Contributions to the Kysthjælper project made by students at DTU Aqua

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In total 8 students contributed to the project. A summary of each report and selected results are provided below and the main findings are highlighted in bold.

Copilot was used to condense text and improve language in this report.

Summary

The Kysthjælper project and students at DTU Aqua developed methods for monitoring fish presence and recording environmental conditions. Recommendations are provided regarding the use of different trap types, measuring oxygen and simplifying processes to ease implementation in citizen science projects. In addition, one student project also explored using juvenile flatfish as bio-indicators of seabed quality and several of the student projects studied eelgrass transplantations compared with a nearby location without eelgrass.

Testing with smaller mesh sizes in the traps suggested potential improvements in capturing a wider variety of species. A protocol for monitoring fish using fyke nets, including an equipment list and printable spreadsheet for data reporting, was produced. An R-shiny app was created to compile and present data from volunteers. No clear conclusions were reached regarding the use of juvenile flounder as an indicator for sediment quality, and further studies are recommended. Fish had more difficulties escaping crabs in fyke nets, resulting in lower survival rates. Emptying lobster traps from crabs was harder in the long lobster trap. Notably, cod were mainly caught in eelgrass during the field campaigns. Oxygen and temperature datalogger were tested and a manual and a tripod to fix the datalogger when monitoring oxygen and temperature in the field were developed for use by volunteers.

Oxygen fluctuated in both eelgrass and sandy habitats, but the daily fluctuations were sometimes higher in eelgrass. Eelgrass habitats supported more species, including prey for cod and juvenile cod, compared to sandy bottoms. Cod catches depended on temperature differences between field trips. The most effective cod-catching tool was the netted lobster trap, followed by the eel fyke and rigid lobster trap. Crabs were extremely abundant and killed 8.3% of all fish in the traps. Mortality was higher in the eel fykes. Significant differences in species abundance were found between eelgrass and sandy bottom. Atlantic cod and corkwing wrasse preferred eelgrass habitats, while eelpout was more abundant in control sites. Species richness and diversity were not

different between the two habitat types. Efficiency comparisons among gear types showed that rectangle fyke nets had superior catch rates, while double eel fyke nets had the highest mortality rate. Atlantic cod, eelpout, goby spp., and sculpin showed significant differences in abundance based on temperature, with all except goby spp. being more abundant in colder temperatures.

Daily fluctuations in oxygen saturation were observed in sand bottom and eelgrass habitats, but less so at the stone reef. Moderate and critical oxygen depletion were recorded once in transplanted eelgrass and at the stone reef, likely due to heavy rain. Fluctuations in eelgrass beds may be higher due to primary producer mass, affecting oxygen levels through photosynthesis during the day and respiration at night. Volunteers could contribute to a BRUV survey to cover more ground spatiotemporally, as long as thorough guidelines are followed, and sufficient training is offered. A comparison between BRUV and eel fykes revealed roughly the same number of species, but only flatfish were observed by both methods. The species observed with the BRUV were smaller.

Report on Data Collection Method for project Kysthjælper

Sissel Kolls Bertelsen (Special course, handed in May 2022)

Summary of the report: Methods and protocols for monitoring the presence of fish in both improved and control areas were developed and tested. Volunteers use eel traps for data collection, chosen for their simplicity and effectiveness. Data is collected before and after habitat improvements to account for various influencing factors. Volunteers record weather conditions, date, time, and other relevant details. Data is reported in two different forms, one for environmental conditions and another for species and quantities of organisms caught. The primary catch consisted of common shore crabs and various fish species, including juvenile cod and flounder. The small sample size limited statistical analysis, but initial observations indicated differences in catch rates between habitat and control areas. **Testing with smaller mesh nets suggested potential improvements in capturing a wider variety of species (Figure 1)**. Consideration of different trap types is recommended, balancing ease of use and effectiveness. Simplifying the process for volunteers, possibly using volume or weight measurements for non-fish species, is also suggested. Addressing fishing restrictions during certain periods, potentially seeking special permissions, is another recommendation. The project highlights the importance of volunteer engagement in scientific data collection and the need for simple, effective methods to ensure consistent and reliable data. **A protocol (in Danish) for monitoring fish using fyke nets, including equipment list and printable spreadsheet for data reporting (appendix A1a, A1b, A1c, and A1d) were produced (Figure 2). Lastly, an R-shiny app was made to compile and present data returned from volunteers in the beforementioned spread sheets (Figure 3)**.

Figure 1. Picture of eel trap (eel fyke) with a small-meshed cover bag to retain some of the smaller species. Photo: Sissel Bertelsen.

Figure 2. A simple inflatable toy boat can make monitoring-fishing so much easier. Photo borrowed from Sissel K. Bertelsen´s report.

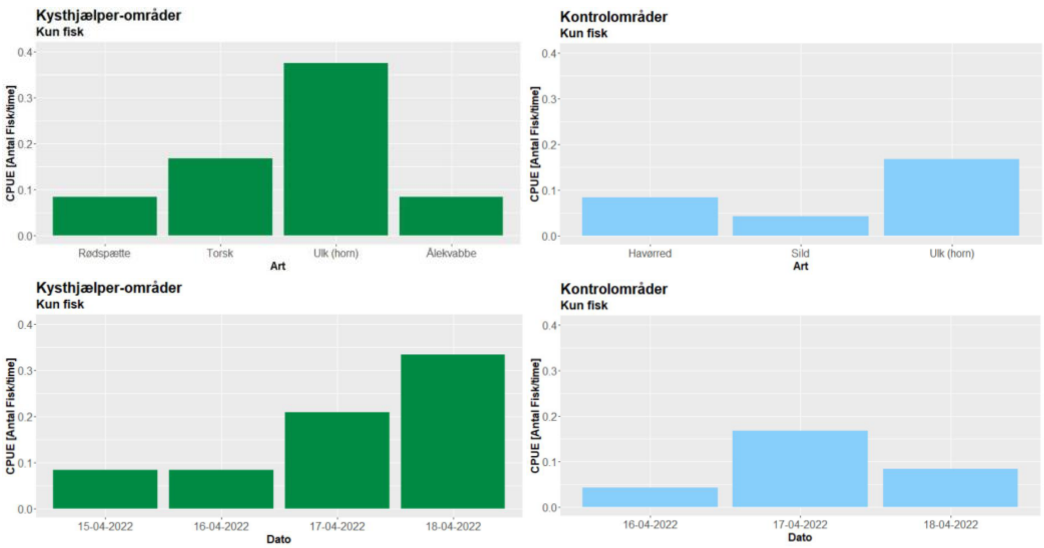

Figure 3. Picture of the figures displayed in the R-shiny app, exemplified with the data collected by Sissel K. Bertelsen. If the monitoring effort was continued and the data from the data reporting spreadsheet is copy-pasted into the "master" data-file connected to the Shiny-app, then these figures would develop over time. The shiny-app program can easily be placed on a webserver, so that figures are made available for everyone via a web-link. Graphs were borrowed from Sissel K. Bertelsen´s report.

Using Juvenile Flatfish as Indicators of Seabed Quality – In Connection with a Citizen Science Habitat Restoration Project

Amalie Broegaard Iversen and Lena Renaberg (double Bachelor thesis, handed in May 2022)

Summary of the report: The potential of using juvenile flatfish as bio-indicators of seabed quality in coastal zones, monitored by volunteers in the Kysthjælper project, was explored. Coastal zones are habitats for many species, including flatfish, but face challenges like habitat loss and environmental disturbances, such as increased hydrogen sulfide production, which is lethal to aquatic animals and eelgrass. Juvenile flounder and plaice were used in experiments to observe their behavior when exposed to sand containing hydrogen sulfide. Results showed minimal behavioral changes, with only 2 out of 20 fish fleeing the sand **(Figure 4)**. Oxygen profiles indicated rapid depletion just below the surface of the sand, and iron analysis revealed dominance of Fe^{+2}, indicating hydrogen sulfide production. Pre-experiments on substrate grain size and color showed juvenile flatfish preferred finer sediment but had no clear color preference. **No clear conclusions were reached concerning the use of juvenile flounder as an indicator for sediment quality and further studies are recommended**.

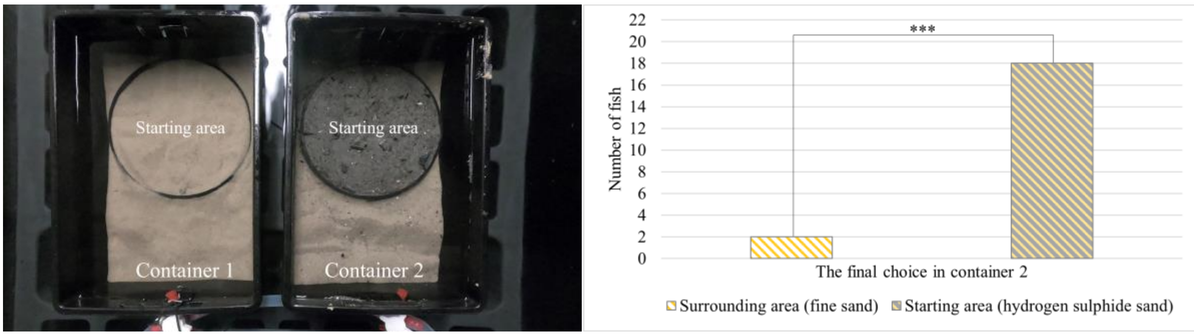

Figure 4. Result from lab experiment with juvenile flounders released in sulfide contaminated sand (container 2 in the picture to the left). The graph to the right shows that only 2 fish fled the starting area, indicating little sensitivity towards sulfide. Graph and photo were borrowed from the Bachelor thesis of Amalie B. Iversen and Laura Renaberg.

Testing and developing manuals for citizen science monitoring of temperature, oxygen and fish Biodiversity

Gustav Skriver Frydenberg (Bachelor thesis, handed in February 2023)

Summary of the report: Over the past 100 years, the decline of eel grass has led to habitat loss for many species in Danish waters and the adjacent Baltic Sea, causing environmental disturbances, stressed fish populations, and the collapse of coastal fisheries. To address this, project Kysthjælper has planted an eel grass meadow in Kalø Vig, using sprouts from a nearby eel grass meadow. This project aims to determine if restoration is possible and if the new bed will provide the same biological benefits as a natural eel grass meadow. In this thesis, a field campaign compared the newly planted eel grass meadow at Kalø Vig with a nearby location without eel grass [there has been some confusion about whether the appointed eel grass was transplanted or natural]. The comparison focused on water temperature and oxygen content during day and night for three days. Additionally, fish abundance and diversity were surveyed using both lobster traps and fyke nets (also known as eel traps or eel fykes and were similar to those used by Sissel K. Bertelsen) and the performance of the two gear types were compared **(Figure 5 & 6)**. The lobster trap caught more fish and a wider size range and proved to be the most effective method for examining fish abundance and diversity. However, **fish also had more difficulties escaping the crabs in the fyke net, hence survival was lower. Emptying lobster traps from crabs was hard work and more difficult than with the fyke nets. Notably, cod (*Gadus morhua*) were exclusively caught in the eel grass during the field campaign**. As a result of this thesis, a citizen science manual was developed to investigate fish abundance and diversity using volunteer data collectors from project Kysthjælper. This work is an extension of the work started by Sissel K. Bertelsen. Additionally, **a manual and a tripod (Figure 7) to fix the datalogger for monitoring temperature and oxygen content in coastal habitats were developed for use by volunteers (appendix A2a and A2b)**.

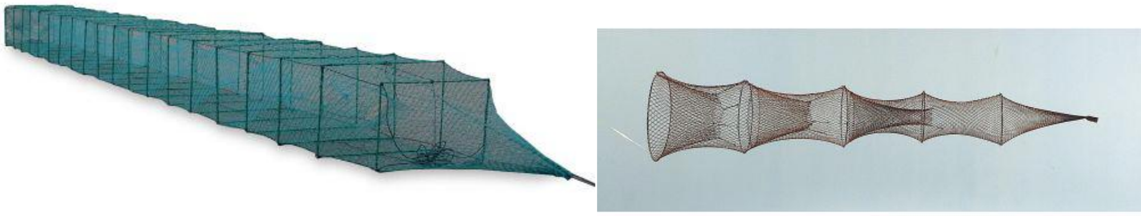

Figure 5. Lobster trap (or netted lobster trap or squared fyke) to the left and fyke net (also known as eel trap or eel fyke) to the right.

Type of trap	Lobster trap	Fyke net
Overall effectiveness	8	2
Small fish effectivity	9	1
Separation of fish and crabs	7	3
Depletion of crabs	3	7
First time setup	6	4
Routine check-up	2	8
Fish survivability	7	3
Total rating	42	28

Figure 6. Rating (0-10) of the two different types of gear. The table were borrowed from the Bachelor thesis of Gustav Skriver Frydenberg.

Figure 7. Photos of the preferred oxygen loggers from miniDOT (left and middle) and the tripod to hold the logger (right). Photo of tripod were taken by Gustav Skriver Frydenberg. Photo of oxygen logger was taken by Antonio Svensson.

Investigating the Decline of Eelgrass, its Role in Marine Ecosystems and as Nurseries for Atlantic Cod

Johan Hauser Jacobsen (Bachelor thesis handed in January 2024)

This project evaluates the processes, considerations, outcomes, and feasibility of eelgrass restoration. Methods developed for fishing and measuring oxygen presented in the project by Sissel K. Bertelsen and Gustav Frydenberg Skriver were tested. Besides the fyke and the lobster trap from the beforementioned study, also a different type of lobster trap (rigid lobster trap) was used in this study (**Figure 8**). Additionally, the study examines how and why juvenile cod utilize eelgrass habitats. Two field trips were conducted to Kalø Vig to collect data on cod abundance, prey species, nutrient concentrations, and oxygen patterns in eelgrass compared to sandy bottoms, which served as the control area. The hypothesis was that more juvenile cod would be found in eelgrass, that ambient phosphorus and nitrogen concentrations would be lower in eelgrass-surrounded waters, and that dissolved oxygen saturation would be more stable in eelgrass areas compared to sandy bottom habitats. A General Linear Model was used to estimate the significance of juvenile cod's preference for eelgrass, though the estimated catch was highly dependent on seasonality and the traps used. Average values for N-NOx (N-Nitrate + N-Nitrite) and P-PO4 concentrations were lower in eelgrass but were not statistically different from the control area. **Oxygen fluctuations were initially higher in eelgrass habitats but later matched those in sandy areas** (**Figure 9**). **Eelgrass habitats supported more species (incl. prey for the cod) and juvenile cod compared to sandy bottoms, though cod catches depended on the temperature as seen by the difference between field trip 1 and 2** (**Figure 10 & 11**). **The most effective cod-catching tool was the netted lobster trap, followed by the**

eel fyke and rigid lobster trap. Crabs were extremely abundant and killed 8.3% of all the fish in the traps (**Figure 12**).

Figure 8. Three types of gear used in the study. Rigid lobster trap (or just lobster trap or squared fyke) (left). Netted lobster trap (middle). Eel fyke (or fyke net or double eel fyke or eel trap) (right).

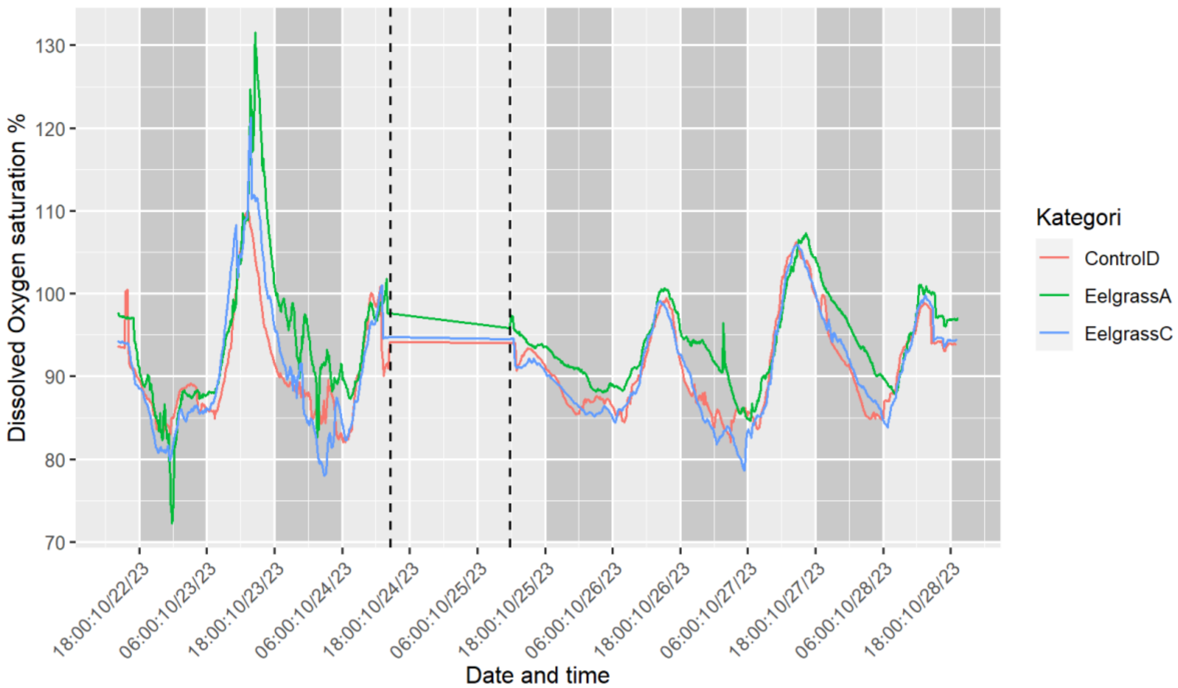

Figure 9. Oxygen measurements in the control area and the eelgrass.

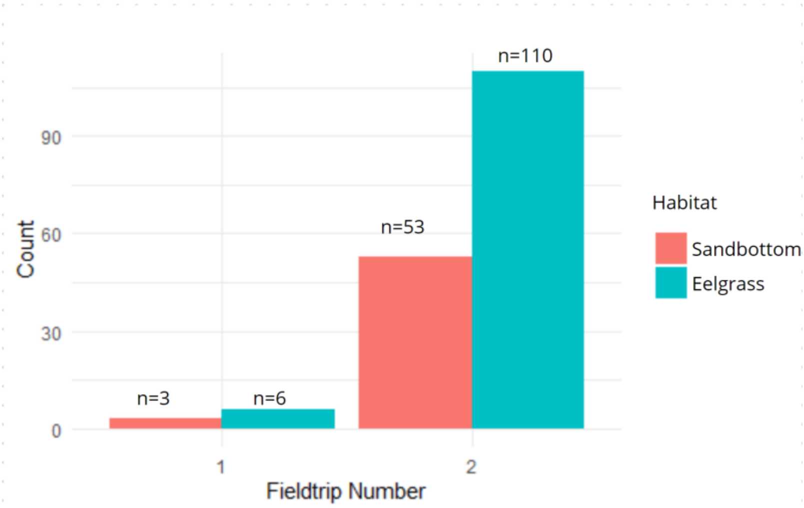

Figure 10. Total number of cod caught during each of the two field trips on sand bottom and eelgrass.

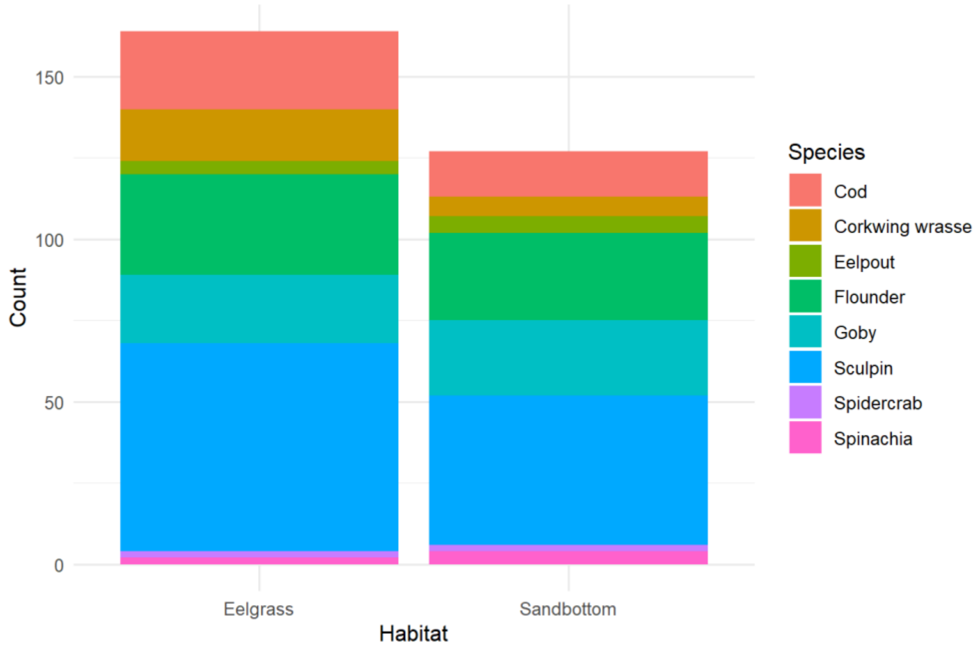

Figure 11. Total number of each species caught in eelgrass and on sandy bottom, respectively.

Figure 12. Example of what the crabs can do to the fish in the traps overnight. In total 11.000 crabs were caught and 8.3% of all fish in traps were killed.

The effect of eelgrass habitats on fish species richness: A case study in Kalø Vig

Pernille Schou Jacobsen (Master thesis, handed in April 2024)

This study examined biodiversity differences between eelgrass habitats and control sites in Kalø Vig, Denmark. Data collection was carried out together with Johan Hauser Jacobsen (see the project above) and the data analyzed in the two studies are the same, but the aim and approach are different. **Results showed significant differences in species abundance between eelgrass and sandy bottom as also shown in the former study by Johan** (using the same data). **Atlantic cod and corkwing wrasse preferred eelgrass habitats, while eelpout was more abundant in control sites. Species richness and diversity were, however, not different between the two habitat types. Efficiency comparisons among the gear types showed that rectangle fyke nets had superior catch rates, while double eel fyke nets had the highest mortality rate, making them the least efficient** (**Figure 13**). **Atlantic cod, eelpout, goby spp., and sculpin showed significant differences in abundance based on temperature, with all except goby spp. being more abundant in colder temperature**s (**Figure 14)**. Incorporating environmental variables like wind and salinity could improve the model. Using multiple gear types is encouraged to catch a wider variety of species. European green crabs were extremely abundant in both habitats, indicating an ecosystem imbalance that may have reduced fish counts and eelgrass density.

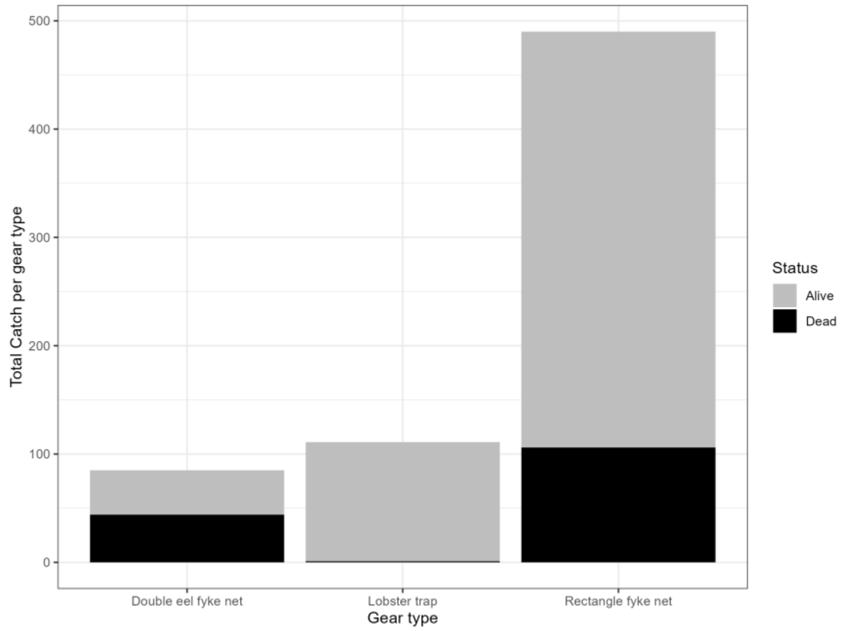

Figure 13. Catch numbers per gear type (all species) divided in to those that were alive and those killed by the crabs.

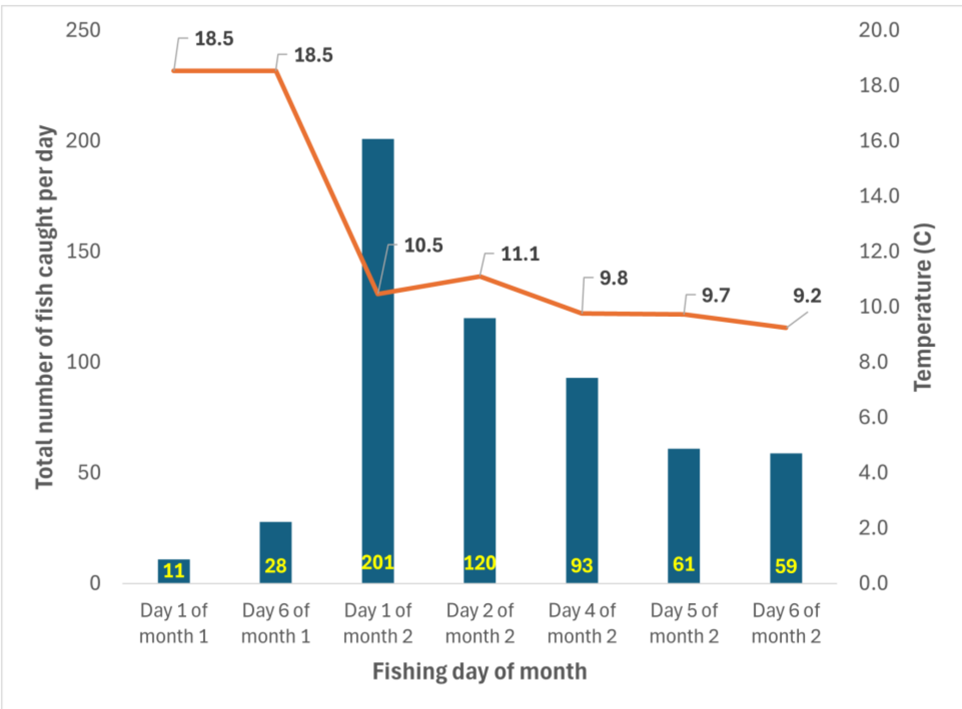

Figure 14. Total number of fish caught (blue columns) and temperature in relation to time of year. Day 1 and day 6 of month 1 corresponds to the 15th and 23rd September, respectively. Days in months 2 are all between 20th and 29th of October.

Oxygen and Temperature Conditions in Vejle Fjord

Antonie Svensson (Special course, handed in December 2024)

This report, which is based on oxygen and temperature measurements between 24th September and 10th October 2024 at Sellerup strand in Vejle Fjord, investigates temperature and oxygen conditions in four microhabitats: natural eelgrass, transplanted eelgrass, stone reef, and sand bottom. Three miniDOT Loggers were used to measure temperature and dissolved oxygen every 10 minutes (same as recommended by Gustav Skriver Frydenberg above). Data was converted to oxygen saturation and visualized (**Figure 15**) and linear regressions were used to explore the correlations between temperature and oxygen saturation. **Daily fluctuations in oxygen saturation were observed in sand bottom and eelgrass habitats, but less so at the stone reef.** Between 4th and 6th October, oxygen saturation reached around 140% in eelgrass and was stable at 80% at the stone reef. Sand bottom measurements reached 110% in the following days. Most measurements showed oxygen saturation above 80%. **Moderate and critical oxygen depletion were recorded once in transplanted eelgrass and at the stone reef, likely as a consequence of the heavy rain on 27th September**. **Fluctuations in eelgrass beds may be higher due to primary producer mass, affecting oxygen levels through photosynthesis during the day, causing over-saturation, and respiration during night, causing drops in oxygen levels**. Depth differences and water movement also influence oxygen saturation**. How to analyze the data from the oxygen loggers and convert to units are described in the report.**

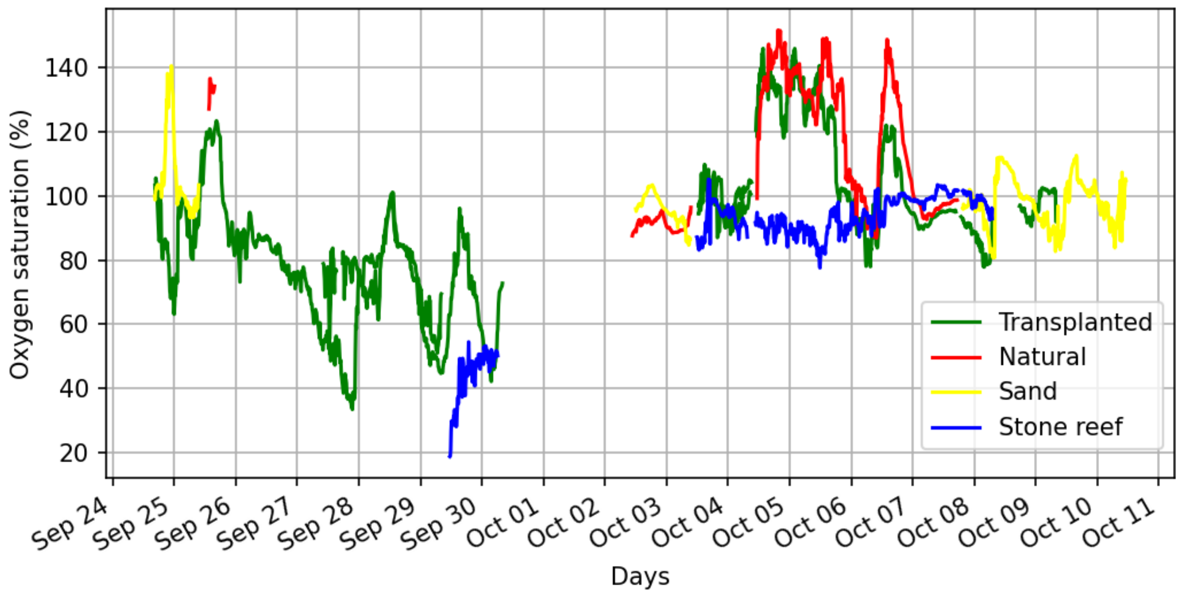

Figure 15. Oxygen measurements in different habitats.

Using Baited Remote Underwater Video to study flatfish behaviour in an eel grass transplantation in Vejle Fjord

Freja Engberg Willumsen (Master thesis, ongoing (hence no report is available yet), enrolled at KU with internship at DTU)

This master thesis project focuses on the re-colonization and behavior of fish in eelgrass transplantations within the context of marine rewilding and nature restoration. Baited Remote Underwater Video (BRUV) are central to data collection in this study (**Figure 16**). Monitoring species diversity can be challenging, and results may vary based on the methods used. Therefore, the study compares different methods and daytime versus nighttime observations to critically evaluate approaches. The field work was conducted at Sellerup strand in Vejle Fjord in late September and early October 2024. This location features eelgrass transplantations of different ages. BRUVs are bottom-placed camera rigs widely used as a minimally invasive, non-destructive and relatively cheap method to investigate marine biodiversity, species abundance, community ecology etc. Using volunteers to deploy BRUVs can be highly beneficial to carry out extensive BRUV surveys. By utilizing a large amount of BRUV rigs simultaneously and collecting spatiotemporal data, large amounts of highly versatile video material can be generated in a short amount of time, to be used for both a priori and a posteriori purposes. Even though the benefits of utilizing BRUVs are numerous, it can also be enormously time-consuming. Therefore, volunteers can contribute to increasing the amount of data collected, likely resulting in a more accurate and representative depiction of any trends in the data. However, BRUV surveys are largely dependent on technical specifications, e.g. cameras, video data storage and video analysis software, especially when using stereo-setups i.e. two synchronized cameras per rig. BRUVs are commonly deployed from research vessels and are often relatively heavy to be able to withstand structural damage and remain positioned in the designated location. To reduce biases caused by temporal- and environmental effects, as well as deployment-related errors, it is essential that volunteers undergo correct and sufficient training, including handling and maintaining SD-cards, batteries and cameras, deploying BRUVs accurately at designated locations and safety at sea. **In conclusion, volunteers could contribute to an extensive BRUV survey to cover more ground spatiotemporally, as long as thorough guidelines are followed and evaluated, and sufficient training is offered to ensure survey quality and safety**. BRUV videos are still being analyzed as the study is ongoing. **On several occasions, flounders were observed to make short distinct feeding excursions into the eelgrass.** Furthermore, a preliminary comparison between BRUV and fyke nets were conducted. **In this comparison, 5 different fish species were caught in 20 fyke nets (fishing for one night each) between 8th and 10th October, while on the 8th October, 6 fish species were observed during just 5 hours of baited BRUV recordings. Interestingly, only one species was common to both methods, which was the flatfish (most likely flounder). The other species seen with BRUV were smaller and could pass through the meshes of the net.** This comparison highlights how different methods can yield varying results in species observation. Another preliminary result relates to the behavior of flounder in at the edges of the eelgrass beds.

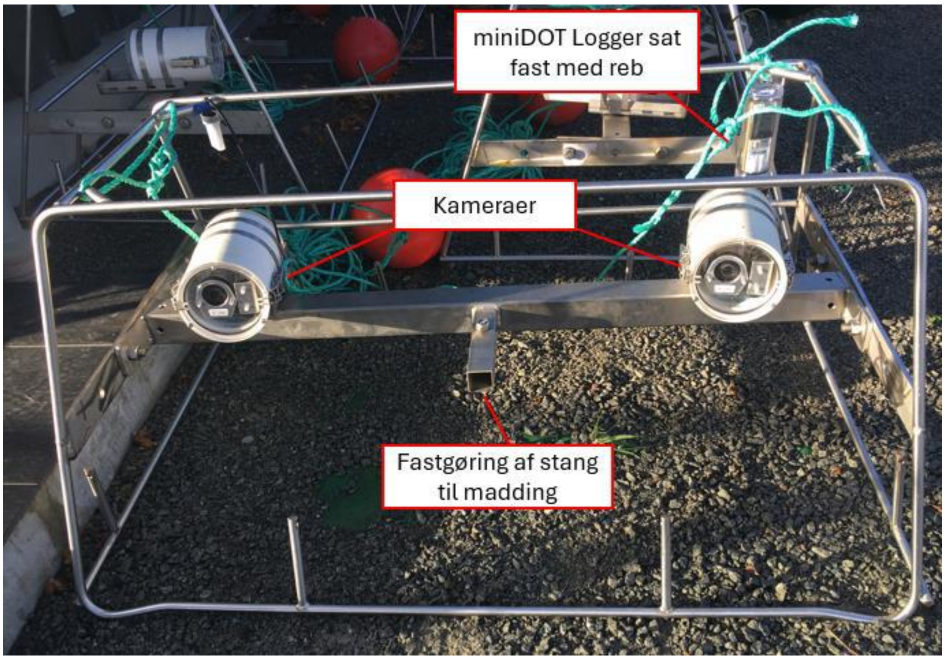

Figure 16. Picture of a stereo BRUV.