marine habitats is a global problem, particularly in Northwestern Europe, East Asia, North America; and the Mediterranean and East Caribbean Seas. Approximately 85% of the European coastlines are degraded. In Denmark, large quantities of boulders have been extracted from coastal zones to provide building material for constructions, including piers and jetties. The extraction of marine boulders ceased in 2010; and boulder reefs are now being restored to meet the requirements of the EU Habitat Directive. However, boulder reefs can be constructed in many different ways, and the optimal construction type for fish abundance and diversity is not known.

**Content:**
Restored boulder reefs will be examined using underwater cameras, and then fish abundance and diversity on each reef will be quantified using video analyses. Field work will be carried out during the spring and summer. The study provides data to identify the optimal type of restored boulder reef. These data will provide guidelines for future restoration projects aimed at improving fish abundance and diversity. Further information is available [here](#) and [here](#).

**Duration:**
Data collection will take 2-3 months over the summer, followed by video analyses taking 1-2 months and 1 month for data analyses. Write-up will take another 1-2 months.

**Contact:**
Jon C. Svendsen: jos@aqau.dtu.dk
**PROJECT 4: The importance of mussel banks for behavioural interactions between fish species in coastal areas: A lab study**

**Aim:**
Using data collection in the lab, the objective of this study is to understand how degraded mussel habitats affect behavioural interactions of various fish species and possibly favour invasive species.

**Background:**
Mussel habitats are degraded in many parts of the world, but the significance of the degradation for interactions between fish species remains uncertain. Knowing marine species interactions in different habitats is important for projects restoring mussel habitats. If invasive fish species perform better in degraded mussel habitats, restoring mussel areas could support indigenous fish species.

**Content:**
Lab data on fish behaviours and species interactions in mussel areas with different degrees of degradation (e.g. low, medium and high density of mussels) will be collected. The data collection will take place at the public aquarium The Blue Planet in large laboratory tanks with a flow through supply of water. Various experimental treatments will be designed and fish behaviours will be quantified to test the hypothesis that fish behaviour and species interactions vary with the degree of habitat degradation. Fish stress levels will be assessed by sampling cortisol levels, both in the different habitats and as a function of various species interactions. In addition to varying mussel densities, environmental factors (temperature and oxygen) could be varied to examine possible outcomes of climate change scenarios. The project offers unique dissemination possibilities because data collection will take place in a public aquarium, although fish tanks are not directly accessible to the public to minimize disturbance and mimic natural conditions.

**Duration:**
Data collection is expected to take approximately 3 months; followed by 1-2 months for data analysis and 1-2 months for write-up. The scope of the work may be expanded and the project duration prolonged beyond 6 months if allowed by the study program.

**Contact:**
Jon C. Svendsen: jos@aqua.dtu.dk
PROJECT 5: Marine migration of anadromous brown trout (*Salmo trutta*) mapped using acoustic telemetry

**Aim:**
The aim of this study is to map the migration and temperature exposure of adult brown trout in the marine environment.

**Background:**
In many rivers, brown trout exhibit an anadromous strategy where fish emigrate from the river to forage on abundant prey sources in the marine environment. While riverine migrations have been investigated by many previous studies, the marine migrations remain poorly understood. For example, habitat use and temperature exposure have rarely been described in the marine environment. Knowledge in this field is important to manage and protect populations of anadromous brown trout. This is particularly important in areas where brown trout populations are supported through the release of juvenile fish raised in captivity.

**Content:**
This study will use fish telemetry to investigate the migration of adult brown trout in the Roskilde Fjord, 40 km west of Copenhagen in Denmark. Fish captured in the wild will be tagged with acoustic transmitters and tracked using stationary hydrophones and manual tracking from a boat. Acoustic transmitters will not only reveal the position of the tagged fish in the shallow fjord, the transmitters will also measure and transmit the temperature inside the fish. Temperature measurements can be used to estimate maximum growth rates and exposures to critical temperatures (e.g. during the summer). Stationary hydrophones will be positioned in narrow parts of the Roskilde Fjord and will be used to determine if the tagged brown trout emigrate from the fjord and enter the Kattegat Sea.

**Duration:**
Data collection for this project is expected to run for 2-4 months, followed by data analyses lasting 1-2 months and 1-3 months for write up. The project is large enough to accommodate 2-3 students.

**Contact:**
Jon C. Svendsen: jos@aqua.dtu.dk