BOOK OF ABSTRACTS

OCEANS & LAKES 2025

Assessment of mining impacts on deep-sea meiofaunal communities with the use of metabarcoding.

BY Nada Al-Damluji

MAIN SUPERVISOR: Ann Vanreusel (Universiteit Gent)
CO-SUPERVISORS/TUTORS: Lara Macheriotou

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Temporal Habitat Risk Assessment (HRA) of the Songdo Tidal Flats: Evaluating Cumulative Ecological Risk from Pollution and Estimating Subsequent Carbon Sequestration Loss Using the InVEST®-HRA Model

BY Nathalie Botros

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CO-SUPERVISORS/TUTORS: Dries Lorre

Tidal flats are among the most productive coastal ecosystems, providing critical ecosystem services, notably carbon sequestration. However, these systems are increasingly threatened by reclamation, industrial expansion, and pollution. This study applied the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST®) Habitat Risk Assessment (HRA) model to quantify cumulative ecological risks to the Songdo tidal flats in Incheon, South Korea, under four temporal scenarios: 2003, 2010, 2025, and 2030. Publicly available spatial datasets were used to map habitat distributions, identify human-induced stressors, and parameterize habitat–stressor interaction scores. For each scenario, reclamation-adjusted habitat layers and scenario-specific stressor layers were used to generate cumulative risk maps, from which minimum, maximum, and mean risk values were extracted. In 2003 and 2010, pollution from reclamation and development were the dominant stressors contributing to risk, while in the later years of 2025 and 2030, pollution from industrial facilities, ports/piers, and ship traffic were bigger contributors to risk. These risk outputs were integrated with carbon sequestration estimates to estimate the compounded impacts of physical habitat loss and pollution on sequestration capacity over time. Results show that while reclamation directly reduces tidal flat area, pollution has the potential to substantially contribute to further declines in sequestration capacity and can account for up to a 54.3% and 25.7% relative increase in loss in 2025 and 2030, respectively, compared to reclamation alone. The findings indicate that pollution risks extend beyond marine protected area boundaries, diminishing their effectiveness against functional ecosystem degradation. This study demonstrates the potential of the InVEST-HRA model to inform ecosystem-based management by providing scenario-based risk assessments, identifying priority stressors, and highlighting the importance of integrated strategies that address both habitat loss and pollution.

ASSESSING PROTECTION AND ENVIRONMENTAL DRIVERS OF TANZANIAN CORAL REEF FISH COMMUNITIES

BY Luca Branger

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CO-SUPERVISORS/TUTORS: Filip Huyghe

Coral reefs of the East African Coast (EAC) support high fish diversity and are crucial for sustaining artisanal fishery yields. Despite their importance, EAC reefs are threatened by unsustainable and illegal fishing practices, and remain understudied compared to other coral ecosystems globally. To assess the state of fish communities, video transects were obtained along the Tanzanian coastline, across various protection categories (no-take zone (NTZ), marine protected area (MPA) and non-MPA), substrate compositions, depths and regions. Statistical analyses found that protection status and substrate composition were significant drivers of fish community composition, whereas depth and region were not. NTZ communities had the highest fish abundance, and MPAs had the poorest performance, likely due to persistent illegal fishing. Rubble was the only significant individual substrate, reflecting the importance of rubble microhabitats and their role as fishing pressure indicators. These findings led to the formulation of three tailored management strategies: functional-group specific management of herbivores and invertivores, habitat-specific protection and research, namely rubble microhabitats, and enforcement prioritization based on proximity to populous urban areas and spillover potential. The study results and proposed strategies contribute to the goals of the SAVE-FISH project, and provide baseline data to inform future research and management directions of coral reef fish communities in Tanzania.

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The Effect of Temperature on the Benthic Copepod Platychelipus littoralis Across Seasons

BY Laura Carreer

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CO-SUPERVISORS/TUTORS: Iene Herman

Climate change is exhibiting pressure on marine ecosystems by amplifying the effect of environmental stressors such as rising temperatures and shifts in food availability. These changes directly impact zooplankton communities, which play a crucial role in marine food webs by transferring energy in the form of lipids from primary producers to higher trophic levels. Copepods are the most dominant group of zooplankton and understanding their responses to environmental fluctuations is essential for predicting ecosystem resilience under future climate scenarios. This thesis investigated how seasonal temperature variations influence lipid accumulation and DNA methylation in the benthic harpacticoid copepod *Platychelipus littoralis*, to assess physiological and epigenetic responses. Copepods were collected at the end of winter and summer and subsequently exposed to their respective ambient seasonal temperatures (6°C and 15°C, respectively), as well as ±3°C treatments for 10 days, with *Nitzschia sp.* diatoms provided ad libitum. In parallel, diatoms were cultured under the same temperature conditions, to determine temperature effects on food availability. Lipid content was significantly higher in winter-acclimated individuals, supporting the hypothesis that copepods accumulate energy reserves under colder conditions. Although DNA methylation analysis did not show significant seasonal differences, results do not exclude epigenetic mechanisms in mediating phenotypic plasticity. Diatom growth was temperature-dependent, supporting the second hypothesis that food supply varies with temperature. These findings highlight the influence of temperature on the lipid metabolism of P. littoralis and underscore the importance of the combined effects of temperature and food availability. Moreover, this thesis suggests that epigenetic plasticity may contribute to copepod adaptation, offering insights into how key zooplankton species may respond to environmental change. Given their central role in marine food webs, understanding their resilience is crucial for predicting the broader ecological impacts of climate change.

Measuring codend dynamics and its impact on catch welfare

BY Marie Cockx

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Improvements to catch welfare in the capture phase of wild-capture fisheries can enhance flesh quality, prolong shelf life and address consumer concerns. In trawl fisheries, one of the factors contributing to injury of accumulated catches are oscillating movements of the codend, driven by vessel motion and waves. This study investigates whether externally visible injuries of beam-trawled flatfish are correlated with codend dynamics, measured by custom-made accelerometer sensors. Data were collected during the Demersal Young Fish Survey in Belgian coastal waters, in September 2024. A total of 148 flatfish individuals were sampled across 11 sites: 90 common dabs (*Limanda limanda*), 28 plaices *(Pleuronectes platessa*), 19 European flounders (*Platichthys flesus*), and 11 common soles (*Solea solea*). Each fish was assessed for external injuries including bleeding (head, body, fins), fin damage, and scale or mucus abrasion. Wave heights (51–161 cm) and average wave periods (2.8–4.9 s) were recorded using nearby weather buoys. Fast Fourier transform analyses of vessel and codend accelerations were used to determine peak acceleration amplitudes and dominant frequencies for each sampling stations. While vessel acceleration amplitudes ranged from 2 to 38 mg (mean = 11 mg), codend data were too noisy for reliable peak detection. Vessel acceleration was thus retained as a proxy for codend movement, based on the assumption of transmitted motion from vessel to gear. Generalized linear mixed models (GLMMs) and linear mixed models (LMMs) were used to evaluate the effects of biological and operational factors—including wave height, wave period, vessel acceleration, fish length, catch weight, gear deployment duration, and catch composition—on injury presence and severity. Significant associations were identified between vessel motion and injury occurrence across species. Additional factors also influenced injury patterns. In a second step, forward model selection was applied to explore interactions between movement and other predictors of injury. Due to technical limitations and a narrow range of weather conditions during the survey, the direct influence of codend movement on fish welfare could not be fully assessed. Nevertheless, significant relationships between vessel motion and injuries were identified, suggesting that further investigation into codend dynamics under commercial fishing conditions is necessary and could lead to gear development to improve catch welfare conditions.

UNDERSTANDING THERMAL STRESS IN BENTHIC COPEPODS: A MULTI-PARAMETER ANALYSIS OF BEHAVIOR, MORTALITY AND NUTRITIONAL HEALTH

BY Juliette de Cauwer

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Climate change alters temperature regimes through both gradual warming and extreme events such as marine heatwaves leading to risks to trophic interactions in estuarine systems. This study investigated the effects of constant high temperature (20 °C) and simulated heatwave 20–26–20 °C on two benthic copepods, *Platychelipus littoralis* and *Tachidius discipes* and their diatom food sources, *Navicula arenaria* and *Nitzschia sp*.
Over 12 days, mortality, fatty acid profiles, grazing intensity, and swimming activity were assessed. The heatwave condition significantly increased mortality especially in *P. littoralis* and caused marked shifts in FA composition in both copepods and diatoms particularly reductions in EPA and DHA and increases in SFA indicating ineffective nutritional transfer. The high temperature treatment induced limited or no significant effects. Grazing activity decreased under heatwave condition and *T. discipes* seem to show reduced swimming speed while P. littoralis showed signs of behavioral inhibition based on spatial displacement, although these two observations were not statistically reliable. Though simplified, these findings highlight that short-term thermal spikes can disrupt biochemical and behavioral processes more severely than constant warming. This underscores the vulnerability of benthic food webs to climate extremes and the importance of integrating multiple biological responses when assessing ecosystem resilience.

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Evaluating river restoration success using carabid beetles: insights from re-meandered riverbanks

BY Alessio De Ruyck

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Natural rivers and adjacent riparian zones can be hotspots of exceptional diversity and productivity, providing ecosystem services disproportionate to their area. For centuries, these habitats have been degraded by human activity and are now under increasing pressure from climate change. In response, river restoration projects have gained momentum in recent decades to improve the ecological health and resilience of our future rivers. In Belgium, the Sigmaplan includes restoration works in the Demer Valley, where cut-off meanders are being reconnected to the main river. We used carabid beetles as bioindicators to evaluate restoration success by comparing carabid assemblages at three restored meanders with those at a near-natural and a degraded reference site. In 2023 and 2024, pitfall trapping yielded 110 carabid species, with many species of conservation concern found at the near-natural site. Restored meanders showed variable patterns: one site resembled the near-natural reference in species abundance and Hill-Shannon diversity, another was more similar to the degraded site, and a third had low species abundance but high Hill-Shannon diversity. This was also reflected in the carabid species composition. The percentage of riparian specialists was significantly higher at two restored meanders. These findings are likely driven by differences in the lateral connectivity between the river and its riparian zone, and by surrounding land use that shapes habitat conditions. Environmental factors such as bare ground cover, slope, moisture, and soil composition—altered by re-meandering—also structured carabid species composition. Furthermore, benches situated closer to the waterline supported a significantly higher proportion of riparian specialists than elevated benches, except at the degraded reference. We conclude that re-meandering positively affects riparian habitats, especially where it creates flood-prone zones with habitat mosaics of open bars and sparsely vegetated banks. Carabid beetles thus serve as valuable indicators for riparian habitat restoration, though long-term monitoring is needed to assess the persistence of these effects, also in light of changing land use and climate change.

ACCUMULATION AND TOXICITY OF TWO SHORT-CHAINED PERFLUOROALKYL SUBSTANCES (PFAS) ON EXPERIMENTALLY EXPOSED ELODEA CANADENSIS AND LIMNOBIUM LAEVIGATUM: PERFLUOROBUTANESULFONIC ACID (PFBS) AND PERFLUOROBUTANE SULFONAMIDE (FBSA)

BY Hanna Deckers

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Per- and polyfluoroalkyl substances (PFAS) are man-made organic substances widely used in industrial and consumer applications. They raise concerns due to their environmental mobility, resistance to degradation, toxicity and bioaccumulation potential. Given their crucial role in the aquatic foodweb, bioaccumulation of PFAS in macrophytes may have important implications for ecosystems health. This study investigated the chronic toxicity and bioaccumulation of two short-chain PFAS, perfluorobutanesulfonic acid (PFBS) and perfluorobutane sulfonamide (FBSA), in two aquatic macrophytes: Elodea canadensis (submerged) and *Limnobium laevigatum* (free-floating). Plants were exposed for 28 days under controlled climate chamber conditions to a concentration range of 0–100,000 ng/L. Toxicity endpoints included biomass, stem length for *Elodea canadensis*, and leaf area and number of floating leaves for *Limnobium laevigatum*. Additionally, analysis of oxidative stress metabolites was performed. Both macrophyte species accumulated FBSA and PFBS and accumulation increased with exposure concentration. A negative relationship between exposure concentration and bioconcentration factors was observed, indicating possible saturation of uptake pathways at higher concentrations. No significant differences in accumulation were observed between plant species or between PFAS types. FBSA exposure led to the formation and accumulation of PFBS in plant tissue at the highest concentrations (10,000 and 100,000 ng/L), suggesting potential biotransformation. No statistically significant toxic effects were found at the tested concentrations for any endpoint. However, physical damage to the stems of Elodea canadensis was observed after exposure to 100,000 ng/L of FBSA. A possible hormetic response was observed, which was more pronounced for *Limnobium laevigatum*. The findings indicate that under environmentally relevant PFAS concentrations, both macrophytes maintain physiological resilience. Although plant uptake contributed to PFAS removal from the water column, non-biological factors such as adsorption and algal uptake dominated at higher concentrations. Therefore, no definitive conclusions could be drawn regarding the phytoremediation potential of *Elodea canadensis* and *Limnobium laevigatum*.

The effects of probiotic treatments on *Laminaria ochroleuca*. Assessing their potential to enhance kelp resilience under heat stress

BY Axelle Defossez

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Kelp forests are one of the most productive marine ecosystems, yet due to climate change and other anthropogenic stressors, they have known serious declines. These forests are characterized to provide ecosystems services as well as primary and secondary habitats. One of the main drivers of their declines is the rising seawater temperature, with marine heat waves increasing in frequency and intensity. This is a trend unlikely to reverse soon.

In recent years, the concept of the kelp holobiont - encompassing the host and its associated microbiota - has gained increasing attention. The stability of this entity is crucial for the survival of kelp, yet the previously mentioned stressors may disrupt this functional host-microbiome symbiosis. Therefore, with increasing external pressures, maintaining or restoring this equilibrium is important. As traditional restoration efforts struggle to keep pace with the rapid rate of climate change, other strategies must be explored.

In this thesis, we investigated the potential of enhancing kelp resilience and reproductive success by adding bacteria we thought to be beneficial to its microbiome. The results indicate that the bacterial strain *Cobetia amphilecti* could be a promising probiotic. This bacterium enhanced the onset and output of reproduction in *Laminaria ochroleuca* and boosted its resilience to heat stress significantly, while maintaining overall physiological health. Although previous studies have shown similar positive effects of microbiota enhancing macroalgae, detrimental outcomes for these microbiome alterations have also been reported. In our study, the effects varied depending on the population to which certain bacterial strains were applied. *Kocuria polaris*, for example, inhibited growth in one population while promoting it in others. This highlights the importance of host-specific interactions and the need for a precautionary approach.

Nonetheless, this research supports the potential of probiotic treatments for kelp forest restoration, especially when combined with restoration methods such as green gravel, where kelp spores or gametophytes are applied to substrates and cultivated under controlled conditions before outplanting. This research opens new avenues for enhancing the resilience of these vital ecosystems in a rapidly changing ocean.

Keywords: *Laminaria ochroleuca*, kelp holobiont, probiotic treatment, marine heatwaves, microbiome engineering, climate change resilience, recruitment success of kelp, kelp restoration, *Cobetia amphilecti*, *Kocuria polaris*

The Role of *Phaeobacter inhibens* in Modulating Benthic Diatom Growth and Associated Bacterial Community Structure

BY Joseph Easton

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CO-SUPERVISORS/TUTORS: Yeseren Kayacan

Interactions between microalgae and heterotrophic bacteria play essential ecological roles. *Phaeobacter inhibens*, a surface-adapted member of the Roseobacter group, exhibits a dualistic interaction with microalgae, shifting from mutualistic to parasitic phases depending on algal exudates. While this dynamic is well documented for the haptophyte *Emiliania huxleyi*, its interactions with benthic diatoms are less understood.

Here, we investigated the direct impact of *P. inhibens* on the growth of two benthic diatoms (*Cylindrotheca closterium* and *Navicula arenaria*) and its influence on associated microbial communities in both biofilm and suspension. Our results demonstrate a dualistic relationship modulated by bacterial growth phase and algal exudates. Specifically, the algicidal effect was linked to the production of 9-Z-AHL C18 in stationary-phase cultures, whereas 3-OH-AHL C10 was dominant during mutualistic or co-culture conditions, suggesting quorum sensing regulates the shift. Additionally, *P. inhibens* functioned as a keystone taxon, significantly altering microbial community composition, especially in biofilms, and unexpectedly increasing species richness. These findings highlight the complex and dynamic roles of *P. inhibens* in diatom-associated communities and suggest bidirectional interactions mediated by chemical signaling.

Linking Activity States to Habitat Preference of Wels Catfish (*Silurus glanis*) in a Freshwater Reservoir

BY Mikayla Ford

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CO-SUPERVISORS/TUTORS: Milan Říha, Rubén Rabaneda-Bueno, Marie Prchalová, Jolien Buyse

Freshwater predators play an important role in the ecosystems in which they live and are typically the focus of economic and ecological interests. Their spatial distribution dictates the direct and indirect influences on these systems; however, the specific behaviours they exhibit are likely to affect the extent, severity, and timing of these interactions. While fish activity is often generalized to the broader scope of seasonal or diurnal timing and habitat, advances in fine-scale acoustic telemetry allow for more precise determination of fish behaviour at a given time and location. This increased resolution enables a better understanding of the relationship between activity extent and habitat use, shedding light on predatory strategies and potential trophic interactions.
In this study Hidden Markov Models (HMM) are used to classify the movement of native Wels catfish (*Silurus glanis*) during summer into activity states and to describe the associated habitats in the Rimov reservoir, Czech Republic. Three activity states (inactivity, low activity, high activity) were identified in 13 individuals in the period from June 1 to August 31, 2017. These states represented 'resting', 'foraging', and 'transiting' behaviours, and differed in the relative proportions of step length, turning angles and utilized space. The probability of being in these states was related with diel period and temperature. Catfish were likely to be inactive during the day and active at night, highlighting their nocturnal tendencies. Temperature (19.7 – 22.7 °C ± 0.6) exerted a moderate influence on this pattern. Distinct habitat usage for each activity state was also observed, as catfish were more likely to be inactive in shallow, nearshore habitats (i.e. littoral areas) during day, and active as fish moved away to further, deeper habitats (i.e. pelagic areas) – regardless of diel period. A diel vertical migration during night was also evident. The use of both littoral and pelagic habitats for foraging and transiting behaviours, as well as the occurrence of foraging during daytime hours may have implications for prey encounter rates and predator-prey dynamics in the reservoir ecosystem. Overall, this study lays the groundwork for future research into wild catfish behaviour and offers novel insights to inform management strategies across both native and introduced range.

Comparison of in-situ and remotely sensed Particulate Inorganic Carbon in a coccolithophore bloom in the Iceland Basin (June 2024)

BY Timotheus Fügl

MAIN SUPERVISOR: Griet Neukermans (Universiteit Gent)

This study investigates the retrieval of particulate inorganic carbon (PIC) concentrations from hyperspectral PACE satellite data during an extensive *Emiliania huxleyi* coccolithophore bloom in the Iceland Basin (May–July 2024) and compares the results with in-situ measurements and multispectral MODIS observations. Ground-truth data were collected aboard the R/V Discovery as part of the CHALKY project using discrete sampling, analyzed in two laboratories, flow cytometry, and the first prototype deployment of the LISST-PIC optical sensor, which is under development at the MarSens research group. Satellite PIC estimates were derived using the CI2 algorithm, which was originally developed for MODIS [Mitchell et al., 2017], and validated against in-situ datasets through robust regression analysis. Results showed high agreement between the two laboratories and between satellite retrievals and discrete samples, with MODIS outperforming PACE due to algorithm tuning for MODIS bands. The comparison between satellitederived PIC estimates and LISST-PIC measurements showed only moderate agreement, a result caused by substantial data loss during quality control procedures of the LISST-PIC derived in-situ PIC. PACE consistently overestimated PIC relative to MODIS and exhibited biases requiring algorithm recalibration for hyperspectral data. Spectral analysis confirmed the known optical fingerprints of coccolithophore blooms and allowed for the discrimination of bloom phases after Neukermans and Fournier [2018]. From PACE Level-3 composites, bloom extent peaked at 830,000 ± 103,000 $km2$ in May 2024, declining to 214,000 $km2$ by July. The event comprised spatially distinct patches at different life-cycle stages. The findings highlight PACE's potential for PIC retrieval, the advantages of hyperspectral coverage to obtain more information from satellites during bloom phases, the value and limitations of the LISST-PIC sensor for satellite validation, and the importance of sensor-specific algorithm optimization for accurate ocean carbon cycle monitoring.

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DNA barcoding of sharks, rays and skates in Kenya and Tanzania

BY Salomé Gallard

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CO-SUPERVISORS/TUTORS: Filip Huyghe, Stephen Bergacker

Elasmobranchs (sharks and rays) are among the most threatened marine vertebrates globally, yet their accurate identification and monitoring remain challenging in many developing coastal regions due to limited taxonomic expertise, poor landing conditions, and morphological similarities among species. This study applied DNA barcoding of the cytochrome oxidase I (COI) gene to investigate the species composition of elasmobranch catches landed in artisanal fisheries along the coasts of Kenya and Tanzania.

A total of 122 tissue samples were collected from various landing sites under diverse field conditions. Due to sample degradation, contamination, and inconsistent collection protocols, only 51 sequences met the quality threshold for further analysis. The selected COI sequences were compared to the NCBI database using BLAST, retaining the top five unique matches for each sample. All sequences showed high similarity (>97% identity) to known elasmobranch species, confirming the effectiveness of COI barcoding for species identification in this region.

Species delimitation using the Assemble Species by Automatic Partitioning (ASAP) method grouped the sequences into 19 presumed clusters. Although some apparent singletons were detected, further BLAST analyses indicated these were the results of low sequence quality or contamination and belonged to the closest well-supported clades in the MEGA bootstrap consensus tree constructed from pairwise distances. The resulting phylogenetic tree and clustering patterns confirmed clear genetic separation among the sampled species.

Notably, several species identified in the study, including *Carcharhinus falciformis* and *Aetobatus narirnari*, are listed under CITES Appendix II and the IUCN Red List as Vulnerable or Endangered, yet were found in local fishery landings despite existing management measures. These findings highlight ongoing challenges in enforcing conservation regulations and the value of genetic tools for supporting monitoring and compliance in data-poor fisheries.

This study demonstrates the potential of DNA barcoding as a practical method for verifying species identities in artisanal elasmobranch fisheries, contributing to improved biodiversity assessments and supporting more effective conservation and management strategies in the Western Indian Ocean.

Keywords: Elasmobranchs, DNA barcoding, COI, species delimitation, ASAP, MEGA, conservation, Kenya, Tanzania, artisanal fisheries

The Human-Crocodile Conflict: A Case Study of the Nile Crocodile (Crocodylus niloticus) in Queen Elizabeth National Park, Uganda, with an Assessment of Mitigation Strategies

BY Antonia Geibel

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CO-SUPERVISORS/TUTORS: Mercy-Gloria Ashepet

Human-crocodile conflict (HCC) is a pressing conservation and public safety issue in areas where communities depend on bodies of water that are also inhabited by crocodiles. This study examines HCC in Queen Elizabeth National Park (QENP) in Uganda through a mixed-methods approach. The approach combines survey data from 145 residents across four fishing communities, one expert interview, and field observations. The research evaluates the awareness, utilization, perceived effectiveness, and suitability of five key mitigation strategies: Crocodile Exclusion Devices (CEDs), Crocodile Translocation Programs (CTPs), education programs, compensation, and Problem Animal Control (PAC). Statistical models and thematic analysis revealed that demographic and attitudinal factors, such as village of residence, perceived safety around water bodies and the perceived likelihood of crocodile attacks, significantly influence the perception and adoption of mitigation strategies. CEDs and education programs were the most widely known and positively rated, though CEDs were often poorly maintained. Translocation and compensation strategies faced skepticism due to logistical, financial, and institutional constraints. Open-ended responses highlighted gaps in community involvement and trust towards authorities, emphasizing the need for transparent communication, equitable access, and sustained support. These findings suggest that successful HCC mitigation requires an integrated, context-sensitive approach that centers on local knowledge and addresses the ecological and social dimensions of the conflict.

Keywords: Human–Crocodile Conflict; Nile crocodile; Wildlife Conflict Mitigation; Mitigation Effectiveness; Community-Based Conservation; Risk Perception; Uganda

Automating Coral Reef Fish Family Identification on Video Transects Using a YOLOv8-Based Deep Learning Pipeline

BY Jules Gérard

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Coral reef fish communities are essential indicators of ecosystem condition, yet monitoring in the Western Indian Ocean remains constrained by reliance on underwater visual censuses, which are labour-intensive and prone to observer bias. Advances in deep learning, particularly convolutional neural networks, offer opportunities to automate fish detection from imagery, but applications in the Wester Indian Ocean are scarce. This study develops the first region-specific YOLOv8 object detection model for family-level identification of reef fish in Kenya and Tanzania, trained on a curated dataset derived from diver-based video transects. Multiple dataset configurations were evaluated to test the effects of class imbalance, annotation thresholds and training strategies. The baseline model achieved moderate performance (precision 0.53, recall 0.37, mAP@0.5 0.37), with improvements when restricting training to the ten most represented families or filtering small bounding boxes. Dominant families such as Pomacentridae and Acanthuridae were consistently detected, while rare taxa remained poorly represented. Error analysis highlighted environment-specific challenges, particularly high false negative rates in coral-rich scenes due to occlusion and visual complexity. Although current configurations are not suited for abundance or biomass estimation, the models demonstrate feasibility for consistent presence–absence monitoring and functional group assessments. These findings establish a functional baseline for deep learning–based reef fish monitoring in the Western Indian Ocean and highlight future priorities including dataset expansion, refined filming protocols and integration of object tracking to support quantitative ecological monitoring.

Keywords: Coral reef ecology, Fish community monitoring, Western Indian Ocean, Deep learning, YOLOv8, Underwater Imagery.

UNDERSTANDING THERMAL STRESS IN BENTHIC COPEPODS: A MULTI-PARAMETER ANALYSIS OF BEHAVIOR, MORTALITY AND NUTRITIONAL HEALTH

BY Juliette Gilbert

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Climate change alters temperature regimes through both gradual warming and extreme events such as marine heatwaves leading to risks to trophic interactions in estuarine systems. This study investigated the effects of constant high temperature (20 °C) and simulated heatwave 20–26–20 °C on two benthic copepods, *Platychelipus littoralis* and *Tachidius discipes* and their diatom food sources, *Navicula arenaria* and *Nitzschia sp*.
Over 12 days, mortality, fatty acid profiles, grazing intensity, and swimming activity were assessed. The heatwave condition significantly increased mortality especially in P. littoralis and caused marked shifts in FA composition in both copepods and diatoms particularly reductions in EPA and DHA and increases in SFA indicating ineffective nutritional transfer. The high temperature treatment induced limited or no significant effects. Grazing activity decreased under heatwave condition and *T. discipes* seem to show reduced swimming speed while P. littoralis showed signs of behavioral inhibition based on spatial displacement, although these two observations were not statistically reliable. Though simplified, these findings highlight that short-term thermal spikes can disrupt biochemical and behavioral processes more severely than constant warming. This underscores the vulnerability of benthic food webs to climate extremes and the importance of integrating multiple biological responses when assessing ecosystem resilience.

The Effect of Chemical Emissions from Offshore Wind Farms on the Sediment-Dwelling *Polychaete Hediste diversicolor* and the Amphipod *Corophium volutator*

BY Klara Grünewald

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CO-SUPERVISORS/TUTORS: Moses Ndugwa

In the context of climate change and the environmental harm caused by fossil fuels, Europe is increasingly prioritizing the transition to sustainable energy solutions, focusing on the expansion of renewable energies, including offshore wind farms (OWFs). OWFs are particularly promising as they contribute to a reduction of greenhouse gas emissions, demonstrate declining costs, and minimize the use of valuable land resources. While OWFs hold significant potential to facilitate a sustainable energy transition, their environmental impacts on marine ecosystems remain understudied, highlighting the need for further research despite recent advancements in this field. This research aims to investigate the ecotoxicological effects associated with corrosion protection systems used in offshore wind farms, such as galvanic anodes and anticorrosion paints. These systems may release trace metals, such as Cd, In, Pb, Al, Zn, and Ga, alongside toxic chemical compounds, such as bisphenol derivatives, tributyltins, benzophenones, and per- and polyfluorinated substances, which may negatively affect marine organisms. In this study, the key bioindicator species *Hediste diversicolor* and *Corophium volutator* were exposed to sediments collected from six sampling locations located within and outside offshore wind farms in the Belgian part of the North Sea, representing areas with varying levels of potential chemical exposure. Additionally, reference sediment obtained from the organisms' sampling area in the Eastern Scheldt was assessed. Organisms were exposed to sieved sediments of each sampling location for 28 days in a laboratory setting, after which specific growth rate, mortality, metal bioaccumulation, and, for *H. diversicolor*, energy reserves, including lipids, proteins, and glycogen concentrations, were measured. The study found no statistically significant negative impacts on *H. diversicolor* and *C. volutator* from exposure to sediment collected within offshore wind farms, with physiological responses comparable to reference locations. However, elevated tissue metal concentrations and negative trends in specific growth rate at one location from within the offshore wind farm were noticed suggesting potential adverse effects that warrant further investigation. This research contributes to a deeper understanding of the potential environmental impacts of offshore wind farms, particularly their role as sources of chemical emissions and their effect on marine ecosystems. This is particularly significant given the rapid expansion and projected growth of the global offshore wind park industry to meet ambitious renewable energy targets.

Keywords: Offshore Wind Farm, Chemical Emissions, Trace Metals, *Hediste diversicolor*, *Corophium volutator*

Effects of Fresh and Freeze-Dried Algae on Copepod Fecundity and Survival in Acartia tonsa

BY Dries Jansen

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Copepods play a crucial role in marine ecosystems as primary grazers that transfer energy from phytoplankton to higher trophic levels, making them essential for both ecological research and aquaculture applications. The marine copepod *Acartia tonsa* Dana 1849 is widely used as a model organism in ecotoxicological studies and as live feed in aquaculture. Diet quality is particularly critical for *A. tonsa* as this species demonstrates immediate investment of metabolic production into egg development rather than energy storage, making reproductive output highly sensitive to nutritional quality. While extensive research has evaluated various fresh microalgae (diatoms, dinoflagellates, haptophytes) as diets for *A. tonsa*, limited research exists comparing the effects of live versus preserved algal diets on copepod performance. This study evaluates the effects of freeze-drying on algal diet quality for *A. tonsa* by comparing survival, egg production, and nauplii hatching success between fresh and freeze-dried microalgae. Three experiments were conducted using monoalgal diets *of Rhodomonas salina* and *Tisochrysis lutea*, as well as a mix of both. Results consistently demonstrated that copepods fed fresh diets produced substantially more eggs and nauplii than those fed freeze-dried diets. The monoalgal diet of *R. salina* showed the greatest reproductive success among fresh diets. Fresh diets maintained low mortality rates while freeze-dried diets showed elevated mortality depending on the algal species. These results demonstrate that fresh algal cultures remain essential for optimal copepod performance in aquaculture and laboratory applications.

Keywords: Copepod; *Acartia tonsa*; Freeze-drying; Microalgal diets; Fecundity; Survival

GROWTH REPRODUCTION TRADE-OFF OF *SOLEA SOLEA* IN THE IRISH SEA AND EASTERN ENGLISH CHANNEL (2004-2022)

BY Pawangi Jayathilaka

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Life-history theory predicts a trade-off between somatic growth and reproduction, especially in species with indeterminate growth like fish. However, it remains unclear whether such trade-offs are universally expressed or vary across geographic regions. In this study, we investigated growth–reproduction trade-offs in female common sole (*Solea solea*) from two ecologically distinct regions, Irish Sea (ICES area 7a) and Eastern English Channel (ICES area 7d), using otolith-based growth reconstructions from fish collected between 2004 and 2022. Otolith increment were analyzed using linear mixed-effects models to test the effects of age, maturity stage, and region, with random effects for capture month and growing year to account for temporal variability. Contrary to expectations, mature and immature fish exhibited no statistically significant differences in annual otolith growth increments, suggesting no detectable energy allocation trade-off during early maturity (ages 2–4). Additionally, there was no significant interaction between maturity and region, indicating that spatial differences in trade-offs were not pronounced. Future research incorporating physiological and individual-level data is needed to confirm whether such trade-offs are truly absent or undetectable under current methodologies.

Keywords: *Solea solea*, Growth–reproduction trade-off, Otolith increments, Linear mixed models, Life history

Presence and Bio-accumulation of Per- and Polyfluoroalkyl Substances (PFAS) and Trace metals in the Hedwige-Prosperpolder Ecosystem (Belgium and The Netherlands)

BY Sanjo Jose

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This study examines the occurrence, distribution, and bio-accumulation of perand polyfluoroalkyl substances (PFAS) and trace metals in sediments, invertebrates, and plant/algal samples collected from the Hedwige-Prosperpolder tidal wetland in the Scheldt estuary. Sampling was conducted across multiple sites to capture spatial variability in contamination patterns following restoration activities. Eleven PFAS compounds, including both legacy and emerging substances, were detected above the limit of quantification in sediments, with the highest concentrations observed near suspected historical and ongoing sources. Trace metals, particularly zinc, chromium, and copper, were also present at elevated levels in specific locations. Bio-accumulation factors (BSAFs) revealed that invertebrates accumulated long-chain sulfonated PFAS and certain metals (Cu, Cd, Zn) to a greater extent than plants and algae, which primarily took up shortchain PFAS and exhibited limited metal accumulation. Negative correlations between BSAF values and sediment organic carbon or clay content indicated a sediment-sorption control on contaminant bio-availability, although the strength of these relationships varied by compound. The findings highlight the importance of monitoring both PFAS and metals in restored estuarine systems, as sediment characteristics, hydrodynamics, and species-specific traits collectively influence contaminant fate and ecological risk. This work underscores the need for integrated management strategies and further research into seasonal variability, trophic transfer, and the combined effects of PFAS–metal coexposure in wetland ecosystems.

Keywords: PFAS, PFOS, BSAF Trace metal, Persistent pollutants, Emerging contaminants, Ecotoxicology, Bio-magnification

COPEPOD – MEIOFAUNA INTERACTIONS UNDER THERMAL STRESS

BY Raymond Kaggwa

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While temperature is a key driver of aquatic ecosystem processes, climate change is altering marine environments by increasing sea surface temperatures (SST) which affects species distributions, abundances, and trophic interactions. These changes influence fundamental essential ecosystem functions such as nutrient cycling, organisms' survival, and species fitness. Understanding how elevated temperatures and species interactions impact marine communities is crucial for predicting ecosystem responses under climate stress.

This study focuses on the harpacticoid copepod *Platychelipus littoralis*, a species that plays a vital role in energy transfer from primary producers to secondary producers. To investigate how temperature and species interactions affect *P. littoralis* fitness, we used fatty acid (FA) biomarkers to assess physiological responses under the varying environmental conditions. Specifically, we conducted 10-day temperature-controlled microcosm experiments at 15oC (optimal) and 24oC (thermal stress), testing the effects of thermal stress alone and in combination with interactions involving other meiofauna (gastropods, oligochaetes, amphipods and randomly assembled meiofauna).

Results showed that both temperature and species interactions significantly influenced *P. littoralis* survival and FA profiles. Temperature effects became more pronounced over time, while species interactions showed strong and variable responses depending on the type of interspecific interaction. These effects of temperature and species interactions on copepod responses were additive rather synergistic and provided further insights on the existing Stress Gradient hypothesis and the biodiversity-ecosystem functioning, highlighting complex interplay between environmental stressors and ecological interactions.

Keywords: *Platychelipus littoralis*, Temperature, Species interactions, meiofauna, Climate change, fatty acids, Stress Gradient Hypothesis, biodiversity-ecosystem functioning.

RECONSTRUCTING HYDROCLIMATE-DRIVEN ECOLOGICAL CHANGE IN A NOW SALINE CRATER LAKE IN WESTERN UGANDA FROM FISH AND MACROINVERTEBRATE FOSSILS

BY Lydia Komuhimbo

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The ~65 fresh crater lakes of western Uganda are small but represent an important natural resource for rural communities in the region, whose livelihoods depend on mixed subsistence agriculture and freshwater fisheries. Excess nutrient input and soil erosion from intensifying land use now compromises the water quality and ecological services provided by these lakes, compounding the problem of shifting weather patterns due to climate change. Lake Ntambi (0.32 km2, 110 m deep) is the only crater lake in the Kasenda-Ndali region which is currently saline (~6000 µS/cm), unexpectedly so because its great depth should have made it less sensitive to past climate-driven changes in water balance than the shallow saline lakes which occur on the dry floor of the Albertine Rift valley.

In this study I analysed the fossil remains of chironomid larvae (non-biting midges) and fish preserved in the bottom sediments of Lake Ntambi to reconstruct the lake's hydrological and ecological history since the last major ice age period (17,700 years ago to present). Particularly fossil chironomid assemblages are very useful to reconstruct past changes in the salinity of African lakes (Eggermont et al., 2006). A total of 22 Chironomid species were found in the 52 samples analysed; most of these are freshwater species. *Kiefferulus disparilis*, a halobiont Chironomid species with a salinity optimum of 10,754.3 µS/cm was mostly found in samples that are from 1050 years BP and younger, but also a few specimens of this species were found in some of the samples dating from before ~14,400 BP. Fish fossils were found in all samples except those that fall within the Last Glacial Maximum + Heinrich 1 period, indicating that fish may have colonized Lake Ntambi shortly before 15,000 years ago. Fish fossil concentration was found to have a positive relationship with *Chaoborus* concentration, suggesting that *Chaoborus* was not a steady food item in the diet of the local cichlid fishes. Multivariate analysis (Principal Component Analysis and Non-metric multidimensional scaling) revealed no clear patterns of the different known climate statuses with regards to the chironomid fossil assemblages in the sediment record from Lake Ntambi with sub-samples from wet and dry climate statuses generally plotted together, indicating that the lake was less sensitive to climatic condition changes.

This study reveals that Lake Ntambi has been a freshwater lake almost continuously throughout most of its recorded history. Only during the Last Glacial Maximum (LGM) and until ~14,000 years ago it occasionally experienced slightly elevated salinity (1000-2000 µS/cm). The lake became truly saline only within the last millennium, probably triggered by regionally dry climate conditions ~1100-750 years ago. Strikingly, salinity continued to increase until today, despite a relatively wet regional climate between ~750 and 500 years ago and in the last ~200 years. This transition to saline conditions appears to have

resulted in extinction of the local fish population as no fishermen are active in the lake today, although small numbers of fish remains still occur in recently deposited sediments.

My results indicate that the freshwater crater lakes of western Uganda may be more sensitive to climate-driven changes in water balance than currently presumed, and that more lakes may become saline in future if increased evaporation due to global warming counteracts increases in rainfall resulting from stronger monsoon dynamics.

Keywords: Western Uganda, chironomid assemblage, climate status, salinity optimum, lake level.

Understanding local perceptions of mangrove ecosystem services to improve community-based conservation: a case study from Xuan Thuy National Park, Vietnam

BY Carlijn Koole

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CO-SUPERVISORS/TUTORS: Nguyen Thanh Hien

Effective interventions are needed to halt ecosystem degradation and to mitigate the resulting negative impacts on human well-being. Marine Protected Areas (MPAs) are widely used to enhance the sustainability of coastal social and ecological systems. Due to MPAs often being introduced by external actors, aligning them with local contexts remain challenging. Previous research has linked stakeholder support for MPAs to their perceptions of ecological effectiveness, social impacts, and governance quality of MPA management. This study uses semi-structured interviews to investigate the ecosystem services provided by the mangrove ecosystem in Xuan Thuy National Park (XTNP), northern Vietnam, and to explore how local communities perceive these ecosystem services in relation to broader MPA management outcomes. We found that stakeholders generally viewed the social impacts and governance of current management positively, while the stakeholders' perceptions of the ecological effectiveness of current management were less positive. Despite this, overall support for the management approach in XTNP was relatively high. Levels of participation were found to be low, while it was economic well-being that appeared to influence stakeholders' perceptions on social impacts and good governance of XTNPs management the most. Our findings suggest that, beyond ecological outcomes, the authorities in XTNP should acknowledge the social context in which they operate and strengthen governance quality to sustain and gain community support and ensure long-term conservation success in this renowned national park.

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Seagrass meadow in Kep's MFMA: ecosystem function metric to evaluate restoration efficacy.

BY Samphors Lor

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Marine scientific data in the Cambodian Sea remains scarce particularly that researching benthic diversity and ecosystem functioning, due to the limitation of research funds, logistical constraints and a generalized lack of local expertise (Pasotti et al., 2023). This lack of baseline ecological knowledge limits the ability to assess environmental change and anthropogenic impact to Kep biodiversity. Conservation efforts including the establishment of a Marine Fisheries Management Area (Kep-MFMA) and the deployment of Fishery Productivity Structure (FPS) were established to restore and protect the degraded marine habitat by IUU fishing. Nevertheless, baseline data to evaluate the effectiveness of these efforts remain limited.

This study aims to assess the applicability of meiofauna and nematode assemblages as bioindicators of recovery of seagrass meadows protected since 2018 around Koh Ach Seh island within the Kep-MFMA. Sediment cores were collected from three stations characterized by different seagrass species composition and total cover. The analysis of biochemical parameters included sediment grain size, organic matter content, meiofauna diversity and abundance (higher taxonomic level) and nematofauna diversity (genus level) and functional group (including trophic group, maturity index (MI), and *colonizers-persisters* (c-p) group composition). A statistical analysis was conducted to assess the significance of observed differences between stations and sediment layers using both univariate and multivariate analyses.

Results showed distinct meiofaunal and nematofaunal assemblages across seagrass meadows with varying coverage and species composition. Nematode trophic analysis revealed a consistent dominance of epistrate-feeders (2A) across all stations, reflecting the availability of microphytobenthos and surface-associated food resources that support early to intermediate successional stages. The highest MI was observed at SG02, the station with moderate seagrass cover and lower organic matter, indicating relatively stable sediments that favor epistrate-feeders (2A). SG01, with dense and mature seagrass cover, supported a more functionally diverse nematode community, with a wider range of *c–p* groups (*c-p* 1–4), reflecting higher habitat complexity and sediment stability. In contrast, SG03, exposed to wind- and wave-driven resuspension, displayed more evenly distributed trophic groups and a lower MI, indicative of a disturbed or early-successional habitat with reduced habitat complexity.

Overall, this study demonstrates the potential of meiofauna, particularly nematode assemblage as an effective bioindicator for assessing ecosystem conditions in habitats such as recovering seagrass meadows. The findings of this study provide valuable baseline data to support the adaptive restoration management in Kep – MFMA.

Keywords: Benthic community, Kep-MFMA, Meiofauna, Nematode, Seagrass meadow

ASSESSING THE EFFECTIVENESS AND LOCAL PERCEPTIONS OF MARINE PROTECTED AREAS (MPAs) AND LOCALLY MANAGED MARINE AREAS (LMMAS) IN KENYA

BY Jackline Mutisya

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Marine Protected Areas (MPAs) and Locally Managed Marine Areas (LMMAs) play a crucial role in conserving marine ecosystems, preserving biodiversity, and supporting the livelihoods of coastal communities. The effectiveness of these two conservation strategies relies on ecological and social dimensions. However, over time the social dimension of MPA and LMMA effectiveness has gained more importance, as the acceptance or lack of acceptance of local communities of MPA and/or LMMA regulations is key . This study aimed to investigate the effectiveness of MPAs and LMMA in Kenya with a specific focus on local communities' perceptions and their understanding of both strategies, benefits sharing, community acceptance, associated laws and ecological data.

A mixed methods approach was used in this study by conducting face to face interviews and online surveys within four coastal villages (Kibuyuni, Wasini, Mkwiro, and Munje) in Kenya. The findings highlighted that fishing plays a role in the livelihoods of the local residents with noticeable disparities based on gender and age which impact their engagement in marine conservation efforts. While the communities generally acknowledged the ecological and socio- economic benefits of MPAs and LMMAs, there were concerns about the transparency of benefit distribution and the level of community participation, specifically within MPAs.

Shared conservation knowledge was evident in the analysis across different sites. However, variations in legal awareness and perceptions of governance fairness were notable factors identified in the study results. Local community-based management characterized the LMMAs which were viewed as transparent and effective in building trust and encouraging participation at higher levels. In comparison to LMMAs, MPAs were often seen as imposing restrictions with lack of inclusivity resulting in occasional conflicts and lower levels of trust among local communities. This research highlights the importance of incorporating community insights and promoting communication and inclusive governance to enhance the effectiveness and support for marine conservation efforts. Local community capacity building and involvement in scientific data collecting and decision-making processes can build trust and encourage compliance to sustainable marine resource management practices. Moreover, consideration of social aspects, e.g. taking into account community perceptions and promoting transparency in benefit sharing through community involvement in participatory governance processes, will significantly enhance both LMMAs and MPAs acceptance and their effectiveness.

Keywords: Conservation Strategies, Effectiveness, Ecological and Social dimensions, Community perceptions, Benefits Sharing Transparency, Community involvement, Participatory governance.

Tracing Microplastics in River Flow: A Case Study of the Zenne River in the Brussels Capital Region

BY Nour Nasrallah

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This study provides insight on the presence and transport of microplastics in the Zenne River within the Brussels Capital Region with a focus on the main sources, Brussels-North Wastewater Treatment Plant and Combined Sewer Overflows. Water samples were collected and analyzed for microplastic concentrations and a yearly mass balance model was developed to estimate annual microplastic loads in the Zenne River. Scenarios were developed to estimate changes in microplastic loads. Results show that Combined Sewer Overflows are the largest contributors to the microplastic input into the Zenne River especially during high rainfall events, followed by a smaller contribution from Brussels-North Wastewater Treatment Plant effluents. The scenario analysis demonstrated that reducing Combined Sewer Overflows discharge and upgrading Brussels-North Wastewater Treatment Plant filtration significantly impacts microplastics in the Zenne, highlighting the need for stricter regulation, infrastructure changes and community awareness.

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STOCK STATUS ASSESSMENT OF FREQUENTLY CAUGHT GRUNTS, SEABREAMS, AND SNAPPERS ALONG THE KENYAN COAST

BY Maorine Okeri

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CO-SUPERVISORS/TUTORS: Nina Wambiji

Small-scale fisheries along the Kenyan coast significantly impact the local economy, enhance livelihoods, and provide nutrition for coastal communities. Grunts (Haemulidae), seabreams (Sparidae), and snappers (Lutjanidae) account for a considerable catch of small-scale fisheries. Although these fish families seem vital, their fisheries are less prioritised by the regulatory framework due to the scarcity of information about their stocks. This study aims to provide baseline information on the stock status of the four frequently caught species: P*lectorhinchus gaterinus, Polysteganus coeruleoupunctatus, Pristpomoides filamentosus*, and *Lutjanus lutjanus* using Catch Assessment Survey (CAS) data from the Kenya Marine and Fisheries Research Institute (KMFRI) collected from 2017 to 2018. Species composition and abundance of the fishers' catch, species diversity, and gear usage were analysed. Length frequency and length-weight relationship (LWR) of the frequently occurring species were assessed. Growth parameters, such as K (growth coefficient) and L∞ (length infinity), as well as mortality were estimated using ELEFAN (electronic frequency analysis). Length-based spawning potential ratio (LBSPR) and length-based indicators (LBI) were used to assess stock status, using the estimated growth parameters K, L∞, mortality, and LWR as inputs. From the whole data set, a total of 1008 species belonging to 146 families were recorded: with a species Shannon diversity index (H') of 4.58 and Pilou's evenness (J) of 0.67. A total of 27 gears were found to target grunts, seabreams, and snappers. Small-sized fish (< 10 cm) were fished using ring nets, basket traps, handlines, monofilament gillnet, reef seine, and beach seine gears. Exploitation rates of *Plectorhinchus gaterinus, Pristipomoides filamentosus*, and *L. lutjanus* were above the threshold (E > 0.5), while *P. coeruleopunctatus* seemed to be underexploited (E < 0.5). The LBSPR results produced a Spawning potential ratio (SPR) for *Plectorhinchus gaterinus* (6 %), *Pristipomoides filamentosus* (17 %), and *L. lutjanus* (8 %), which were below the lower limit (SPR < 20), unsustainable threshold indicating growth and recruitment overfishing, whereas *P. coeruleopunctatus* maintain a health stock with a SPR of 54 %. LBI assessment indicated that stocks of *Plectorhinchus gaterinus, Pristipomoides filamentosus*, and *Lutjanus lutjanus* were in poor condition with signs of over-exploitation in most indicator ratios. Contrary, *P. coeruleopunctatus* exhibited moderately health status. The finding of this study recommends a need for management strategies, including gear regulation, protection of spawning areas, and seasonal closures to enhance the sustainability of these critical fisheries.

Characterizing perceived risks and risk management in the seaweed farming value chain in south coast Kenya: A case study of three selected seaweed farming villages

BY Winnie Okoth

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Although mariculture activities (such as seaweed farming) are high risk ventures, risk assessment studies in this regard remain limited. In the closely knit yet dynamic seaweed farming value chain of Kenya, determination of the likely sources of risks is crucial as disruptions in one part of the value chain can cascade throughout the entire system, thereby threatening the viability of this vital activity. Studies on the Kenyan seaweed subsector also show that despite its merits in driving socio-economic development, its full productive capacity is yet to be realised. This probes the question of whether this sub-sector may be exposed to risks or otherwise. To potentially disclose answers to this critical question, this study used a qualitative risk evaluation approach to characterize perceived risks and risk management strategies based on opinions of seaweed farmers, traders and domain experts. The perceptions were elucidated using focus group discussions and key informant interviews. The results show that the value chain is seen as vulnerable to diverse yet interrelated risks that lead to cross-cutting impacts. Farmers and experts cite that seaweed production is hindered by environmental risks (unfavourable weather, pests and ice-ice disease, pollution), operational risks (inadequate infrastructure and PPEs), and market risks (high input costs, low output prices and unreliable markets). Whereas farmers were also concerned about financial and social risks, experts perceived them as neither constraining nor improving seaweed production, possibly because these risks could sufficiently be managed through adequate institutional support. The different perception held by farmers may be attributed to their different and in-field position which makes these risks to be more proximate and of concern. Regulatory risks (absence of seaweed-specific policies and high taxation rates) and market risks (price volatility and sporadic supplies) were also cited to constrain seaweed trade. Farmers and traders used a combination of formal (e.g. contractual farming) and informal (e.g. livelihood diversification) prevention, mitigation, and adaptation strategies to manage the multidimensional risks encountered. While these strategies appear to be useful, this does not necessarily mean they are efficient and thus require complementary institutional support. Targeted intervention by the government through policy development, infrastructural investments, establishment of local processing plants (to stimulate value addition) and incentivization schemes is viewed as pivotal in addressing the differential yet interrelated risks constraining seaweed production and trade. Among other key strategies, Public Private Partnerships (PPP) and Integrated Multi Trophic Aquaculture (IMTA) are proposed as possible solutions to the various risks. The findings of this study can support policy decisions on what and where interventions need to be directed to promote a more performant Kenyan seaweed sub-sector. Beyond that, the results highlight the importance of multi-stakeholder risk assessment approaches and their relevance in understanding discourses on sustainable mariculture practices.

Keywords: Mariculture, seaweed farming, risks, uncertainties, risk management strategies, risk evaluation, focus group discussions, key informant interviews

Exploring the Genetic Population Structure of Indo-Pacific Coral Reefs: A Next-Generation Sequencing Approach Utilizing *Amphiprion clarki* as a Model species

BY Lode Op 't Roodt

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CO-SUPERVISORS/TUTORS: Filip Huyghe

Clownfish, members of the family Pomacentridae, are iconic coral reef inhabitants characterised by their intricate social structures. Despite their importance for conservation, the mechanisms driving the dispersal of coral reef fishes remain not fully understood. Previous studies have documented genetically highly differentiated populations of *Amphiprion clarkii*, suggesting significant regional isolation or even possible cryptic species. Furthermore, humaninduced stressors, including direct impacts such as overexploitation (e.g., ornamental fisheries) and indirect impacts such as climate change, have contributed to reduced population sizes and an increasing risk of local extinctions. To protect reef fish species effectively, it is essential to unravel their genetic population structure and connectivity, providing the foundation for targeted management strategies.

This study further investigates the genetic population structure of *A. clarkii* across the Indo-Pacific, with a particular focus on previously underexplored regions such as the Central Indian Ocean. By analysing samples from six distinct ecoregions — Maldives (33), South India and Sri Lanka (73), Sunda Shelf (16), the Western Coral Triangle (46), South China Sea (6), and South Kuroshio (7) - and employing next-generation sequencing (NGS) techniques to assess genetic diversity through single nucleotide polymorphisms (SNPs), we identified complex population structure. Multiple genetic breaks were detected resulting in the identification of the four genetic groups: (1) Maldives, (2) South India and Sri Lanka, (3) Sunda Shelf, and (4) a remaining cluster consisting of the Western Coral Triangle, the South China Sea, and the South Kuroshio ecoregions. This study, expands on previous research confined to the Western pacific, the Indo-Malay Archipelago, and the Maldives.

The restricted genetic connectivity identified highlights the importance of treating these populations as separate management units. Effective conservation strategies, such as the designation and protection of marine protected areas (MPAs), should account for this genetic structure to ensure the long-term survival and resilience of *A. clarkii* populations in the face predicted climate change.

Beyond The Catch: Spatio-Temporal Assessment of ETP Bycatch in Suriname's Demersal Trawl Fishery

BY Mishel Valery Rañada

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In fisheries management, monitoring both target and non-target species is essential to be able to estimate quantities and impact —especially when non-target catch includes Endangered, Threatened, and Protected (ETP) species that play vital roles in marine ecosystems. Understanding where and when these bycatch events occur is key to informing effective conservation and management strategies. This study provides the first spatio-temporal assessment of ETP species bycatch in Suriname's demersal finfish trawl fishery. Observer-derived bycatch-per-unit-effort (BPUE) estimates were used to characterize the spatial and seasonal distribution of the five most observed ETP species. These estimates were subsequently scaled using fleet-wide Vessel Monitoring System (VMS) fishing effort data to generate total annual bycatch estimates and evaluate their spatio-temporal patterns. From 360 observed hauls, a total of 19,402 ETP species encounters were recorded, including 25 elasmobranch (14 sharks and 11 batoid fish), three sea turtles, and one marine mammal species. Elasmobranchs dominated the bycatch, with Smalleye smoothhound shark (*Mustelus higmani*) (IUCN Red List status 'endangered') emerging as the most impacted species, exhibiting the highest BPUE (5.96 ind/hr), the broadest spatial distribution, and the greatest temporal variability. When scaled to the entire fleet using VMS effort data, total ETP bycatch of the Suriname demersal finfish trawl fleet was estimated at approximately 241,746 individuals (95% CI: 225,823 - 258,102) in 2023, with *M. higmani* alone comprising an estimated 83,302 (95% CI: 75,487 - 91,295) individuals. Spatial analysis revealed distinct bycatch hotspots, while temporal patterns indicated peak bycatch during the third quarter for most species. These findings underscore the importance of spatially and temporally targeted mitigation strategies, such as area-based closures, seasonal effort reductions and/or use of bycatch reduction devices (BRDs). While observer data provided critical insights, its limited temporal coverage (1.6% of fishing effort) points to the need for improved monitoring, including fisher self-reporting. Nevertheless, this study provides essential baseline information to guide adaptive bycatch mitigation and promote sustainable fisheries management in Suriname.

Mitochondrial Phylogeography and Species Delimitation of Sexual and Asexual populations of the Ostracod *Cypridopsis vidua* Across Continents

BY Álvaro Peñuelas Sanchez

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CO-SUPERVISORS/TUTORS: Marc Kochzius, Koen Martens

This study investigates the evolutionary history, genetic diversity, and reproductive biology of the widespread non-marine ostracod *Cypridopsis vidua*. We curated and analysed 170 mitochondrial COI sequences from specimens collected across five regions, Belgium, North and South America, Turkey and New Caledonia. Phylogenies under the best-fit substitution model were reconstructed with both maximum-likelihood and Bayesian inference. Four statistical species-delimitation methods (ABGD, ASAP, bPTP, KoT) were applied to identify genetic species. Our results reveal remarkably shallow COI divergence and a star-like haplotype network with extensive haplotype sharing, indicating a single, genetically cohesive lineage including both sexual and asexual populations. Nevertheless, sensitive delimitation methods identify multiple genetic species, suggesting the presence of incipient cryptic diversity that lacks strict geographic segregation and warrants morphological validation. The first molecular analyses of the recently discovered North American sexual population, a rarely reported phenomena for *C. vidua*, highlights mixed reproduction as a key driver for mitochondrial cohesion, contrasting patterns seen in parthenogenetic ostracods. Finally, we discuss the limitations of COI barcoding for resolving fine-scale genetic divergence and advocate a multi-locus, integrative taxonomic framework to refine species boundaries and elucidate the role of reproductive transitions in shaping ostracod diversity.

Keywords: *Cypridopsis vidua*; Ostracoda; COI barcoding; Cryptic diversity; Parthenogenesis – Sexual reproduction; Phylogenetic inference; Species delimitation.

Impact of nitrate and heatwave on a small cyprinid fish (*Leucaspius delineates*)

BY Niels Reyns

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Nitrate pollution and heatwaves are both stressors impacting the survival of freshwater species, especially freshwater fish. The majority of research conducted has been focusing on the impact of one of these stressors alone, while the combined effects of both nitrate and heatwave are largely unknown. In this study, the combined effects of nitrate pollution and heatwaves were examined on the standard metabolic rate (SMR), critical thermal maximum (CTMax), hypoxia tolerance (LOE), cardiorespiratory attributes (heart to body mass ratio and hemoglobin level), growth (body and length) and the hepatosomatic index of silverbacks (*Leucaspius delineates*). Experimental setup consists of three nitrate conditions (0 mg NO3- L-1 , 50 mg NO3- L-1 , 200 mg NO3- L-1) and two heatwave conditions (no heatwave and long heatwave), resulting in 18 conditions in total. Fish were exposed during 6 weeks. The SMR of nitrate exposed fish was significantly higher compared to control fish, but this was only restricted to 200 NO3− L−1. Exposure to both stressors significantly lowered the SMR, indicating a cross-tolerance between heatwave and nitrate. Exposure to a heatwave caused fish to reach the highest CTMax, but this was concentration dependent, as this was only restricted to high levels of nitrate (200 NO3− L−1). Nitrate significantly increased the hypoxia tolerance of fish regardless whether fish were exposed to heatwave or not. Heatwave fish lost their equilibrium at a significantly higher oxygen level in comparison with fish exposed to no heatwave. The combination of both stressors did not seem to have any significant impact on the hypoxia tolerance. The hepatosomatic index on the three different nitrate levels was found to be lower when being acclimated at heatwave. The heart to body mass ratio was independent of nitrate concentration, but was reduced when exposed to a heatwave. The hemoglobin level was reduced by exposure to both stressors. As silverbacks showed some resilience to temporal and chemical changes in their environment, it seems that high levels of nitrate in combination with heatwaves will be too much for this species to deal with.

Keywords: *Leucaspius delineates*, heatwave, nitrate, hypoxia tolerance, standard metabolic rate, critical thermal maximum

Experimental Study on Safe *Eriocheir sinensis* Densities for Aquatic Vegetation Conservation

BY Alexandra Schloss

MAIN SUPERVISOR: Jonas Schoelynck (Universiteit Antwerpen)

The aim of this study was to determine the threshold at which the Chinese mitten crab *(Eriocheir sinensis*) causes significant biomass loss in *Myriophyllum spicatum*, which is an important submerged macrophyte in aquatic habitats. A mesocosm experiment was conducted in a controlled environment with crab densities ranging from 0 to 10 individuals per tank (equivalent to 0–37.83 crabs/m²), and the biomass reduction of the macrophytes was measured over 30 days. Using a fitted logistic model, the inflection point of the dose-response curve indicated the steepest biomass decline approximately at 0.46 crabs per tank (≈ 1.7 crabs/m²). This point marks a critical ecological threshold at which biomass loss begins to accelerate sharply. Beyond this number of crabs, additional crabs contributed less to further vegetation reduction, with a saturation effect at 1.98 crabs per tank. These findings are valuable for establishing ecologically safe crab densities in freshwater ecosystems and for developing more targeted control strategies, such as in the Schelde system in Belgium.

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Genetic connectivity of *Patella vulgata* (Gastropoda) from Belgian offshore wind farms

BY Epiphania Shayo

MAIN SUPERVISOR: Steven Degraer (Universiteit Gent)
CO-SUPERVISORS/TUTORS: Isabelle Schön, Thomas Kerkhove

Offshore wind farms (OWFs) are rapidly increasing in the North Sea, altering marine habitats by introducing artificial hard substrates. *Patella vulgata*, a limpet species native to rocky shores of the northeast Atlantic, has successfully colonized these new offshore habitats, including in the Belgian part of the North Sea (BPNS), where natural rocky substrates are rare. This study examined the genetic connectivity and population genetic diversity of *P. vulgata* in Belgian OWFs compared to other coastal regions using two molecular markers: mitochondrial COI and nuclear microsatellites.

COI sequences and five microsatellite loci data from several populations along the North Sea coast and offshore were analyzed. The COI haplotype network showed a dominant central haplotype shared across all sites, indicating low phylogeographic structuring. Microsatellite analysis also revealed low overall genetic differentiation, with most variation occurring within individuals. Pairwise comparisons showed some significant differences in southern populations but not in the Belgian OWF populations.

These findings suggest high gene flow and connectivity among *P. vulgata* populations, including those at offshore sites. Belgian OWFs likely function as ecological stepping-stones rather than isolated habitats. As offshore wind development continues, understanding genetic connectivity is crucial for biodiversity conservation and marine spatial planning.

Spatio-temporal variability of the Abra alba community in the Norther Offshore Wind Farm Area (2020-2022)

BY Miel Somers

MAIN SUPERVISOR: Carl Van Colen (Universiteit Gent)

Offshore wind farms (OWFs) have become increasingly prevalent in the pursuit of green energy. The placement of turbines in coastal areas has impacted existing macrobenthic communities. The NORTHER OWF is a recent addition to the green energy zone within the Belgian part of the North Sea (BPNS). Its proximity to the coast and location in shallow waters make it unique compared to other farms in the region. This distinctive placement coincides with the habitat of the species-rich *Abra alba* community. In this study, the spatio-temporal impact of turbine presence on the *A. alba* community was assessed and compared to a pre-construction study conducted in 2016. Samples were collected over a course of three years (2020–2022) at three different positions (VC,FAR,REF), representative of the *A. alba* community, with VC and FAR being positions located within the wind farm and corresponding to 32.5 m and 300-500 m from the turbines centre respectively as well as a reference zone (REF) outside of the wind farm. Results indicated high variability in both biotic and abiotic parameters across the wind farm and reference zone. Positions in close proximity to turbines exhibited significant inter-turbine variability and were characterised by macrobenthic communities dominated by hard-substrate associated fauna benefiting from the habitats created by the rocks near the base of the turbine. The turbines create low-energy zones, which alter the hydrodynamic conditions and eventually promote sediment refinement in both VC and FAR, potentially increasing organic matter retention. The different years show differences in recruitment for different dominant taxa depending on the position, due to the interplay between both abiotic and biotic factors affecting the eventual community structure. With annual recruitment dynamics in both NORTHER and REF being different and caused by turbine related and potential fishery exclusion effects respectively. Continued monitoring will be necessary to determine the long-term effects and outcome of the A. alba community for the reference zone and the NORTHER OWF.

More than one species? Exploring the possible existence of cryptic species in the giant clam *Tridacna maxima* using mitochondrial COI sequences

BY Joseph Ricky Tamayo

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Giant clams of the subfamily *Tridacninae* are ecologically significant marine invertebrates threatened by global environmental change and anthropogenic pressures. All 12 extant species, distributed across the Indo-West Pacific (IWP), are listed under Appendix II of CITES. However, effective conservation of these vulnerable species requires consistent species description and delimitation. Previous studies using mitochondrial COI and nuclear markers have revealed deeply divergent groups within the small giant clam, *Tridacna maxima*. This study analysed mitochondrial COI sequences from 200 *T. maxima* individuals sampled across 22 marine ecoregions spanning the (1) Northern & Central Red Sea, (2) East African Coral Coast, (3) Western & Northern Madagascar, (4) Maldives, (5) Sunda Shelf/Java Sea, (6) Andaman Sea Coral Coast, (7) Western Sumatra, (8) Southern Java, (9) Lesser Sunda, (10) Sulawesi Sea/Makassar Strait, (11) Palawan/North Borneo, (12) Eastern Philippines, (13) East China Sea, (14) South China Sea Oceanic Islands, (15) Papua, (16) Bismarck Sea, (17) Solomon Archipelago, (18) Torres Strait/Northern Great Barrier Reef, (19) Society Islands, (20) Tuamotus, (21) Line Islands, and (22) Gilbert/Ellis Islands. Four species delimitation methods were applied, namely: ABGD, ASAP, bPTP, and GMYC. A group was considered a valid operational taxonomic unit (OTU) if it is comprised of more than one sample, is monophyletic, and is consistently identified across methods. The mean Kimura 2-Parameter (K2P) genetic distance within T. maxima was 6 % and the species delimitation methods agreed on eight deeply divergent OTUs (1.77 %-10.21 %), with three in the Pacific (OTUs 1–3) and five in the Red Sea & Indian Ocean (OTUs 4–8). OTU1 (n = 20) is distributed from Papua to the Northern Great Barrier Reef; OTU2 (n = 40) from the Society Islands to the Gilbert/Ellis Islands; OTU3 (n = 40) from Southern Java to the South China Sea Oceanic Islands; OTU4 from the Sunda Shelf to Western Sumatra; OTU5 in the Maldives; OTU6 (n = 11) and OTU7 (n = 29), potentially sympatric, at the East African Coral Coast and Western & Northern Madagascar of the Western Indian Ocean (WIO) province; and OTU8 in the Northern & Central Red Sea. Notably, this study documents a divergent OTU in the Maldives (4) for the first time. These results provide indication for cryptic speciation within T. maxima, shaped by geographic, oceanographic, and historical factors. The presence of these divergent groups should be considered in conservation strategies, particularly in Marine Protected Area design and management.

Keywords: phylogenetic analysis, species boundaries, phylogeny

Climatic control of biodiversity in an ancient insular ecosystem. Are tropical communities governed by different processes than temperate communities? A case study with invertebrates from ancient rock pool ecosystems

BY Olivia Toles

MAIN SUPERVISOR: Bram Vanschoenwinkel (Vrije Universiteit Brussel)

Many studies have documented latitudinal changes in biodiversity. However, the underlying mechanisms remain poorly understood. Here, we use a unique ancient insular model ecosystem to analyze 1) which aspects of local climatological conditions can contribute to explaining biodiversity, and 2) test whether the importance of different community structuring processes changes with latitude and associated climatic conditions. For this, a large-scale dataset of freshwater invertebrates from inselberg rock pool systems in different parts of the world was used. We evaluated entire communities as well as assemblages of only the passive and active dispersers separately. Active dispersers are organisms that may move between environments without a vector, while passive dispersers require vector-mediated dispersal. Active dispersers may be better at taking advantage of more favorable conditions, as they propel their migration, while passive dispersers are more desiccation resistant. Because the rock pools are small aquatic ecosystems, they are vulnerable to desiccation and subsequent refilling, which depends on precipitation and temperature. Warm, tropical seasonal climates boosted the richness and diversity of active dispersers. In contrast, passive dispersers responded weakly to climate itself but were more diverse where their climate type occupies a larger fraction of the globe, providing evidence that the geography of climate helps explain present-day diversity. Despite these effects on richness, climate did not alter the strength of environmental filtering compared to spatial filtering, indicating that assembly mechanisms were relatively invariant across latitude and climatic harshness. Together, these findings 1. corroborate the tropical diversity peak, but show that it is life-strategy dependent, 2. demonstrate that movement constraints modulate the effects of climate on biodiversity and 3. identify the geography of climate as an overlooked correlate of diversity in freshwater ecosystems. These findings help to clarify the climatic constraints underlying latitudinal patterns in this ancient system.

Antarctic meiofauna : a spatial analysis of assemblage food-web structure of remote and unknown shallow water sediments of the WAP affected by climate change

BY Fanny Tziovaridis

MAIN SUPERVISOR: Francesca Pasotti (Universiteit Gent)

Shallow soft-sediment habitats along the Western Antarctic Peninsula (WAP) are experiencing rapid environmental change, yet the trophic organization of their meiofaunal assemblages is poorly constrained. This study quantified relative trophic niche width and structure of dominant meiofauna (Nematoda, Copepoda) across sites differing in disturbance, sediment status, and food supply within the surficial 0–2 cm layer. Carbon and nitrogen stable isotopes ($\delta^{13}C$, $\delta^{15}N$, ‰) were analysed and compared using community-wide metrics (CR, NR, CD, TA, MNND, SDMNND) and ellipse-based metrics (SEA, SEAc, SEAb) implemented in SIBER. Because a universal producer or sentinel-consumer baseline was unavailable, consumer values were standardized to station-specific bulk sPOM/surface-sediment medians prior to analysis; environmental interpretation drew on pigment profiles and site descriptors. Key limitations include absence of a calibrated baseline, uneven and often low replication for several taxa/morphotypes, and environmental covariates that represent short-term surface conditions. Within these constraints, the results indicate that resource heterogeneity and disturbance regime jointly structure meiofaunal isotope niches in WAP soft sediments and provide a first isotopic reference for future, higher-resolution assessments.

Keywords: Stable isotope analysis, isotopic niche, SIBER, Layman metrics, meiofauna, Western Antarctic Peninsula, glacial disturbance, baseline

POTENTIAL IMPACTS OF DEEP-SEABED MINING ON MEIOFAUNA COMMUNITIES IN THE NODULE-BEARING ABYSS

BY Venesa Utami

MAIN SUPERVISOR: Ellen Pape (Universiteit Gent)

The small-scale disturbance from the pre-prototype nodule collector trial Patania II removed and compressed the upper sediment layer along its track. Nonetheless, sediment plumes were dispersed and redeposited, with greater thickness near the collector track. This study aims to evaluate the immediate and longer-term (1.5 years later) impacts of the trial on sediment metazoan meiofaunal communities in the eastern Clarion–Clipperton Zone (CCZ). Analyses of abiotic factors and meiofaunal communities were conducted across three expeditions: SO268 (2019), IP21 (2021), and SO295 (2022). The baseline study indicated that the Trial and Reference areas had comparable initial conditions, reliably representing undisturbed environmental conditions prior to experimental disturbance. However, post-disturbance observations during SO295 showed significantly higher clay content at the Plume Impact Thin site, suggesting plume-related fine sediment resedimentation. Collector Impact sites exhibited marked TOC depletion, likely due to the removal of organic-rich surface layers. Meiofaunal responses varied across sites and time periods. While no significant changes in abundance or diversity were observed immediately post-disturbance (IP21, $p > 0.05$), significant declines emerged 1.5 years later during SO295. Meiofaunal abundance and diversity at Collector Impact sites were significantly lower than at Reference and Plume Impact sites (SO295, $p < 0.01$). In addition, the Plume Impact Thick site showed higher mean meiofaunal abundance. Nematoda remained dominant across all sites. Multivariate analyses identified median grain size and chlorophyll-a as key environmental drivers of community structure, with taxon-specific responses suggesting complex post-disturbance ecological filtering. These findings demonstrate that the nodule collector trial induced longer-term (1.5 years) alterations in habitat conditions and benthic community structure, with recovery trajectories that are slow and taxon-specific.

Keywords: Meiofauna, deep-seabed mining, pollymetalic nodule, Patania II, Clarion-Clipperton Zone

THE ECOLOGY AND HABITAT REQUIREMENTS OF SPIONID SPECIES (ANNELIDA: POLYCHAETA) ON COASTAL ARTIFICIAL HARD SUBSTRATES

BY David Alejandro Valencia Soto

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CO-SUPERVISORS/TUTORS: Thomas Kerkhove, Danae-Athena Kapasakali, Francis Kerckhof

Coastal artificial structures are important infrastructure built in seaside urbanised areas that play roles in commerce, production of energy and transportation. Among these, coastal defence structures protect the coastline from erosion and flooding. However, these structures modify epibiotic and benthic ecosystems and can provide suitable environments for non-indigenous species, such as spionid polychaetes, which pose a threat to both biodiversity and economic activities. Research on spionid polychaete communities associated with coastal defence structures in Belgium is scarce, especially concerning habitat preferences and spatial variation.

The main objectives of this thesis were: (1) to determine whether spionid species composition varies across western to eastern localities, (2) to assess whether spionid polychaetes on Belgian groynes show specific habitat preferences, and (3) to provide an updated taxonomic account of identified species. Collection of spionids was made in Nieuwpoort, Raversijde and Blankenberge, on three distinct habitats supported by groynes: Algae zone, Mussel *Mytilus edulis* beds and *Polydora* patches. The hypotheses were tested using a generalised linear latent variable model (GLLVM) to analyse species abundance-predictor associations. Coefficient plots and a residual correlation matrix were made to visualise associations and correlations induced by latent variables. All analyses and plots were carried out using R.

Results revealed variations in species composition across localities and distinct habitat preferences. *Pygospio elegans* and *Boccardia proboscidea* exhibited positive associations with the Algae zone; *Polydora ciliata*, *Malacoceros fuliginosus* and *Boccardiella hamata* were positively associated with Mussel beds, and *Polydora cornuta*, *P. ciliata* and *B. proboscidea* showed positive associations with *Polydora* patches. No new species were identified in this study that had not already been described in the North Sea. These findings improve our understanding of the spionid communities associated with Belgian groynes and set a baseline for future ecological research and monitoring of non-indigenous spionid species. An updated taxonomic account of the species identified is provided.

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ASSESSING POST-HURRICANE IOTA MANGROVE RECOVERY ON PROVIDENCIA ISLAND, COLOMBIA: INTEGRATING FIELD-BASED AND REMOTE SENSING INDICATORS

BY Emmeline Van Lent

MAIN SUPERVISOR: Tom Van der Stocken (Vrije Universiteit Brussel)
CO-SUPERVISORS/TUTORS: Diana Di Nitto, Nico Koedam, Farid Dahdouh-Guebas

Mangrove forests are increasingly affected by climate change-induced extreme weather events, causing extensive tree defoliation, uprooting and ensuing mortality which compromise biodiversity, carbon storage, and coastal protection. This study quantified post-hurricane recovery of mangroves in four sites on Providencia Island, Colombia, following Hurricane Iota (November 2020). Using Sentinel-2 imagery (2019–2025), recovery trajectories were evaluated through six spectral indices (NDVI, NDMI, MVI, NDWI, NBR, CMRI) and compared with field-based surface and porewater quality measurements. All sites experienced severe damage with >80% canopy loss in the most exposed areas. Five years post-hurricane, none have regained 80% of their pre-Iota condition. The site Manchineel (MZ) showed the strongest improvement while Santa Catalina (SC) remained most degraded. Multivariate analysis revealed that water quality differed significantly among sites, with surface parameters more strongly linked to spectral indices than porewater conditions. At SC and John Mangrove (JM), poor water quality conditions (e.g. high salinity, low ORP) were strongly correlated with limited recovery, whereas MZ, despite having the least initial damage, showed no significant water quality–spectral index relationships. The findings demonstrate that mangrove regeneration is slow and highly variable after a major disturbance, with recovery constrained by initial damage severity, species composition and water quality conditions.

Keywords: mangrove vegetation, Hurricane Iota, resilience, regeneration dynamics, remote sensing, spectral indices, satellite imagery, water quality, Colombia, Providencia Island

Transcriptomic responses and growth dynamics of the red alga *Furcellaria lumbricalis* along a salinity gradient

BY Loeka Vandenschrick

MAIN SUPERVISOR: Olivier De Clerck (Universiteit Gent)
CO-SUPERVISORS/TUTORS: Sofie Vranken, Louka Noyen

Furcellaria lumbricalis is a red macroalga with a large distribution in both marine and brackish environments. It has an important ecological and economic role as its polysaccharide furcellaran is used in many industries. The broad distribution range suggests potential local adaptation or phenotypic plasticity in response to salinity gradients. In this study, we investigated the physiological and molecular responses of two geographically distinct populations, Estonia and Ireland, exposed to varying salinities of 7, 15 and 30 psu. The growth rate was monitored over 3 weeks in a controlled experiment and after the first week, thalli were harvested for RNA sequencing to asses transcriptomic responses. *Furcellaria lumbricalis* showed clear physiological and morphological shifts, including depigmentation under non-native salinities. RNA sequencing revealed salinity- and population-specific expression, with population identity explaining most of the variation. A thorough understanding of this species' growth patterns is critical to guide future cultivation strategies and management decisions.

Towards reconstructing Holocene snow cover on Villarrica Volcano, Chile, using lacustrine biomarker proxies: disentangling climate and source variability

BY Rosalia-Alba Vittiglio

MAIN SUPERVISOR: Maarten Van Daele (Universiteit Gent)
CO-SUPERVISORS/TUTORS: Cindy De Jonge, Kimberly Demeestere

Strato-volcano Villarrica, bordered by Lake Villarrica and Lake Calafquén, produces volcanic mudflows or lahars when the volcano erupts and the volcanic residues interact with the snow cover on the top of the volcano. These lahars are hazardous for anything and anyone on their path. In the larger project the goal is to understand the influence of the snow cover on the lahars. In this initial stage we try to determine which biomarkers are well suited to determine the temperature variability and precipitation (i.e. snow cover) throughout the Holocene and look if they can be linked with the lahar events. For this study we analysed GDGTs, n-alkanes and fatty acids and their derived variables for recent samples and samples from the equivalent Little Ice Age (LIA)-period, Middle Holocene and Antarctic Cold Reversal (ACR). Besides derived lipid variables for provenance and environmental variability, also δD analyses were performed on a few n-alkane and fatty-acid samples. The GDGTs were used for temperature reconstructions. Middle-chain-length n-alkanes and FAMEs are sourced from aquatic macrophytes, containing the potential to store snow melt signals. Long chain n-alkanes are sourced from terrestrial plant waxes (C27-C29 trees, C31 grasses, only C3). δD from the terrestrial plant waxes give a precipitation and evaporation signal for trees and grasses respectively. Results showed a wide variability in preservation of each biomarker group within both lakes. Remarkably, locations with higher concentrations in fatty acids and n-alkanes had lower concentrations in GDGTs and vice versa. Over time vegetation changes could be noticed based on the ACL (average chain length). Certainly in the last century a decrease in trees was noticed, probably as a result of deforestation since the 1900s. This variability was also noticeable in the Paq index were an increased input of higher plants was observed in the lakes, and the BIT-index represented an increased soil signal in these recent samples. For Lake Villarrica, the ALST(TEX86) formula by Blaga et al. (2009) provided reliable temperature reconstructions based on the limnological study of Campos (1984). Due to dependencies between the GDGT0/cren-ratio and TEX86 in Lake Calafquén could the ALST not be applied for temperature reconstruction. Further, the BIT-index showed dependencies with the MBT'5ME, making this proxy unreliable for temperature reconstruction. As a result, no temperature reconstructions in lake Calafquén were reliable enough to discuss. Although, only a selection of all the n-alkane and fatty acid samples were analysed for δD, could the downcore variability explain changes in precipitation, evaporation, snow melt and small difference between vegetation (grasses vs trees). The differences between the middle-chain length and long-chain length δD for n-alkanes and fatty acids were compared to the ALST(TEX86) and well dated lahar events. The increase in temperature at the end of the ACR and the LIA does correspond with a depletion of the δD difference, suggesting snow melting by a temperature increase. Snow melt input in the lakes as a result of a lahar event was less clear in this data record. At some time intervals you could assume that the depletion in δD is the result of a lahar event. But in other cases, becomes the δD more enriched after a lahar event, which is odd. At this moment give the δD values of the fatty acid the what we assume most thrust wordy signal in terms of snow melt input. But only 10 fatty acid samples were analysed for D and thus more samples need to be analysed to receiver a higher resolution.

Bioaccumulation of PFAS and Metals in Translocated and Resident Mussels from the Meuse River (Belgium).

BY Danaé Winandy

MAIN SUPERVISOR: Lieven Bervoets (Universiteit Antwerpen)
CO-SUPERVISORS/TUTORS: Thimo Groffen

This thesis assessed the occurrence and bioavailability of PFAS and metals in the Meuse River using a combination of active biomonitoring with translocated zebra mussels (*Dreissena polymorpha*) and passive biomonitoring with resident mussels. Translocated mussels were deployed at six locations in the Meuse River around Liège (Wallonia, Belgium), with water samples collected in parallel. A total of 29 PFAS were targeted. In water, three long-chain PFAS (ΣPFAS = 10.5 - 465 ng/L) were detected, with particularly elevated PFDoDA concentrations at most sites (129 – 384 ng/L). Mussel tissue analysis revealed both long-chain and short-chain PFAS (ΣPFAS = 21.0 - 68.6 ng/g ww), including compounds not detected in water, and with PFBS dominating the PFAS profiles (11.3 – 23.9 ng/g ww in translocated mussels). PFOS concentrations exceeded the European Environmental Quality Standard (0.65 ng/L) for inland waters at several sites, with the highest value being 84.4 ng/L. In addition to contaminant profiles, mussel health status was evaluated through condition index measurements and a negative relationship between PFBA bioaccumulation and the condition index was observed, suggesting a possible toxic effect of PFBA on mussel health. For metals, 11 elements were investigated. Dissolved concentrations were generally below the Flemish EQS in water, yet translocated mussel tissues showed marked bioaccumulation levels of Al and Zn, particularly at Seraing (85.5 µg/g ww and 27 µg/g ww, respectively). Except for one site, resident and translocated mussels exhibited similar trace element profiles, supporting the use of translocated mussels as reliable biomonitors.

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Metagenomic Insights into Microbial Community Structure and Biogeochemical Functions in North Sea Sediments

BY Zhijing Xu

MAIN SUPERVISOR: Sofie Derycke (Universiteit Gent)
CO-SUPERVISORS/TUTORS: Martijn Callens

Marine sediments host highly diverse microbial communities crucial for global biogeochemical cycles. In this study, we combined short- and long-read metagenomic sequencing and hybrid assembly to analyze microbial diversity in surface sediments from the Belgian North Sea. We reconstructed 24 high-quality metagenome assembled genomes (MAGs), with *Pseudomonadota*, *Bacteroidota, Acidobacteriota*, and *Verrucomicrobiot*a as dominant groups. *Pseudomonadota* played central roles in carbon, nitrogen, sulfur, and metal cycling. Bacteroidota were key organic matter degraders, while *Acidobacteriota* and *Verrucomicrobiota* contributed functional redundancy. No evidence of methanogenesis, nitrogen fixation, or anammox was found, likely due to oxic conditions and technical limits. Notably, up to 97% of sequencing reads remained unmapped, highlighting vast unexplored microbial diversity. Our study underscores both the ecological significance of key bacterial groups and the large unknown fraction in marine sediment microbiomes.

Keywords: metagenome assembled genomes, bacteria, North Sea, functional diversity

Bioaccumulation of PFAS and metals in caged animals exposed in the Scheldt river

BY Ioannis Zachos

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Per-and polyfluoroalkyl substances (PFAS) and metals are persistent environmental contaminants of increasing concern in estuarine ecosystems due to their bioaccumulative potential and associated risks to aquatic organisms and human health. This study assessed the accumulation of 29 PFAS and 11 heavy metals in two bivalve species: the caged Asiatic clam (*Corbicula fluminea*) and resident blue mussel (*Mytilus edulis*). The study was conducted across eight sites along the Western Scheldt estuary. Water and sediment samples were also analysed to explore spatial patterns and potential drivers of contaminant uptake. Results revealed distinct contaminant profiles between species and sites. PFBS and PFBA dominated PFAS profiles, particularly at upstream sites, while longer chain PFAS occurred at lower levels. For metals, Zn, Cu, and Al were most abundant, with hotspots near industrial and urbanised areas. Mixed-effects models indicated significant influences of conductivity and dissolved oxygen on PFAS uptake, while sediment metal concentrations, conductivity and condition index influenced accumulation. Notably, negative relationships between sediment PFAS and tissue concentrations suggest that strong absorption of PFAS to sediment particles and organic matter reduces their freely dissolved fraction, limiting bioavailability for uptake by filter-feeding bivalves. These findings highlight spatial heterogeneity in contaminant exposure and the value of using both resident and caged bivalves as bioindicators. The PFAS and metal dataset provides a baseline for future monitoring in the Scheldt, with implications for EU Water Framework Directive compliance and seafood safety assessments.