
BOOK OF ABSTRACTS

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Enhancing the understanding of environmental parameters on vegetative growth, photosynthetic efficiency, and asexual reproduction in *Porphyra umbilicalis* Kützting

BY Arias Moran, Alex

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CO-PROMOTER: Jessica Knoop

The cultivation of seaweed has been practiced in Asian countries for decades, however, in recent years there has been an increase in the commercial interest of this crop in European countries. However, only a few local species can be successfully cultivated as several bottlenecks in life cycle control and best growth conditions limit upscaled cultivation. *Porphyra umbilicalis* is part of one of the most valuable commercially seaweed groups known as Nori and is commonly found in Europe. The main goal of this study was to enhance the knowledge about the life history of *Porphyra umbilicalis* by testing an isolated strain from Europe in a series of experiments. The effect of temperature (10, 14, 18, 20, 23 °C), photoperiod (8:16, 12:12 and 16: 8 h light: dark), light intensity (30, 50, 100, 150 and 200 $\mu\text{mol photons m}^{-2} \text{s}^{-1}$) and stocking density (0.5, 1, 3 and 5 g fw l⁻¹) was tested on the specific growth rate and photosynthetic efficiency of photosystem II (PSII) of *P. umbilicalis*. In addition, trials were carried out with blades treated with allantoin (0, 1, 5, 10 and 20 mM) and hydrogen peroxide (0.1 mM), where the effect of these treatments on the specific growth rate and the production of asexual archaeospores and free cells was identified. Growth rates were high ($\geq 9\%$ d⁻¹) in blades grown at 14 °C, with light intensities $\geq 30 \mu\text{mol photons m}^{-2} \text{s}^{-1}$ and ≥ 12 h of light observed with stocking densities ≤ 1 g fw l⁻¹. Photosynthetic efficiency values of PSII (Fv/Fm) were significantly affected ($p < 0.001$) by photoperiod, temperature and light intensity. Moreover, in allantoin/H₂O₂ trials the highest growth rates were observed in the controls, where the higher value ($\approx 8\%$ d⁻¹) was found in blades grown at 18 °C. No archaeospores or free cells were obtained in this experiment after homogenization, however, structural and pigmentation changes in the cells were observed under the microscope. These results provide additional physiological information on *P. umbilicalis* from the North Sea that will possibly help to improve the implementation of commercial scale aquaculture of this species in Europe.

Projecting impacts of ocean warming on seagrass distribution in the Central Indo-West Pacific region

BY Assidiq Muhammad Irlan

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The temperature of the ocean has been continuously rising to a level not seen for a million years ago, with potential negative impacts on marine ecosystem. Seagrasses are key primary producers and ecosystem engineers which provide significant ecosystem services in shallow water communities. It is predicted that ocean warming will lead to seagrass distribution shift and habitat loss. In this study, we assessed factors affecting habitat distribution of tropical seagrass species and forecasted the impact of future ocean warming on the species. We used species distribution modelling (SDM) to project the future distributions of the seagrasses under 3 warming scenarios in 2050 and 2100. We run the SDM based on occurrence data of five seagrass species: *Thalassia hemprichii*, *Enhalus acoroides*, *Cymodocea serrulata*, *Halodule uninervis* and *Halophila ovalis*. These species are broadly distributed in the Central Indo-West Pacific and represent a variety of seagrass ecological traits. Our study shows that inclusion of photosynthetic rate affects the percentage number on both habitat gain and losses for the selected seagrass species. Under different ocean warming scenarios, seagrasses shown habitat losses ranging from 6% to more than 31%, and habitat gain less than 3% in 2050 under 3 different scenarios. In 2100, habitat loss ranges from 3% up to more than 33%, while habitat gain was not more than 3.25%. Increase ocean temperature favored small seagrass species with rapid recovery rate (*Halophila ovalis*) more than seagrass with large size with long life span (*Thalassia hemprichii* and *Enhalus acoroides*). Distributional shifts shown to be polar – ward where the losses were projected to occur along the tropical region. *Cymodocea serrulata* has the lowest habitat loss projected, in comparison with other species, displaying its potential as a potential species for transplantation. *Halophila ovalis* has the highest habitat gain, potentially showing its invasive capacity in the area.

Keywords: Seagrass, Species Distribution Modelling (SDM), Hybrid SDM, Ocean Warming, Diffuse Attenuation, Central Indo-West Pacific

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Macrobenthos succession dynamics and sediment change in a developing coastal lagoon habitat

BY Ayeni Anuoluwapo Victoria

PROMOTER: Ann Vanreusel (Universiteit Ghent)

CO-PROMOTER: Carl Van Colen

The Zwin lagoon until its restoration was subjected to various anthropogenic pressures in relation to natural processes that caused a gradual reduction in biodiversity and loss of ecological and economic importance. This negatively impacted inundation the time and range of the feeding habitat in the tidal flats.

To assess the Spatio-temporal variability in sediment composition and macrobenthos in the extended Zwin tidal lagoon, sampling was accomplished at the developed tidal flat area with the mud (M), Sand (S) and Pump (P) stations. Additionally, samples from three more stations at the matured marsh area were analysed. A total of 18 species were found in the area, the most dominant were *Hediste diversicolor*, *oligochaete spp*, *Heteromastus filiformis*, *Polydora cornuta*, *Streblospio benedicti*, *Pygospio elegans* and *Limecola balthica*. It was found that all stations exhibited varying sediment characteristics during the monitored period between April 2019 to June 2020. The developed area exhibited a succession involving gradual colonisation of macrobenthos. And sediment characteristics in the developing tidal area were similar to the mature tidal area. Spatio-Temporal differences reveal the restoration success at the developing tidal lagoon.

Keywords:

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Experiences from Italian and French marine Natura 2000 practitioners: management challenges and adaptation to climate change

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The marine Natura 2000 network, under the Habitats and the Birds Directives of the European Unions, covers approximately 9,5% of the European seas [European Commission, 2019]. These sites are not shielded from human activities and involvement of various sectors in a same territory create challenges for practitioners of management in these marine protected areas (MPAs). Moreover, climate change is increasingly impacting marine ecosystems and the resilience of the marine Natura 2000 sites. This study reviews the perception and expertise of marine Natura 2000 managers regarding the management challenges and the management adaptation under the climate change risks. We surveyed Natura 2000 practitioners from France and Italy in the Ligurian Sea and its wider region. We investigated their perception about the management tools used and management challenges encountered. We also assessed their views on risks associated with climate change, their perceptions regarding the role, importance, and feasibility of adaptation for managing these risks. This comparative study of two Member States allowed us to highlight differences and similarities in managers' perspectives about major elements of marine Natura management. We synthesised the key lessons that emerged from this comparative study, and we made four recommendations: i) To develop and define clear guidance between Italian management bodies in charge of the marine Natura 2000 sites in the Liguria region. ii) We emphasise the necessity to develop the French management tool for the Natura 2000 marine sites. iii) In line with the EU Biodiversity strategy 2030, we recommend stricter protection of the marine Natura 2000 and the development of management to regulate the use of the sea in Natura 2000 areas. iv) We recommend better knowledge transfer between research science and Natura 2000 governance to achieve adaptive management. Moreover, this study contributes to new insights about Natura 2000 marine managers' perspective of adaptive management under climate change uncertainty. MPA managers' perceptions in this subject matter have already been investigated in the past, but without any particular focus on the Natura 2000 network.

Keywords: Natura 2000, EU Directives, Italy, France, Marine protected area management, survey, climate change adaptation

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Population genetic structure and connectivity of the commercially important cephalopod *Octopus cyanea* Gray, 1849 in the Western Indian Ocean (WIO)

BY Benjamen Debora Mussa

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CO-PROMOTER: Quentin Jossart

Octopus forms an important fishery in Tanzania and Mozambique. Increasing international market demand rises the exploitation level, threatening the sustainability of the fishery. This study investigated (1) genetic diversity, (2) genetic structure and connectivity of *Octopus cyanea* populations in the Western Indian Ocean (WIO). A part of the cytochrome C oxidase subunit 1 (COI) gene was sequenced from 181 octopus individuals originated from Tanzania (Tanga, Dar es Salaam, north Pemba, Kilwa and Mtwara) and Mozambique (Ibo, Angoche, Vilanculos and Maputo). Additional sequences were retrieved from GenBank, increasing the data set to 410 sequences. All 181 samples (563 bp) collected were identified using DNA barcoding and they all belonged to *Octopus cyanea*. A total of 30 haplotypes were found in the 410 sequences and were used in genetic population structure analyses. AMOVA revealed small but significant genetic population structure among all sites ($\phi_{ST} = 0.071$, $p < 0.001$). The null hypothesis of panmixia was also rejected when samples were grouped based on the WIO biogeographical regions described by Obura, (2012): (1) Northern Mozambique channel (2) Kenya and Tanzania coast (3) West Madagascar coast and Southern Mozambique channel, and (4) East & Southwest Madagascar ($\phi_{CT} = 0.052$, $p < 0.01$). Significant differentiation was also detected among (a) Kanamai (Ka), (b) Pemba (Pe), (c) southern Kenya, Tanzania mainland, North and East Madagascar (Sh, Tn, Da, Kl, Mt, Ra, No, Ta, Sm), (d) West Madagascar (Mo, An, Sa, Ma), (e) Southwest Madagascar (Be, Bb), (f) North Mozambique (Ib, Ag), (g) South Mozambique (VI, Mp) ($\phi_{CT} = 0.068$, $p < 0.01$). Our results suggest seven management units to be considered in the management of *O. cyanea* in the WIO region.

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A historical analysis of macrobenthos from the Flemish banks region: did the community structure and seasonal dynamics change during the Anthropocene?

BY Broos Sarah

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CO-PROMOTER: Carl Van Colen

Marine ecosystem services are of great economic importance and human pressures on the marine environment can affect the functioning of these systems. Macrobenthic communities are ideal for studying the status of the marine environment because they are long-lived and have low mobility. Moreover, they play a key role in the marine energy and nutrient cycles. To understand the effect of human pressures, a good knowledge of the natural variability of the community is needed, but since there are currently no systems without human influences, this natural variability can only be studied using long-term data. Historical data is an important part of long-term data but because it is often not digitally accessible, it is regularly overlooked in long-term studies. Therefore, this study aimed to reconstruct the macrobenthic community composition and seasonal dynamics of *Nephtys* spp., *Abra* spp. and *Spisula* spp. along the west coast of the Belgian part of the North Sea in the 1970s and compare these with the current community structure and seasonal dynamics. To achieve this, macrobenthos data from "Projet Mer/Projekt Zee" (PMPZ) conducted in 1970-1975 available from notebooks was digitized. Further, a monthly series of unprocessed samples from this project was analyzed in the laboratory. The community in the 1970s was dominated by genera *Nephtys* spp., *Kurtiella* spp. and *Abra* spp.. A comparison with available data from a monitoring campaign conducted by ILVO in 2016 revealed that species composition, species richness, diversity indices, and density have changed from the 1970s to the present. The most dominant genus in the 1970s was *Nephtys* spp. while in 2016 *Oligochaeta* dominates the composition. Furthermore, in 2016 the density, species richness, Shannon diversity index, and Simpson's diversity index were significantly higher. The observed differences may be explained by sediment refinement but given the low spatial coverage in the 1970s compared to that of 2016, this refinement may be due to a spatial bias. Nevertheless, a shift in the macrobenthic communities can be observed, as communities with similar mud content from both periods are not clustered together. A comparison with available data from the Ph.D. of Gert Van Hoey conducted in 2002/2003 revealed that the seasonal dynamics also have changed from the 1970s to the present. *Abra* spp. and *Nephtys* spp. did not have seasonal dynamics in 1970/1971 but did in 2002/2003. For *Abra* spp. this may be due to spatial bias whereby the station in 2002/2003 has finer sediment which may favor the settlement of recruits. For *Nephtys* spp., the difference is possibly caused by a milder winter in 2002, which stimulates *Nephtys* spp. reproduction. For *Spisula* spp., no seasonal dynamics were observed in 2002/2003, but it was observed in 1970/1971. The absence of seasonal dynamics in 2002/2003 may have been due to predation and/or unsuccessful settlement, but as this could not be demonstrated in this study, this remains a hypothesis. In general, this study showed that old data can still be relevant for contemporary research and provide new insights into a well-studied area. Therefore, there is a great need to digitize the remaining data from the PMPZ project. Moreover, there is a need for models that reconstruct early environmental variables to place the historical data in a broader context.

Keywords: soft sediment macrobenthos, communities, seasonal dynamics, North Sea, historical data

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Change in North Sea meiobenthic communities: reconciling the role of broadscale climate phenomena versus local drivers

BY Decorte Ines

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CO-PROMOTER: Carl Van Colen

The widespread and local impacts of human activities on marine environments are being studied all over the world in recent decades, as well as in the Belgian Part of the North Sea (BPNS). Changes are observed in natural environments and in the ecosystem services they provide due to these impacts. The benthos are essential in the functioning of marine ecosystems via their roles in energy transfer and nutrient cycling. Yet, research of these impacts on one benthic group is lacking, namely on the meiobenthos inhabiting the sea floor environments. The inclusion of meiobenthos as an indicator of anthropogenic impacts could provide a more solid understanding of the drivers of change in benthic communities in the North Sea, thereby assisting the management of coastal ecosystems. This study identifies whether the variability of meiobenthic communities during 2002-2012 in the Belgian part of the North Sea is related to climatic oscillations and/or local drivers (e.g. sediment granulometry, turbidity, chlorophyll a concentration). Both broad-scale climate variability and local habitat change are found to be of importance in explaining some of the temporal variations found in various meiobenthic parameters in both stations. This study highlights the need for further studies on the temporal variation of meiobenthos and its relation to broad-scale and local influences to investigate long-term patterns.

Keywords: meiofauna, time series, climate change, anthropogenic pressure, soft-sediment benthic Invertebrates

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Connectivity of *Tridacna maxima*: a genetic approach using microsatellites

BY De Pauw Axel

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CO-PROMOTER: Quentin Jossaert

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Assessment of climate change impact on flood risk in the upper Citarum basin, Indonesia

BY Durahman Arfah

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CO-PROMOTER: Ann Van Griensven and Jan Cools

The upper Citarum basin has experienced devastating flood events multiple times. Coupled with land-use change, excessive groundwater withdrawals, and non-sustainable land management practices, climate change is suspected to drive high frequency and intensity of the floodings. To assess the notion, this study simulated the effects of climate change on future discharges in the upstream Citarum, West Java Province, Indonesia, by using the Soil and Water Assessment Tool Plus (SWAT+), a semi-distributed hydrological model. A global spatial data from various sources was selected to set up the SWAT+ model, and five global forcing models of the simulation round ISIMIP3b were extracted to obtain projected climate dataset under historical, SSP1-RCP2.6 and SSP5-RCP8.5 climate scenarios. Out of the climate models, GFDL-ESM4 was found to be the most reasonable product in simulating precipitation and discharges over the historical period 1985-2014. In conjunction with the climate model, the SWAT+ model simulated discharges over the future period 2021-2050 under SSP1-RCP2.6 and SSP5-RCP8.5. The statistical trend analyses showed that the monthly mean discharge tends to decrease under the sustainable pathway ($z = -2.210$; $p\text{-value} = 0.027$) and to increase under the fossil-fueled pathway ($z = 1.298$; $p\text{-value} = 0.019$). The results indicate that flood risk would change corresponding to the climate narratives. Therefore, GFDL-ESM4 could be considered as a selected global model to produce regional climate models for Indonesia, and these scientific efforts subsequently helps stakeholders in reducing flood vulnerabilities and managing flood protection in the upper Citarum basin.

The community structure of macrozoobenthos at the Northernmost part of the Antarctic Peninsula (South Shetland Islands and Trinity Peninsula)

BY Engelbrecht Jacobus

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

The widespread and local impacts of human activities on marine environments are being studied all over the world in recent decades, as well as in the Belgian Part of the North Sea (BPNS). Changes are observed in natural environments and in the ecosystem services they provide due to these impacts. The benthos are essential in the functioning of marine ecosystems via their roles in energy transfer and nutrient cycling. Yet, research of these impacts on one benthic group is lacking, namely on the meiobenthos inhabiting the sea floor environments. The inclusion of meiobenthos as an indicator of anthropogenic impacts could provide a more solid understanding of the drivers of change in benthic communities in the North Sea, thereby assisting the management of coastal ecosystems. This study identifies whether the variability of meiobenthic communities during 2002-2012 in the Belgian part of the North Sea is related to climatic oscillations and/or local drivers (e.g. sediment granulometry, turbidity, chlorophyll a concentration). Both broad-scale climate variability and local habitat change are found to be of importance in explaining some of the temporal variations found in various meiobenthic parameters in both stations. This study highlights the need for further studies on the temporal variation of meiobenthos and its relation to broad-scale and local influences to investigate long-term patterns.

Keywords: meiofauna, time series, climate change, anthropogenic pressure, soft-sediment benthic invertebrates

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The effect of fringing mangroves on tidal wave propagation through a multi-branched river delta: a model analysis

BY Espinoza Celi Maria Esther

PROMOTER: Stijn Temmerman (Universiteit Antwerp)

CO-PROMOTER: Ignace Pelckmans

Low-lying coastal areas are under increasing flood risk due to sea-level rise by climate change and El Niño events. Mangrove forests are generally recognized to act as natural coastal barriers against wind waves, tsunamis, and storm surges. However, there is less knowledge on the capacity of mangroves to attenuate tides or reduce high-tide levels, especially under extreme sea-level rise caused by El Niño events at tropical deltas. Numerical modelling is a useful approach to improve our understanding of long-period wave propagation at mangrove estuaries, such as tides. Models have been commonly applied to study mangroves capacity to attenuate other types of long-period waves, such as storm surges and tsunamis. However, at tropical estuarine areas, observed data for modelling studies is usually scarce or absent. Under this important limitation, there is not enough knowledge on how sensitive hydrodynamic modelling results of tidal propagation are to data assumptions or simplifications of reality. In this context, this study applied a numerical modelling approach at the Churute mangrove area located in the Guayas River estuary in Ecuador to simulate tidal propagation through a mangrove forest. We evaluated model sensitivity to changes in wetland characteristics or properties, such as channel bathymetry, mangrove topography, friction exerted by mangroves and channels on the flow, and a temporal increase of incoming water levels due to an El Niño event. Additionally, using our model, we identified which wetland properties have a greater impact on tidal attenuation rates. We considered two components of tidal attenuation, along-estuary attenuation of tides as they propagate upstream along the channels and within-mangrove attenuation of tides propagating into the vegetation. Results revealed that attenuation within the mangroves was outstandingly larger $\approx 60 \text{ cm/km}^h$ than attenuation along the channels $\approx 1 \text{ cm/km}^h$. Tidal propagation and attenuation at the Churute estuary might be primarily affected by changes in mangrove platform elevation, flow resistance exerted by the mangroves on the tidal flow, and temporary incoming high-tide levels during an El Niño event. Channel bathymetry and the friction exerted by the channels on tidal flow also impact tidal propagation and attenuation rates, yet to a minor extent. Thus, more elevated and denser mangrove forests might be more efficient in attenuating tidal floods for areas behind the mangroves. Moreover, Churute mangroves might lose their tidal attenuation capacity under more extreme El Niño SLR but we discuss common model limitations likely affecting this finding. This study provides a useful example for other researchers developing hydrodynamic models to research tidal propagation in estuarine regions where field data is limited or nonexistent, as in the Churute estuary. We find that mangrove properties should be prioritized over channel properties when studying tidal propagation along a mangrove wetland. The mangroves' efficiency on tidal attenuation evidenced in our study opens an opportunity to raise attention to consider mangroves in coastal management strategies using nature-based solutions.

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The school of hard knocks: is the survivability of trawled-and-discarded European plaice (*Pleuronectes Platessa*) affected by rocks in the catch?

BY Goley Joanna

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The newly reformed European Common Fisheries Policy introduced a discard ban, with an exemption of 'high likelihood of survival' species if it can be scientifically demonstrated. The commonly discarded European plaice (*Pleuronectes platessa*) being one of these species. To boost the survival of discarded plaice, the Belgian government necessitated beam-trawl vessels (> 221 kW) to fish with a flip-up rope that excludes large stones (> 25 cm in diameter) and unwanted debris from the catch. During eight commercial beam-trawl trips on five Belgian beam trawlers between 2019 and 2020, the efficacy of the flip-up rope was assessed as well as catch composition. Two scientific observers monitored 197 deployments and assessed vitality, reflexes, injury, and on-board survival of 3195 plaice and recorded post-release survival among a sub-sample (n = 268 plaice). On-board survival was negatively related to the total catch weight and the weight of stones, both in interaction with wave height and to a lesser degree with the proportion of injury-inducing elements among the unwanted catch fraction (i.e., 10 - 20 kg sample of discards). One detailed catch comparison was conducted in December 2020, with the backboard side equipped with a flipup rope and the other without. The use of the flip-up rope slightly improved survival: 51 % vs 44 % of plaice survived 26 days after being discarded from the catch caught with vs without a flip-up rope, respectively, but this effect was not significant.

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Survival variability of commercially trawled-and-discarded European plaice (*Pleuronectes platessa*)

BY Kibor Sammy

PROMOTER: Gudrum De Boeck (Universiteit Antwerp)

CO-PROMOTER: Abbas Alloul and April Grace Rojo Opinion

Ornamental fish value increases with the intensity of the skin color, which is an important quality criterion. Fish cannot synthesize their own carotenoids and are therefore dependent on external supplementation. In the present study, effects of dietary inclusion of *Rhodobacter capsulatus* and *Rhodospseudomonas palustris* at a rate of 5g Purple non-Sulfur Bacteria (PNSB)_{protein} 100g⁻¹feed_{protein} on skin color, standard growth rate, feed conversion ratio and physiological fitness in guppy (*Poecilia reticulata*) was assessed. The results were compared with a commercial feed (control), and inclusion of astaxanthin or algae (*Chlorella pyrenoidosa*). Fish fed on PNSB diets showed higher absolute specific growth rate (SGR) values compared to those fed on the commercial feed. In terms of the feed conversion ratio (FCR), *Ch. pyrenoidosa*, *Rps. palustris* and *Rb. capsulatus* showed better absolute FCR values (1.8 ± 0.1 , 1.9 ± 0.2 , 1.9 ± 0.2 g feed g⁻¹ fish biomass respectively) compared to the control (2.3 ± 0.2 g feed g⁻¹ fish biomass). Statistically however, all candidates exposed to the different treatments displayed similar performance in terms of SGR, FCR, wet body mass gain, swimming speed (U_{crit}), aerobic scope (AS), standard metabolic rate (SMR), maximum metabolic rate (MMR) and skin pigment intensity ($P > 0.05$). There was neither mortality nor adverse behavior observed during the whole 8 weeks course of the experiment, with similar performance for all experimental diets and the control feed ($P > 0.05$). Linear mixed model analysis shows no significant random effects of tanks and respirometers on SMR, MMR, AS and U_{crit} .

From the study, inclusion of *Rb. capsulatus* and *Rps. palustris* at 5g PNSB_{protein} 100g⁻¹ feed_{protein} in the diet for guppy had similar effect on the skin coloration, growth, feed conversion, weight gain and physiological performance with the control feed which is proxy of what is used in the field. Therefore, for environmentally friendly aquafeed production, PNSB shows to be a promising alternative source of ingredients in ornamental fish feed.

Study of the effect the rapid changes in temperature have on the impairment of *Pleuronectes platessa* during hauling onboard the fishing vessel and discarding back to the sea

BY Konstantinos Theodoridis

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

CO-PROMOTER: Sven Sebastian Uhlmann

Under the “high survival” exemption of the European landing obligation or discard ban, monitoring vitality and survival of flatfish such as European plaice (*Pleuronectes platessa*) becomes relevant to a discard-intensive beam trawl fishery. For Belgian fisheries, previous research addressed the impact of gear deployment duration, and air exposure on vitality and mortality of plaice and also indicated the relevance of temperature changes to fish when being trawled through the water column, exposed to air on deck, and being re-submerged under water (Uhlmann et al., 2016). Similarly to van Beek et al. (1990), Uhlmann et al. (2016) repeatedly observed higher survival at cooler days in winter compared with trips in summer onboard the Eurocutter vessels. It is unclear, however, whether higher temperature per se or thermoclines during the hauling process cumulatively stressed captured fish. The objective of this proposed study is to address temperature tolerance of trawl-caught plaice and determine the effect of temperature changes on survival probability.

The experiments took place on board RV Simon Stevin (three trips) and the monitoring in land based facilities at a research laboratory in Ostend. The sampling was performed by the research vessel with a beam trawler. After every trawl twenty individuals of different sizes (mainly undersized between 10 and 25cm in total length), were collected randomly. Then, they were divided into four batches of five and every batch underwent a different treatment. The treatments consisted of air exposure and then recovery in water. The temperature of both mediums was controlled. For the air treatment, it was kept about 5 degrees colder or 5 degrees warmer than the water ambient temperature and the water was either ambient water or water cooled down by 10 degrees. Sixty individuals were collected per trip and their vitality was quantified and scored based on a reflex impairment index similar to what was proposed in Uhlmann’s et al. (2016). Once treated the fish were kept onboard in tanks. Afterwards, the fish were then transported to the laboratory. The fish were retained in tanks for a week for monitoring, where seawater was regulated through a circulatory system.

The results didn’t prove the initial hypothesis true, though further studies are needed for a more definitive result. On the side, several factors for the outcome were considered such as the length of the fish, air exposure time and trawl duration. Not taking into consideration factors such as the condition of the fish and lack of biochemical data may have steered the results a bit off. So more thorough and extensive research is needed for a more solid outcome.

Marine distribution of olive ridley turtles (*Lepidochelys olivacea*) along the Pacific Coast of Nicaragua outside the breeding season

BY Mertens Géraldine

PROMOTER: Marc Kochzius (Vrije Universiteit Brussel)

CO-PROMOTER: Joëlle De Weerd

Olive Ridley turtles (*Lepidochelys olivacea*) are classified as vulnerable on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species (Abreu-Grobois, 2008) and are known to migrate between breeding and foraging sites (Da Villa, 2011). Most research studies and conservation efforts focus on nesting beaches, but coastal distribution and habitat use patterns have been poorly investigated (Peavey, 2017). It is unclear where olive ridley turtles exactly occur and how their distribution overlaps with anthropogenic activities, especially with fisheries. Nicaragua is a known breeding area for olive ridley turtles, but little is known on their ecology and marine distribution. This study aims to identify hotspots outside the breeding season and critical habitats to ensure effective and successful management plans for the recovery of Olive Ridley turtles. To reach this objective, sightings of turtles were collected on boat-based surveys initially planned for cetacean research expeditions along the Pacific coast of Nicaragua. The study was conducted in the southwestern part of the coast, in San Juan Del Sur that is facing coastal anthropogenic pressure such as fisheries and unregulated ecotourism. Research expeditions took place between January and April from 2016 until 2021 (except 2019) which are outside breeding season. Whenever a turtle species was encountered, the number of individuals, their behaviour (Surfacing, Mating or dead), gender, time, date and geographic position were gathered. The presence of any type of boats was assessed every thirty minutes during survey efforts. The Kernel Density Estimation algorithm of QGIS 3.16.4 (QGIS Development Team, 2002-2019) allowed to generate maps of marine hotspots of olive ridley turtles and fishing activities to investigate potential overlaps. We also analysed the influence of three environmental parameters (chlorophyll a, sea surface temperature and bathymetry) on this species' distribution by retrieving the data from satellites and performing multivariate analyses. This study identified one hotspot inside La Flor Wildlife Refuge, close to the beach La Flor that is known for hosting mass-nesting events (arribada) of olive ridley turtles. This research also suggested that the chlorophyll a concentration (0.0 to 5.0 mg/m³), bathymetry (50 to 99 m depth) and sea surface temperature (25.0 to 28.0 °C) significantly influenced the olive ridley turtles distribution. Several overlaps between fishing activities and olive ridley turtles highly used areas were identified. Increasing knowledge of turtle distribution will help increase conservation measures in the future. This research gave a first insight on the marine distribution of the species, which will give important information for decision-makers to reconsider the management of their marine protected areas and the conservation enforcement needed in the area to preserve olive ridley turtles.

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Towards a sustainable use of marine resources in Galapagos: linking local seafood consumption to their nutritional contribution and ecology in COVID-19 context

BY Mino Arias Cristina Aracely

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CO-PROMOTER: Carl Lachat and Jorge Ramirez

Fish and seafood are a pivotal supply of essential fatty acids (FA) for the human diet. They are fundamental for global food security, especially for coastal communities. However, seafood uses in relation to their nutritional value and sustainability have not been analysed before in the Galapagos Islands. Hence, this study aims to expand the understanding of the seafood consumption patterns in the scenario of the COVID-19 pandemic and to expand the knowledge of sustainability of seafood consumption linked to their nutritional composition in terms of FA. Data on seafood consumption were collected from 258 interviews during the period of COVID-19 measures in the Islands to determine the consumption patterns. Additionally, fish tissue samples were collected to assess the content of FA and a sustainability assessment was performed based on literature and expert's validation. Fish was considered fundamental for food security in the archipelago. No significant changes in the consumption patterns were reported during the pandemic. Furthermore, from 9 species that were analysed, we concluded that *Seriolella violacea* has the potential to contribute to sustainable seafood consumption. On the contrary, *Xiphias gladius* should be avoided due to nutritional and environmental implications. This study provides new insights in the context of sustainability of the Galapagos Islands from the perspective of seafood consumption.

Keywords: seafood consumption; sustainable seafood; fatty acids; food security; Galapagos fisheries

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Time weighted average concentrations measured with Diffusive Gradients in Thin films (DGTs) for uranium in response to simulated pollution events

BY Pienaar Zahné

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This thesis aims to investigate the use of a passive sampling technique, Diffusive Gradients in Thin films (DGTs), to measure the time-weighted average of uranium in water from the Gaffière river, at the Orano Tricastin processing plant. In this way the feasibility of the DGT technique as an environmental monitoring tool for Tricastin could be explored.

An in-depth laboratory investigation was carried out using the Diphonix resin gel. The influence of various deployment times, water composition and simulated pollution events on the quantitative uranium accumulation by the DGT was investigated. Experiments were carried out under laboratory conditions, mainly on the surface water from the Tricastin site. Nevertheless, for better understanding of the influence of the water composition on the uranium speciation and therefore the performance of the DGT technique, two experiments were carried out with either a simple solution of 0.01 M NaNO₃ or filtered tap water diluted with Milli-Q water as deployment solutions.

The water at the Tricastin site has a high calcium and carbonate content which has a significant influence on the uranium speciation. Thus, a combination of parameters was investigated during the laboratory experiments. In the Tricastin water the DGTs which were deployed for shorter time periods (1.5h) accumulated uranium in accordance with the theoretical values that were calculated using the simple DGT formula. The uptake efficiency was $70 \pm 19\%$ in this case. The DGTs deployed for longer periods (~7 days) accumulated up to $89 \pm 4\%$ of expected values and DGTs analysed at intermediate phases accumulated from $40 \pm 14\%$ to $97 \pm 9\%$. The DGT variants deployed in the simple solution and tap water had uranium uptake efficiencies ranging from $24 \pm 4\%$ to $96 \pm 20\%$, and $45 \pm 3\%$ to $99 \pm 3\%$.

Experiments evaluating the response of DGTs to the accidental spills (Ass) that may potentially occur on the Tricastin site shows that, DGTs deployed in a matrix resembling the composition of treatment baths of the raw material and processing effluent water of the conversion reactor (From the Orano uranium processing site, Tricastin) had uranium uptake efficiencies ranging from $61 \pm 3\%$ to $89 \pm 6\%$ and $85 \pm 13\%$ to $90 \pm 4\%$. The uptake of U was not disrupted by the U species distribution and the DGT was able to measure U with varying pH and matrix.

The combination of parameters evaluated during laboratory experiments makes it possible to better understand the usefulness and applicability of the DGT technique as an environmental monitoring tool for the uranium processing site, Orano Tricastin.

Very-high resolution ro-orne multibeam mapping of dynamic seabed features over a contourite drift, offshore Ireland

BY Shymbaliova Nadzeya

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Bottom currents are responsible for the creation of large-scale contourite drifts, characterized by a wide range of smaller-scale erosional and depositional bedforms. The Belgica Mound Province (BMP) located on the eastern slope of the Porcupine Seabight (PSB), SW of Ireland is known for its complex oceanographic processes and associated deep water habitats, such as cold-water coral mounds, embedded in contourite drift deposits. The hydrodynamic environment in the BMP is characterized by the presence of intensified bottom currents varying in temporal and spatial scales. In order to better understand the local temporal and spatial bottom currents characteristics, the sedimentary features (type, dimensions, and orientation) and seafloor composition (estimated grain size) were analyzed and mapped along the moat of the contourite drift in BMP based on the very-high-resolution (VHR) bathymetry and high-definition (HD) video data. Dominant bottom current flow velocities and directions were subsequently inferred from the bedform morphologies, distribution and lithological characteristics. This allowed analyzing the main sedimentary processes dominated in the area. Four different bedform types were identified: (1) sinuous ripples; (2) linguoid ripples; (3) degraded ripples with gravelly pavements; (4) obstacles with gravel tails. Moreover, larger-scale erosive features – sediment escarpments - were encountered along the transect. A range of flow velocities between <20 to 70 cm s⁻¹ was inferred based on the bedform morphology and distribution. This enhancement of bottom currents is believed to occur due to the interactions between the generally northward-flowing water masses and internal tides in a presence of complex seabed topography. The deflection of the currents by topographical irregularities such as coral mounds appears to induce variable flow patterns in a moat and thus is responsible for active remobilization of sediments, reflected in complex bedforms pattern. This is the first study that allows a detailed view on sedimentary bedforms and related depositional and erosional features over the studying drift moat at such a small scale (centimeters to meters).

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A comparative study of the morphometry and life history of three commercially exploited skate species, *Raja brachyura*, *R. clavata* and *R. montagui* in the Southern North Sea and Eastern English Channel

BY Thys Kelly

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Skate life-history and morphological traits make them particularly vulnerable to exploitation. Northeast Atlantic skate fisheries management lacks species-specific measures due to data limitation, and species-specific reporting is often inaccurate. Given these caveats in current management, detailed information on commercially relevant skate stocks at species level is warranted.

The morphometry and life-history parameters of 154 individuals (56 *Raja brachyura*, 78 *R. clavata*, and 20 *R. montagui*) were determined from samples of commercial fisheries, and a scientific survey between November 2020 and March 2021. Whole individuals were measured for various morphometric parameters, weighed, and dissected, allowing derivation of morphometric conversion ratios, and length weight relationships. Measurements and weights of reproductive structures were taken. Based on the morphology of the reproductive system, macroscopic maturity was determined, and the relationship between body size and sexual development was ascertained. Age was assessed by visual inspection of enhanced vertebral centra, allowing derivation of von Bertalanffy growth parameters.

Morphometric measurements differed among species, and sexual dimorphism was observed in *R. clavata* disc widths. Morphometric ratios were successful in species classification of landing-sized skates (88%). Length-weight relationships indicated greater growth rates in females. The maximum estimated age was 14 years for *R. brachyura*. Length-at-age data differed significantly among the focal species, and between sexes for *R. clavata*. Von Bertalanffy growth parameters ranged between $K = 0.0743$ ($L_{\infty} = 1105$ and $t_0 = -3.9597$) for large-sized male *R. brachyura* and $K = 0.1734$ ($L_{\infty} = 780$ and $t_0 = -1.6244$) for smaller-sized and faster growing male *R. montagui*. Macroscopic maturity assessment revealed that male *R. montagui* matured at the smallest size ($L_{50} = 532$ mm) and earliest age ($A_{50} = 5.5$ years) while female *R. brachyura* matured at the largest size ($L_{50} = 849$ mm) and latest age ($A_{50} = 12$ years). Length-at-maturity and age-at-maturity differed between species. An abrupt increase in gonad weight, and clasper length was associated with the onset of maturity, in each species. Gonadosomatic index and hepatosomatic index differed among species, and between mature and immature individuals.

Morphometric ratios were proven to provide an accurate tool for identification of easily confusable species of skate. Interspecific differences in the morphometry and life history traits highlight the need for species-specific management of commercially relevant skate stocks in the Northeast Atlantic Region.

Keywords: Rajidae, K-selected, morphometry, life history, fisheries management

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Habitat suitability of the red squat lobster (*Pleuroncodes monodon*) in the Northern Humboldt Current System

BY Valderrama Noelia

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The Northern Humboldt Current System (NHCS) is well-known for being the most productive Eastern Boundary Upwelling System in terms of secondary production, mainly associated with small pelagic fish. Since the mid of 1990s, the red squat lobster (*Pleuroncodes monodon*; henceforth RSL) steeply increased its biomass and became the species with the second-highest biomass in the pelagic community after Peruvian anchovy (*Engraulis ringens*). Due to its high abundance RSL plays a key ecological role as prey for multiple species. In this work we explore the spatial and temporal distribution and the main drivers of RSL in the NHCS using data collected from acoustic scientific surveys (2001-2019) during austral summer and spring seasons. Environmental (temperature, salinity, thermal fronts and chlorophyll-a) and geographic covariates (distance to coast and bathymetry) were proposed as the predictors of the probability of presence of RSL. A generalized linear mixed model including space and time as random effects under a Bayesian approach show that distance to the coast, surface temperature and salinity play a significant role in the horizontal structure of RSL habitat. In addition to the fixed covariates, other mesoscale processes in the order of ~70 km could also be important for the distribution of RSL. Lower temporal autocorrelations suggests that the distribution of RSL does not exhibit temporal dependence but varies from year to year. A more accurate prediction of RSL habitat could improve RSL management but also the management of other species preying and competing with RSL.

Keywords: distribution modelling, *Pleuroncodes monodon*, Northern Humboldt Current System, SPDE, INLA

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Saltmarshes vs. mangroves: A comparative study of the geometric properties of their tidal channel networks

BY Van Wouwe Tom

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Saltmarshes and mangroves provide a wide range of invaluable ecosystem services, but are threatened by increasing rates of sea level rise and decreasing sediment supply. These coastal wetlands are characterized by the presence of tidal channel networks, which play a crucial role for their resilience by conveying water, sediments, and nutrients between the sea and the vegetated platforms. Vegetation affects tidal channel network geomorphology and thereby wetland ecosystem functioning. However, how much this differs among differently vegetated systems (in this case, saltmarsh grass vs. mangrove tree species) and how much of this difference can be attributed to vegetation is not yet well understood. To address this, tidal channel network characteristics (i.e. upstream mainstream length, channel width, watershed area, unchanneled flow length) are analyzed for four saltmarsh and four mangrove study sites from 5 different continents, using high resolution spectral satellite imagery. Both manual and automated channel extraction methods were applied and revealed to lead to significantly different results. Based on the manual extraction method, upstream mainstream length was determined to be higher in saltmarshes than mangroves for similar watershed areas. Channel width for similar watershed areas was not found to be different. Unchanneled flow length was also found to be lower for saltmarshes than for mangroves. These results indicate that saltmarsh channel networks are more dense and therefore more efficient at transporting sediment throughout the wetland. Thus, this study suggests that saltmarshes are more resilient to increasing rates of sea level rise than mangroves.

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European seabass (*Dicentrarchus Labrax*) habitat suitability in the northeast Atlantic

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The European Seabass (*Dicentrarchus labrax*) is an important species for the European commercial and recreational fisheries. Despite its relevance, no scientific fisheries survey in the Northeast Atlantic (NEA) specifically targets this species, leaving current knowledge of the species' ecology, distribution, and spatiotemporal heterogeneity, insufficient and relying on seabass occasionally caught during scientific bottom trawl surveys and commercial fisheries data. Furthermore, the identification of abiotic key factors which together enhance the suitability of an habitat, is crucial in understanding and to predict seabass distribution for its management. This thesis used Generalized Additive Models to, investigate the relationship between the probability of seabass presence, from catch per unit of effort (CPUE) data extracted from the Database of Trawls Surveys (DATRAS), bottom trawl fisheries landings data from the Fisheries Dependent Information (FDI) database for the NEA and abiotic factors (bottom temperature, salinity, primary production, distance to the coast and bathymetry). Sea surface temperature and primary production were key in the spatiotemporal distribution of seabass, being significant in all models developed and increasing seabass probability of occurrence and landings between 10 and 24°C and between 0.5 and 3 mg/m³ Chl. Seabass were less likely to be caught in bottom trawls scientific hauls and with lower fisheries landings at a distance higher than 300-400m from the coast and in water with depths higher than 250 m. Salinity and bottom temperature were less important factors in explaining seabass movements in the NEA. In accordance with the results of tagging studies, seabass was predicted to migrate southward from the North Sea towards the English Channel, Irish Sea, Celtic Sea and Bay of Biscay during the autumn and winter months, as temperatures drop under 9°C in the North Sea. The highly productive coastal waters in the EU and UK favor seabass presence and landings in the North Sea during spring and summer. The resolution of the explanatory and response variables used in thesis, limited the detail on which conclusions and recommendations could be establish from it, highlighting the need of targeted survey data for better and finer predictions. Nonetheless this methodology provides cost effective tools to analyse the link between seabass distribution and abiotic factors and predict its spatiotemporal variability, which can be used as a tool for conservation and management of the species, when seabass targeted data is not available. For instance, such models will result in a cost effective tool to predict the effect of climate change in seabass distribution and abundance and assess future management strategies.

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