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Oral presentations

O-1 – Uncovering the National Treasures of the Norwegian Environmental Specimen Bank

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Abstract: The Norwegian Environmental Specimen Bank (N-ESB) (www.miljoprovebanken.no) functions as a temporal repository, systematically preserving environmental samples from Norway and the Arctic. This extensive archive serves as a critical resource for elucidating the impacts of environmental contaminants on national and international scales. Samples are collected annually since 2012 in accordance with national sampling programs initiated by the Norwegian Environmental Agency. The primary objective is to establish longitudinal data series with selected species from healthy populations, ensuring the availability of appropriate materials for future studies on emerging contaminants, and for studies related to biological effects. Rigorous protocols are implemented to prevent cross-contamination throughout the entire process. Indoor air quality in lab is monitored annually for selected contaminants. Our sample categories include: 1) Marine and freshwater fish, 2) Blue mussels collected along the entire coastline, 3) Marine mammals, such as ringed seal and polar bears from Svalbard, 4) Terrestrial mammals, 5) Eggs from terrestrial and marine birds. In addition, atmospheric samples are collected from Svalbard and southern Norway, and sewage sludge from wastewater treatment plants. We welcome applications for sample withdrawals to support scientific research and proposals. A temporal and spatial overview of the material in the biobank will be presented, and the research potential of the archived material in the N-ESB will be communicated and discussed.

O-2 – EARLY DEVELOPMENTAL RESPONSES IN ATLANTIC COD (*GADUS MORHUA*) TO AZAMETHIPHOS AND IMIDACLOPRID: INVESTIGATING TEMPERATURE-DEPENDENT EFFECTS OF AQUACULTURE BATH TREATMENTS

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Abstract: Sea lice (*Lepeophtheirus salmonis*) infestations are one of the most pressing challenges in salmonid aquaculture, causing health issues in farmed fish and contributing to parasite transmission to wild salmonid populations. To mitigate these impacts, the industry widely uses bath treatments with chemotherapeutants, including azamethiphos, an organophosphate that inhibits acetylcholinesterase, and imidacloprid, a neonicotinoid insecticide targeting nicotinic acetylcholine receptors. While effective against sea lice, both compounds may pose risks to non-target marine organisms, particularly during early life stages when critical developmental processes are underway. This study investigates the potential impacts of azamethiphos and imidacloprid on early life stages of Atlantic cod (*Gadus morhua*), a species that spawns in coastal areas where aquaculture is prevalent. We conducted controlled 96-hours bath exposures at two different water temperatures. Key endpoints assessed include mortality, hatching success, morphological deformities, and heart performance. This experimental approach allows us to evaluate how delousing agents and temperature interact to affect early life-stage development in a non-target fish species. The findings will contribute to a more comprehensive understanding of the environmental risks associated with antiparasitic treatments in marine aquaculture and support more ecologically informed management practices.

Keywords: chemotherapeutants, developmental deformities, hatching, paralysis, risk assessment

O-3 – Presence of pharmaceuticals and personal care products discharged via a wastewater treatment plant in the marine environment, what's next.

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Abstract: Concerns about the environmental implications of pharmaceuticals and personal care products (PPCPs) have prompted the need for robust tools to assess their potential risks in aquatic environments. In this context, a combined approach was explored, incorporating a dose-related risk and effect assessment model to estimate predicted environmental concentrations and compare them with predicted no-effect concentrations, alongside in vitro whole effluent toxicity testing to characterise PPCP-related hazards.

Monitoring campaigns measured PPCPs in Norway at the influent and effluent stages of wastewater treatment. These data served to inform a fate model and evaluate removal efficiency. Of the 22 detected compounds, 12 showed removal rates exceeding 90%, although removal efficiency varied broadly (12% to 100%) and appeared independent of compound class or initial concentration. The risk contribution of each detected compound in treated effluent was quantified. Model simulations further yielded insights into the temporal and spatial dynamics of the effluent plume, offering valuable support for the planning of future environmental monitoring strategies.

Looking ahead, the development of more environmentally sustainable pharmaceuticals, particularly antibiotics, is crucial. One promising avenue is the design of photodegradable compounds that naturally break down under environmental conditions. This concept is illustrated through recent research on antimicrobials engineered for photodegradability.

Keywords: modeling, discharge, antibiotics, green pharmaceuticals

O-4 – Low level oil exposure alters development and behavior in a key forage fish

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Abstract: The lesser sandeel (*Ammodytes marinus*), a crucial North Sea forage fish, plays a vital role in marine food webs. Its life cycle includes a benthic juvenile and adult phase, and a pelagic larval stage, which makes it particularly sensitive to environmental stressors. We investigated the sublethal effects of crude oil exposure on early-stage sandeel larvae, assessing developmental morphology, cardiac function, pigmentation, lipid composition, and behavior. Larvae were exposed to low, real-world oil concentrations (15–150 µg THC/L) from 2 to 16 days post-hatch. Even at the lowest levels, significant developmental issues emerged including jaw deformities, disrupted heart rhythms, and silent ventricles. Fatty acid analysis revealed altered lipid distribution in the eyes and head, suggesting impaired delivery of essential nutrients, likely due to heart dysfunction. These physical impacts extended to behavior. Behavioral analyses showed that sandeel larvae are normally highly sensitive to light, but this sensitivity was significantly altered following oil exposure, pointing to visual system disruptions. Together, these findings show that even sublethal oil levels can harm critical systems during early development, threatening larvae survival. Considering the sandeel's ecological importance and recent population declines, the study highlights the urgent need for early life stage-specific environmental risk assessments and conservation strategies.

Keywords: Ammodytes marinus, light, larval exposure, abnormalities, risk assessment

O-5 – Mechanism of ocular toxicity of antidepressants in zebrafish

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Abstract: Global use of antidepressants is steadily increasing, with incomplete removal during wastewater treatment raising concerns about risks to aquatic ecosystems. Antidepressants act on the neuronal system by affecting neurotransmitter levels and have shown to cause behavioural effects in aquatic organisms. While behavioural effects are often attributed directly to altered neurotransmitter levels, there is a knowledge gap regarding whether effects on the visual system also contribute to these effects.

This work aims to assess adverse effects of antidepressants on the visual system of early life stage zebrafish and to determine the underlying mechanism. Embryos were exposed to sublethal concentrations of the tricyclic antidepressants amitriptyline (AMI) and nortriptyline (NOR) and the selective serotonin reuptake inhibitor sertraline (SER). Effects to visual function were assessed via the optokinetic response (OKR) assay, cellular structure of the eye via histology, and gene expression via mRNA sequencing and qPCR.

The OKR assay, which measures eye movements in reaction to an optical stimulus, showed significant effects for 4.99 and 234 µg/L of AMI and 20.7 µg/L of NOR (measured concentrations), with zebrafish embryos exhibiting 24%, 83% and 60% less eye saccades compared to the solvent control (0.01% DMSO) respectively. Histology revealed a significant increase in retinal pigment epithelium (RPE) thickness for both the 234 µg/L AMI (13.34 µm) and 20.7 µg/L NOR (13.29 µm) groups, compared to the solvent control (11.52 µm). Transcriptomics revealed significant effects to processes including synaptic signalling, neuron morphogenesis, and visual perception. Among the differentially expressed genes associated with visual perception, several genes involved in photoreception (opn1mw1, rho) and vision (arr3a, pde6c) were dysregulated.

OKR assay with SER showed a significant decrease in eye saccades compared to the control, 34% and 86% respectively, at 100 and 1000 µg/L (nominal). Histology revealed a significant decrease by 17% in RPE thickness for 1000 µg/L SER.

The results provide evidence that antidepressants can induce ocular toxicity in early life stage zebrafish on multiple levels of biological organization. While serotonin is implied to be involved in the mechanism, current experiments with the transgenic zebrafish line tg(tg:mCherry) focus on testing the hypothesis that thyroid disruption is the mechanism connecting altered serotonin levels to ocular toxicity.

O-6 – Integration of lines of evidence to facilitate prioritisation of plastic leachates for toxicity testing

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Abstract: Plastics and chemical leachates from plastics have recently been taken under scrutiny due to concern for environmental and human health. However, major data gaps remain for many plastics and chemicals released. The EU-PARC project "PlasticLeach" will determine the hazard of real-life plastic leachates using a combination of computational and experimental efforts.

To facilitate prioritization of plastics and plastic chemicals for *in vitro* toxicity testing, we propose an approach for integrated consideration of several aspects contributing to concern for a given type of plastic. Relevant aspects include production volumes of plastic chemicals known to be contained in a given type of plastic, known uses which may indicate increased potential for human or environmental exposure, as well as knowledge about the leaching behaviour, persistence, bioaccumulation, mobility, toxicity (PBMT) and mechanisms of action of the chemicals. We highlight how existing data from sources like the PlastChem database, ToxCast, ECOTOX and NORMAN can be used for leachate hazard prediction, prediction of primary mechanisms of action of leachates, and prioritisation of plastics for leachate toxicity testing *in vitro*.

Keywords: hazard assessment, computational toxicology, emerging contaminants, one health

Acknowledgements: This work was supported by the Research Council of Norway project EXPECT (RCN-315969), EU-HEU project PARC (#101057014) and NIVA's Computational Toxicology Program, NCTP (RCN- 342628).

O-7 – Analyzing the impacts of aquaculture farms on benthic scavenging amphipods in Northern Norway

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Abstract: Aquaculture is a divisive issue in Norway. Many are concerned about the environmental impact of salmon farms and potential negative effects on local ecological communities. Sea lice drugs, net pen antifoulants, plastic wear and contaminants in the feed are all potential sources to pollution near salmon farms. To understand the impact of the salmon lice drug emamectin benzoate (EMB) released from aquaculture farms on the local benthic community, two farms were sampled for scavenging amphipods and sediment, one treated farm and one untreated. Following a 7-day pesticide treatment, collected amphipods were assessed for EMB concentrations.

Alongside that, exposure experiments with EMB were performed in the lab on two species of scavenging amphipods common in the Northern Norwegian fjords to determine 7-day LC50 concentrations. Surviving amphipods were tested for behavioral impacts and neurotoxicity at increased concentrations, and for oxidative stress. Estimated LC50 values of 210 nM for *T. cicada*, and 10 nM for *O. obtusa* were established and decreases in movement (velocity and mobility) as well as decreased respiration rates were established. Overall, the impact of aquaculture farms is widely distributed, but the changes in sublethal endpoints are only seen at relatively high concentrations.

Keywords: ecotoxicology, sediment, amphipods, emamectin benzoate, SLICETM

O-8 – Tracking chemicals from aquaculture feed pellets to sediments using non-target screening

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Abstract: Aquaculture is often blamed for polluting the marine environment. The pollution may affect the fish in the pens but also the surrounding environment depending on water currents and sedimentation rates. This study has examined the fish feed, fish tissue (Norwegian quality cut) and faeces, as well as sediments at two fish farms on the Trøndelag coast. Identification and semi-quantitative analyses of these sample matrices is a valuable addition to the environmental assessment of fish farm operation as well as the environmental pollution profile. Identification and quantification of accumulated contaminants can help to document the pollution source and inform strategies for environmental protection.

A second analysis stream following a non-target screening approach employed GC×GC-qToF-MS for analysis and library searched for tentative and suspect identity matching. The toxicity of the tentative suspect pollutants, whether known or unknown, is then assessed by an in-house script facilitating automated searched against toxicity databases.

Keywords: Multiresidue analysis, GCxGC-MS, Automated toxicity search

O-9 – Developmental effects and endocrine disrupting potential of *in ovo* exposure to per- and polyfluoroalkyl substances (PFASs) in mallard ducklings (*Anas platyrhynchos*)

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Abstract: Waterbird populations are declining globally. Environmental contaminants and endocrine disrupting chemicals, such as per- and polyfluoroalkyl substances (PFAS), are potential contributors to these declines. PFASs have been linked to multiple adverse health effects in wildlife species, yet the specific modes of toxicity in avian species remain uncertain and establishing clear links between exposure and toxicity is complicated by factors such as co-contaminants, environmental conditions and biological variables.

This study experimentally investigated the developmental toxicity and endocrine disrupting potential of two unregulated PFAS, Perfluoro-4-ethylcyclohexanesulfonic acid (PFECHS) and Perfluorododecanesulfonic acid (PFDoDS), alongside the regulated Perfluorooctanesulfonic acid (PFOS), using the mallard duck (*Anas platyrhynchos*) as a model organism. Farmed mallard eggs were exposed to PFAS via *in ovo* injections at environmentally relevant doses. A lower hatching success was observed in eggs exposed to PFECHS and PFDoDS compared to controls and PFOS exposed eggs. Changes in plasma levels of corticosterone, 11-deoxycorticosterone and progesterone levels were found, with significant differences in corticosterone levels between the PFAS-exposed groups. These findings highlight the potential of PFAS for developmental effects and endocrine disruption, particularly among unregulated PFAS, emphasizing the need for further research on their effects on avian health and population dynamics.

Keywords: PFAS, endocrine disruption, developmental toxicity

O-10 – Perfluoroalkyl substances disrupt metabolic function in killer whale fibroblasts

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Abstract: Fibroblasts derived from killer whale (*Orcinus orca*) skin biopsies were used in this study to investigate PFAS-induced metabolic alterations using Seahorse (Agilent Technologies) metabolic assays.

All exposure experiments were conducted using non-cytotoxic PFAS concentrations (3.125–50 μM). Oxygen consumption rate (OCR) increased with 12.5 μM and 50 μM PFOSA, and 50 μM PFOA after 24 h exposure time. Our study showed that 50 μM PFOSA and PFOA disrupted proton leak, ATP production, and non-mitochondrial respiration. Additionally, 12.5 μM PFOA elevated basal and compensatory glycolysis. PFOSA induced a rapid, dose-dependent increase in OCR within 20 min, reaching FCCP-equivalent levels at 6.25 μM, suggesting strong uncoupling activity. PFOA, however, showed no OCR change at this time point.

Our study demonstrates that PFOSA exhibits the highest cytotoxicity among the PFAS compounds tested, significantly altering mitochondrial bioenergetics and increasing OCR. In contrast, PFOA primarily disrupts the glycolytic pathway after 24 h of exposure, with no effect on OCR at the 20 min time point. These findings highlight distinct compound-specific perturbations in cellular metabolic pathways in killer whale fibroblasts.

Ongoing investigations, including UPLC-HRMS, are being conducted to elucidate the effects of these compounds on the electron transport chain and the tricarboxylic acid (TCA) cycle. Additionally, confocal microscopy is being employed to assess alterations in mitochondrial dynamics.

Keywords: PFOSA, mitochondrial uncoupler, metabolism

Acknowledgements: The Marma-detox project is funded by the Research Council of Norway (project #334739).

O-11 – The Source To Outcome Pathway (STOP) – Next Generation Risk Assessment (NGRA) put into practice.

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Abstract: Advancing environmental risk assessment requires a paradigm shift from traditional single-chemical evaluations to more holistic approaches capable of addressing complex, real-world chemical exposures. Next Generation Risk Assessment (NGRA) promotes this transition by integrating diverse data sources and mechanistic understanding to inform both single and cumulative chemical risk assessments. Central to this evolution is the Source-To-Outcome Pathway (STOP) framework, which combines the Aggregated Exposure Pathway (AEP) and Adverse Outcome Pathway (AOP) concepts. AEP structures information on chemical use, fate, and exposure, while AOPs link molecular initiating events to adverse biological outcomes. Together, they support a more transparent and mechanistically informed weight-of-evidence approach.

As bioassay data spanning different levels of biological organisation proliferate, frameworks like STOP will become essential to manage and contextualize disparate data. This work illustrates the use of STOP in NGRA through a case study involving priority pollutants and emerging contaminants, demonstrating how qualitative descriptions and quantitative assessments can be combined for more wholistic assessment. It will also introduce a Graphical User Interface, the Source-to-Outcome Predictor (STOPredictor) that aligns exposure information with effects thresholds to predict risk of ecologically relevant mixtures of pollutants.

Acknowledgements: This work was supported by the Research Council of Norway project EXPECT (RCN-315969), EU-HEU project PARC (#101057014), and NIVA's Computational Toxicology Program, NCTP (RCN-342628).

Keywords: monitoring, exposure assessment, hazard characterisation, risk assessment

O-12 – Insights Into The Stress Response Of The Red Seaweed *Palmaria palmata* Under Anthropogenic Pressure

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Abstract: Seaweed aquaculture is rapidly developing, and information is needed regarding the potential impact of anthropogenic pressures. Here, the response of *Palmaria palmata* (a commercial red seaweed) to hyposalinity (HS), heatwave (HW) events, and pollutants (P) as single and combined environmental stressors was assessed. Additionally, responses to targeted oxidative stress were evaluated. Seaweed blades were exposed to HS (-8 PSU), HWs (3°C), and wastewater treatment plant effluent (P) for 2 weeks, then recovered for 6 weeks. Growth, photosynthetic ability and stress-related analytes were measured at regular intervals. All stressors negatively affected growth rates; however, seaweeds recovered rapidly. Damage to photosynthetic ability lasted longer but was only caused by HWs. Seaweed fragments were also exposed to hydrogen peroxide (0-2 mM), and protein and phenolic contents, antioxidant power, and proteome changes were measured over 28 days. Low-to-medium concentrations led to increased phenolic production and antioxidant activity for up to 7 days, and to decreased proteins involved in photosynthesis and growth metabolism. Results show effects of environmental stressors on the physiology of *P. palmata*. Stress leads to the activation of a phenolics-driven defence response, with trade-offs in photosynthetic activity and growth. Combined and/or repeated events may cause severe damage, both environmentally and economically.

Keywords: oxidative stress, climate change, pollution, seaweed aquaculture, omics

O-13 – Characterization of molting disruptors using Adverse Outcome Pathway (AOP)-informed screening tests in crustaceans

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Abstract: This case study aims to establish efficient screening methods for identifying molting disruptors, drawing from existing knowledge of molting-related adverse outcome pathways (AOPs). Currently, the study is in its initial phase, where an AOP network has been established using existing AOPs from AOP-Wiki to guide method development across domains such as chitin synthesis, enzyme activity, and hormone regulation. A bioassay testing toolbox is under development, using *Daphnia magna* as the primary model organism and reference compounds. A standardized protocol has been developed to quantify key molting features of *D. magna*. Target gene analysis is underway to verify MoAs associated with selected reference chemicals. Next phases will refine methods by incorporating transcriptomics, bioassays, morphological and histological analysis, and expand implementation to other arthropods. The validated tools will then be applied to identify molting disruptors among chemicals (e.g., bisphenols, PFAS, pesticides) and characterize their MoAs. The obtained data integrated with related public mechanistic data will be submitted to data repositories such as NIVA Risk Assessment database (RAdb) and Zenodo using available FAIRification tools for subsequent dose(concentration)-response modeling, consolidation of existing AOPs and development of quantitative AOPs for next generation risk assessment (NGRA). Successful implementation will provide valuable tools for environmental monitoring and risk assessment of molting disruptors.

Keywords: Screening methods, standardization, mode of action, bioassay, next generation risk assessments.

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O-14 – Polar bears on thin ice: effects of sea-ice decline and pollutants on plasma lipidome and adipose tissue transcriptome

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Abstract: Polar bears, as Arctic apex predators, accumulate pollutants through dietary intake. Their contaminant load is also indirectly affected by sea ice decline through reduced foraging opportunities and lower body condition. Yet, the combined effects of pollutants and global warming on polar bear health is little described. 112 free-ranging female polar bears were sampled in the Norwegian archipelago of Svalbard in Spring and Autumn 2012 and 2013. We studied the influence of body condition index, fasting status, reproductive status as well as circulating per- and polyfluoroalkyl substances and lipophilic pollutants (e.g. polychlorinated biphenyls, polybrominated diphenyl ethers, oxychlordane) in adipose tissue on plasma lipidome and adipose tissue transcriptome (RNAseq). Analyses on plasma lipidome suggested associations between persistent organic pollutant levels and lipids involved in energy storage, cell membranes and signaling. Analyses of transcriptome in fat indicated that fasting status was related to lipid metabolism and oxidative stress pathways. Further analyses will be done on correlations between pollutant levels and adipose tissue transcriptome. This study highlights the potential implications of human activities on polar bears energy homeostasis and health.

Keywords: apex predator, persistent organic pollutants, global warming, fasting

Acknowledgements: This work is funded by the Research Council of Norway (SLICE project #335489 and Marma-detox project #334739).

O-15 – Signs of life in precision-cut adipose tissue slices of whale species: A viable *ex vivo* model to study effects of environmental stressors

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Abstract: Cetaceans are both vital components and sentinel species of marine ecosystems. Yet, they are facing exposure to multiple environmental stressors (i.e., climate change, pollution and human activities) potentially threatening the survival of their populations. Despite the urgent need to assess the impact of these stressors, cause-effect studies remain scarce due to the ethical and logistical constraints of studying such large, wild, and protected species at sea. To address this challenge, we adapted an *ex vivo* model of precision-cut adipose tissue slices (PCATS) previously established on northern elephant seals (*Mirounga angustirostris*) to four free-ranging whale species from northern Norway. Functionality of PCATS was assessed measuring lipolytic response to □-adrenergic stimulation with isoproterenol (10 μM). PCATS from pilot whale (PW, *Globicephala melas*), humpback whale (HW, *Megaptera novaeangliae*) and sperm whale (SW, *Physeter macrocephalus*) exhibited significant lipolysis as opposed to those of killer whale (KW, *Orcinus orca*). The viability of PW and SW PCATS was further verified measuring significant oxygen consumption, MTT metabolization and ATP production compared to negative controls. Altogether, our study validates the use of the PCATS model for *ex vivo* exposure experiments on whales. This represents a breakthrough to deepen our understanding of toxicological responses to multiple stressors in cetaceans.

Keywords: cetaceans, blubber, toxicology, marine mammals, lipolysis

O-16 – Fish to flask: Advancing crude oil toxicity testing with *ex vivo* and *in vitro* techniques

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Abstract: Crude oil is a complex mixture of toxicants that can disrupt the endocrine system, particularly through interactions with the aryl hydrocarbon receptor (Ahr) and estrogen receptor (Er) pathways. To improve environmental risk assessment, it is essential to identify causative compounds beyond well-studied polycyclic aromatic hydrocarbons (PAHs) and understand the specific drivers of toxicity. In this study, we investigated the toxicity pathways of specific chemical fractions from a crude oil water-accommodated fraction (WAF) using *ex vivo* and *in vitro* models in Atlantic cod (*Gadus morhua*). WAF was fractionated into five groups (saturates, monoaromatics, naphthalenes, PAHs, and resins), characterized by GCxGC-MS. The resin fraction was the most diverse with ~250 compounds identified, whereas the PAH fraction was less abundant and diverse, primarily composed of phenanthrene (50%). To assess hepatic toxicity pathways, we used *ex vivo* exposure in precision-cut liver slices (PCLS) and biomarker assays. The results show activation of Ahr pathway by both WAF extract and resins fraction. In parallel, we investigate receptor-specific responses using a previously established *in vitro* luciferase reporter gene assay for receptors linked to detoxification pathways, energy metabolism, and reproduction. This combined approach offers mechanistic insight into crude oil toxicity while reducing reliance on live animal testing.

Keywords: precision-cut liver slices, luciferase reporter gene assay, water-accommodated fractions

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O-17 – Metatranscriptomic Insights into Polar Cod Gut Microbiome Responses to Crude Oil Water-Soluble Fractions

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Abstract: Polar cod (*Boreogadus saida*), a key Arctic species, is vulnerable to contamination from crude oil. The mechanisms underlying sublethal effects at the individual level, and their potential consequences for population stability, remain insufficiently understood. In particular, effects on the fish gut microbiome are essential, as this could mediate resilience to environmental stressors. This study used metatranscriptomic analysis to elucidate microbial responses to crude oil water-soluble fraction (WSF) contamination as a proxy for oil spill accidents. Metatranscriptome was assessed in the intestine of fish exposed to WSF before and after the spawning period and under two feeding regimes. Bioinformatic pipeline included Gene Ontology, DGE, CAZy, KEGG, and eggNOG for functional annotation, alongside taxonomic annotation. CAZy indicated upregulation of glycosyltransferases in GT47 (248%), GT59 (8342.86%), GT64 (735.59%), and GT16 (88.36%), and glycoside hydrolases GH15 (111.75%), suggesting microbial stress adaptation. KEGG pathway analysis revealed alterations in antigen presentation (27.90%), apoptosis (31.06%), and neurotrophin (35.49%) signalling, indicating immune-related alterations. EggNOG indicated downregulation in energy production (50.80%) and defence mechanisms (51.94%), revealing weakened immunity. Taxonomic analysis revealed community shifts due to exposure and identified key species, including *Chinook salmon calicivirus* and *Demequina soli*. Our findings provide evidence of microbe-host-environment interactions under pollutant stress.

Keywords: Polycyclic aromatic hydrocarbons (PAHs); Host-microbe interactions; Microbial stress response; Marine pollution.

O-18 – Development of a cell-free new approach methodology (NAM) for assessment of xenoestrogenic compounds in a non-model teleost species

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Abstract: Establishing standardized and validated new approach methodologies (NAMs) is essential for the transition from *in vivo* studies towards *in vitro* and *in silico* approaches. Cell-based luciferase reporter gene assays with ligand-activated transcription factors have been frequently used for chemical toxicity testing and assessment of endocrine disrupting properties. Although these assays are sensitive and to some extent adjustable to high-throughput testing, they still suffer from being labour intensive and time consuming. Time-resolved fluorescence resonance energy transfer (TR-FRET) has emerged as a promising cell-free technology for assessing the interaction of nuclear receptors with various chemicals. We have developed a TR-FRET assay for the estrogen receptor alpha (Era) from Atlantic cod (*Gadus morhua*), based on the liganddependent recruitment of the steroid receptor coactivator (SRC-1). Its performance was evaluated towards a suite of bisphenol A analogs and compared to the cell-based cod Era reporter gene assay. Era demonstrated similar ligand-activation profiles in the cell-free TRFRET assay as in the cell-based assay, but the TR-FRET appears to be more sensitive, producing EC50 values that are between one and two orders of magnitude lower. Thus, TRFRET appears as a promising NAM for chemical toxicity assessment that can be established for ligand-activated receptors from non-model species.

Keywords: TR-FRET, estrogen receptor, bisphenols, Atlantic cod

Acknowledgements: The XENOSENSE project is funded by the Research Council of Norway (project #342186).

O-19 – Anthropogenic particles in Svalbard waters; sea ice has an important role in regulating available particles in surface waters.

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Abstract: Anthropogenic particles are everywhere globally, also in the Arctic waters. Neuston nets (mesh size 330 um) sampling of the upper 20 cm of the water column was used at 9 locations both offshore and near shore inside fjords around Svalbard. Anthropogenic particles, including stained fibres, were found at all locations. Particles were observed at most locations except near shore in Adventfjorden where Longyearbyen is situated. Highest levels were observed in the northern Barents Sea close to the sea ice. This is in accordance with anthropogenic particle levels found in sediments from the same locations. Finding similar patterns in several environmental compartments highlights the role sea ice has in regulating the available particles found in the Arctic environment.

Keywords: Microplastic, manta, Arctic, surface

O-20 – SHORT- AND MEDIUM-CHAIN CHLORINATED PARAFFINS IN AN ARCTIC MARINE FOOD CHAIN

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Abstract: Chlorinated paraffins (CPs) are contaminants of emerging Arctic concern, yet data on their occurrence and behavior in Arctic marine food chains is limited. We investigated the concentrations and congener profiles of short-chain (SCCPs: C10-C13) and medium-chain chlorinated paraffins (MCCPs: C14-C17) in selected species from the Barents Sea and evaluated their biomagnification potential. Samples of capelin (*Mallotus villosus*), polar cod (*Boreogadus saida*), ringed seal (*Pusa hispida*), and polar bear (*Ursus maritimus*) were collected in spring 2017 and 2021. SCCPs were detected in all species, while MCCPs were below detection limits in marine mammals. CPs showed no evidence of biomagnification in this Arctic food chain; the highest median CP concentrations were quantified in the fishes (capelin: 40.2 ng/g lipid weight; polar cod: 29.6 ng/g lipid weight), and the lowest in polar bear (0.7 ng/g lipid weight). More volatile SCCPs dominated in polar cod and marine mammals, indicating exposure via long-range atmospheric transport, whereas less volatile MCCPs were more prevalent in capelin. As a migratory boreal species, capelin may act as a biological vector of MCCPs to Arctic ecosystems, with potential implications for contaminant dynamics under climate change-induced shifts in species distributions.

Keywords: climate change, borealization, contaminants

O-21 – Anthropogenic particles in surface waters from Adventfjorden (Svalbard)

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Abstract: The ubiquitous presence of microplastics and other anthropogenic compounds in the marine environment are unfortunately not surprising anymore. Recent publications are revealing the occurrence of those synthesized particles in even remote and/or pristine areas in different marine matrices like biota, water and sediment. Nevertheless, the knowledge about sources and transport mechanisms of those anthropogenic particles (APs) is still lacking, especially in the Arctic. In this study we investigated surface waters from Isfjorden and the branching Adventfjorden, where Longyearbyen the largest settlement of Svalbard is located. Here, untreated wastewater is released into the fjord system. At two sample sites upstream and two sample sites downstream, three replicates at each location have been collected in June 2021. APs larger than <50µm were investigated regarding size, shape, and polymer type via µFTIR spectroscopy. At each sampling station, APs were present. The highest concentration of APs was found upstream and downstream Isfjorden; whereas lower concentrations were found within Adventfjorden, closest to the wastewater outlet. Additives and polypropylene showed the highest frequencies. Besides local sources like the untreated wastewater, freshwater inputs, ship traffic or the northwards long-range transport from the south into the Arctic needs to be considered.

Keywords: Microplastic, µFTIR, Isfjorden, Longyearbyen, Niskin bottles

O-22 – Marma-detox: Whales and polar bear in a petri dish: decoding marine mammal toxicology through *in vitro* and *in silico* approaches

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Abstract: Arctic marine ecosystems, home to top predators like whales and polar bears, are threatened by bioaccumulative pollutants. Fin whales accumulate phthalates, while killer whales and polar bears accumulate PFAS and legacy POPs. Due to challenges in studying these species in the wild, the Marma-detox project (NFR no. 334739) establishes *in vitro* models to explore marine mammal toxicology. Primary cells were isolated from biopsies of whales and polar bears. A luciferase reporter assay showed that phthalates modulate PPARG, THRB, and GR activity in fin whales. RT-qPCR analysis of phthalate-exposed fin whale fibroblasts revealed higher sensitivity of the GR pathway compared to PPARG and THRB. Killer whale fibroblasts were exposed to PFAS to investigate effects on lipid metabolism. However, low pparg and ppara expression in whale fibroblasts limits their utility for such studies. Killer whale fibroblasts were used to assess broader PFAS effects on metabolism and cell state. Preliminary findings indicate that directly converting primary cells into adipocytes offers a more suitable model for studying pollutant impacts on lipid metabolism. Overall, these cell-based models, together with *in silico* analyses, provide valuable insight into the molecular mechanisms of pollutant toxicity, offering a tool for assessing environmental risks in vulnerable Arctic species.

Keywords: Cetaceans, Arctic top predators, Cell models, Phthalates, POPs, Molecular mechanisms of toxicity

O-23 – Increased aluminium accumulation in fish gills in a fjord estuary due to mobilization of river transported colloidal aluminium species and the impact of flooding events

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Abstract: The transport of colloidal and particle associated contaminants increase in river during high flow events due to increased erosion in the catchment. In coastal water colloids and particles can aggregate and settle due to the high salinity, and the concentration of dissolved bioavailable trace metals is assumed to be low.

Exposure of *Salmo salar L.* smolts in cages in the Sandnesfjord in south of Norway demonstrated, however increased accumulation of Al in the gills of the fish located in the saline fjord water compered to in the river entering the fjord. During high flow, the Al accumulation was higher in fish located further out into the fjord. Fractionation of water demonstrate that the Al speciation change from freshwater to seawater, from colloidal and particulate Al species in freshwater to low molecular mass and bioavailable Al species in the coastal water. Results demonstrate that trace metals such as Al can remobilize in coastal water due to increase in salinity and be more bioavailable than in freshwater, although total concentration is lower. The study highlights that flooding events with high waterflow can impact coastal water at a large distance from the river outlet, with reduced salinity and increased metal exposure.

Keywords: high runoff, metal distribution, bioavailibilty, coastal water

O-24 – Tissue accumulation and toxicity of waterborne uranium and cadmium to Atlantic salmon (*Salmo salar L.*) depend on life stage and combined exposure

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Abstract: Aquatic organisms such as fish can be exposed to a mixture of naturally occurring radionuclides and other metals in Black shale influenced surface waters.

In the present study, controlled laboratory experiments were performed to investigate the uptake and toxicity of waterborne uranium (U) and cadmium (Cd), individually and in combination on two life stages (embryos and juveniles) of Atlantic salmon (*Salmo salar L.*). Results showed that U and Cd taken up in both eggs and juveniles were positively correlated with waterborne concentrations and toxic effects. However, the embryos were more sensitive to U, while the juveniles were more sensitive to Cd. The toxic effects of U and Cd was different, as the tissue concentration of U correlated well with increased blood glucose and reduced plasma Cl concentrations in the juveniles, while no such responses were observed during Cd exposure. Results also suggest an antagonistic interaction between the two elements, where U reduced the uptake of Cd. The study provides new insight into the impact of bioavailability and tissue dependent accumulation of waterborne metals in metal mixtures, as well their different effect on survival and physiological responses.

Keywords: bioavailability, bioaccumulation, metal mixtures, multiple stressors

O-25 – Timing of embryonic exposure to produced water discharges and toxico-developmental effects in lumpfish (*Cyclopterus lumpus*)

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Abstract: The regular discharge of produced water (PW) from offshore oil and gas industry installations on a global scale constitutes the largest direct and intentional release of industrial effluent containing oil components into the marine environment. In the present study, we have investigated the molecular and phenotypic relationship between timing of embryonic exposure to PW discharges and toxicological effects related to developmental deformities, biotransformation, lipid homeostasis, bone vasculogenesis and oxidative stress using lumpfish (*Cyclopterus lumpus*) as a model species. PW was collected at the point of release of a Norwegian Sea offshore oil-producing platform, acidified, extracted, and reconstituted. The exposure solutions targeted a nominal total polycyclic aromatic hydrocarbon (tPAH) concentration of 20 µg/L, and fish eggs were subjected to a 48-h exposure starting at three different timepoints, namely: 0 - 48 h post-fertilization (hpf; DEP1), 38 - 86 hpf (DEP2) and 10 - 12 days post-fertilization (dpf; DEP3). We observed exposure-specific significant effects in heart rate (HR), lipid composition and morphometry in PW exposed embryos. Overall, our data demonstrated that the timing of lumpfish embryonic exposure to PW discharges leads to specific toxicological, physiological, morphological, and other developmental effects related to bone formation, vascular development, and osteogenic differentiation. DEP3 showed unique response patterns, compared to DEP1 and DEP2, suggesting that 10-12 dpf is a sensitive developmental stage for toxicological effects of PW in lumpfish. These effects were correlated with the presence and concentration of PAH compounds in PW. The findings suggest a potential health and developmental impacts on lumpfish and other marine species regularly exposed to PW discharges.

O-26 – Blubber under stress: Immune Gene Expression in Humpback Whale Blubber Exposed to Stress Hormones

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Abstract: Cetaceans are exposed to various anthropogenic stressors, including pollution, noise, and climate change which contribute to elevated levels of circulating stress hormones, such as glucocorticoids (e.g. cortisol). While stress response mechanisms are vital in the short term, prolonged exposure to stress can have serious health implication, yet the impacts on cetaceans remain unknown. To address this knowledge gap, the present study established an *ex vivo* precision-cut adipose tissue slices (PCATS) model, using blubber biopsies of humpback whale (*Megaptera novaeangliae*) to investigate the effects of stress hormones on immunoregulatory and stress-related genes. Viability of PCATS were assessed through measuring oxygen saturation in the culture medium, as a proxy for mitochondrial respiration. Furthermore, PCATS were cultured for 48 hours with 400 nM cortisol introduced every 12 hours to mimic chronic stress response alone or combined with 10 µM epinephrine, another stress hormone involved in the immediate stress response, in the final 12 hours to simulate an acute stress response. RT-qPCR analysis revealed that cortisol alone and combined with epinephrine upregulated *PPARG* and downregulated *TNFα* and *TLR4* expression, suggesting that cortisol contributes to an anti-inflammatory state. Our study opens new opportunities to investigate the impact of anthropogenic stressors on cetacean blubber physiology.

O-27 – When Tourism Meets Toxicants: Using the COVID-19 Lockdown to Investigate the Interactive Effect of Whale Watching and Contaminants on Cortisol in Norwegian Killer Whales

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Abstract: Marine mammals are persistently exposed to multiple stressors. Killer whales (*Orcinus orca)* from Norwegian waters have high concentrations of contaminants, often exceeding established thresholds for risk of toxic effects. Boat traffic can cause physiological and nutritional stress in killer whales, and winter whale watching has increased dramatically since 2012 in Norway. This study aimed to assess the association between cortisol levels in killer whales sampled in seasons of low boat traffic (spring/summer months and winter 2020, with reduced boat traffic due to COVID-19 travel restrictions) and seasons of high boat traffic (winters 2019, 2021 and 2022), in relation to other steroid hormones and contaminants. Blubber biopsy samples were taken from 87 photo-identified killer whales, including five individuals sampled in both low and high boat traffic seasons. We found no effect of boat traffic on cortisol across all whales, however all re-sampled whales had higher cortisol levels in the high boat season, indicating the necessity of accounting for inter-individual variation. We found a positive correlation between pollutants and cortisol, and a subtle but significant interaction effect between pollutants and boat traffic, with whales sampled in times of high boat traffic exhibiting a stronger stress response to pollution. This is the first investigation of the interaction between contaminants and boat traffic, which can aid the establishment of protective conservation and management strategies.

Keywords: Steroid hormones, Cortisol, Multiple stressors, Organohalogen Contaminants, PCBs

Poster Highlight presentations

PH-1 – European Monitoring Data Reveal Temporally Extended Pesticide Occurrence Over Time

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Abstract: Pesticides infiltrate aquatic ecosystems via various pathways, presenting substantial threats to non-target aquatic organisms. Traditionally, the evaluation of these risks has been limited to either acute or chronic assessments. However, it is imperative to advance our understanding of pesticide exposure patterns in aquatic environments and the profound impacts of pesticide applications and environmental dynamics. This knowledge is pivotal in establishing and verifying assumptions in ecotoxicological testing protocols. In this context, the utilization of comprehensive, large-scale monitoring data emerges as a transformative approach. This approach offers an expansive foundation for assessing aquatic exposure by examining sequential pesticide concentrations. This novel perspective will not only enhance our grasp of the dynamics of pesticide exposure in aquatic ecosystems but also contribute significantly to the development of ecotoxicological methodologies and the safeguarding of non-target aquatic species.

We investigated the likelihood of pesticides reappearing in European streams over medium-term (4 - 7 days) and long-term (8 - 30 days) periods, meaning their tendency to remain present at quantifiable levels for periods beyond the typical 96-hour (4-day) exposure duration, reflecting the minimum duration of chronic ecotoxicity testing. We collected and analyzed publicly available data on pesticide levels in European streams to establish probabilities of reoccurrence (POR) for approximately 360 different pesticides, ranging from less than 1% to 100%. By comparing medium-term and long-term probabilities of reoccurrence, we identified three categories that describe most pesticides: *(1)* occasionally reoccurring, *(2)* repeatedly reoccurring, and *(3)* continuously reoccurring substances. Fungicides were the most common among repeatedly reoccurring substances, while neonicotinoid insecticides and legacy compounds were found to continuously reoccur. The results of this study challenge the current understanding of how we assess the persistence and impact of pesticides and emphasize that substance-specific factors, such as physico-chemical properties, application recommendations, and regulations, influence how pesticides

affect aquatic environments. This study underscores the need to evaluate pesticide exposure by considering consecutive concentrations, enhancing our understanding of the real exposure risks to aquatic ecosystems on a substance-by-substance basis.

PH2 – Evolution of the Chemical Defensome in Marine Mammals

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Abstract: The chemical defensome comprises an integrated network of gene families and pathways that together function to sense, metabolize and eliminate harmful compounds. The absence of functional nuclear receptors PXR and CAR in cetaceans, and their presence in polar bears, pinnipeds and sirenia, makes the case for an interesting comparison of how these species sense and respond to environmental toxicants that target these receptors. Many marine mammals are top predators, feeding high in the food chain, resulting in a high intake of persistent, bioaccumulating pollutants with the potential to cause harm to the organism. Publicly available genomes (NCBI/Ensembl) were used for genome mining, targeting the genes representing the *chemical defensome* of 30 selected marine mammal species and 51 close relatives. Our analysis revealed large-scale loss of defensome genes in cetaceans compared to closely related species. Gene losses are found across the whole spectrum of defensome genes, ranging from transcription factors, oxygenases (CYP2, CYP3, and CYP4 family) and reductases (NQO1), to transferases (UGT, GST) and transporters (ABC, OATP/SLCO). Overall, our results suggest a significant remodelling of the chemical defensome in Cetacea, suggesting the convergent and divergent susceptibilities towards chemical pollution across marine mammals.

Keywords: Cetaceans; gene loss; biotransformation; phase 1-3

Acknowledgements: The Marma-detox project is funded by the Research Council of Norway (project #334739).

PH-3 – Marine mammals and polar bears in a petri dish: *in vitro* modeling to study multiple stressors on remote species

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Abstract: Arctic marine mid and top predators such as whales and polar bears, are threatened by bioaccumulative and biomagnifying contaminants such as persistent organic pollutants (POPs). Due to difficulties in studying these species in the wild, we aimed to develop surrogate *in vitro* cell models to characterize toxicological responses to POPs and chemicals of emerging concern (CECs) in marine mammal cells. We isolated fibroblast cells from skin biopsies of five species of whales (killer, fin, sperm, humpback, and pilot), and from polar bears. In addition, we isolated adipose-derived stem cells (ASCs) from the blubber and adipose tissues of the five whale species and polar bears, respectively. Exposure of killer- and pilot-whale fibroblasts to a mixture of POPs allowed us to assess the cytotoxicity of the most abundant pollutants measured in their blubber tissues. Further, we developed an *in vitro* differentiation model that directly converts primary cells into (pre)adipocytes to investigate the impact of POPs on cell function (e.g. lipid metabolism). We differentiated both ASCs and fibroblasts from polar bears into adipocyte-like cells by exposing them to a differentiation cocktail with or without insulin. These cell-based models will provide new insights into the molecular mechanisms underlying pollutant toxicity in marine mammals and enhance our understanding of environmental impacts on these endangered species.

Keywords: Cetaceans, Apex predators, Fibroblasts, Adipose-derived stem cells, POP mixture

PH-4 – eData: A format and FAIRification tool for exposure data

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Abstract: In the environmental sciences, effective, timely risk assessment is all too often limited by data availability and accessibility. The FAIR principles state that to maximise the impact and scientific value of research, effort should be made to make sure that data is Findable, Accessible, Interoperable and Reusable. These are noble goals, but when added to the already heavy workload of researchers it can seem an imposition. Our poster presents a draft FAIR format for environmental exposure and monitoring data, and the accompanying interactive graphical tool for formatting, harmonising, exploring and cleaning this data. Using R Shiny, we have developed a prototype tool that walks users through the process of harmonising and uploading their data, significantly reducing administrative work without taking important decisions out of the hands of data owners. A structured reporting framework and support for repository submission with FAIR assessment make the barriers to entry for FAIR data as low as possible. As a consequence maximum value and benefit can be extracted from each study, and data can be reused for exposure and risk assessment.

Keywords: exposure, FAIR, risk assessment, computational toxicology, environmental risk assessment

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PH-5 – qData – a web-based FAIRification workflow for (eco)toxicological dose(concentration)-response data.

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Abstract: Effect-based methods produce data across biological levels, from molecular to apical, which vary greatly in structure and format. This heterogeneity hinders integration into mechanistic frameworks like Adverse Outcome Pathways (AOPs) and limits their use in hazard and risk characterization. To address this, we developed a Data Reporting Format (DRF) and prototyped a web-based user interface (qData UI) to streamline data collection, validation, and analysis of quantitative dose–response data from (eco)toxicological studies. qData is currently under internal and external testing using example datasets, including a case study on Diuron toxicity in Chlamydomonas reinhardtii. This dataset spans multiple biological levels and time points (6–72 h), capturing endpoints such as PSII inhibition, mitochondrial membrane potential, ATP content, and growth. The interface supports structured data and metadata entry, submission to different repositories (e.g., NIVA Risk Assessment database and Zenodo), benchmark dose (BMD) analysis for event sensitivity ranking, and future implementations will facilitate structural equation modeling (SEM) to quantify causal relationships and time-dependent dynamics across the AOP continuum. The UI and connected workflows will ultimately be integrated into the Source-to-Outcome Predictor (STOPredictor), an UI linking environmental exposure assessment with hazard characterization for the risk assessment of single substances and mixtures.

Keywords: toxicity data, hazard characterisation, FAIR, dose-response modeling

Acknowledgements: This work was supported by the Research Council of Norway project EXPECT (RCN-315969), the EU-HEU project PARC (#101057014), and NIVA's Computational Toxicology Program, NCTP (RCN-342628).

PH-6 – Integrating point of departure and structural equation modelling to AOP development: A case study of diuron toxicity in microalgae

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Abstract: Adverse Outcome Pathways (AOPs) and their quantitative extensions (qAOPs) provide structured frameworks to understand toxicological mechanisms, thereby supporting risk assessments. However, quantitative data for key event relationships (KERs) are often limited. This study used multiple points of departure (POD), including No Observed Effect Concentration (NOEC), Lowest Observed Effect Concentration (LOEC), Benchmark Dose (BMD) and half-maximal effective concentration (EC50), combined with structural equation modelling (SEM) to verify and quantify the causal relationships within AOP frameworks. The case study involved *Chlamydomonas reinhardtii* exposed to Diuron, analysis of dose-response data for PSII inhibition, photosynthesis, mitochondrial membrane potential (MMP), ATP content, and growth at different exposure durations. Most endpoints exhibited clear dose-response patterns, with sensitivity increasing over time. A conceptual AOP was developed based on the new experimental evidence and supporting literature. As expected, BMD-based PODs of molecular events (e.g., PSII inhibition) occurred at lower concentrations and earlier than downstream events such as MMP, ATP and growth. The SEM verified the proposed AOP and quantified the KER to support qAOP construction. Additionally, the SEM identified supplementary mechanisms, such as MMP disruption, contributing to growth inhibition. This work proposes a hybrid framework combining POD-based analysis and SEM to strengthen qAOP development.

Keywords: Toxicity test, microalgae, herbicide, temporal response, statistical modeling

Acknowledgements: The present work was financed by the Research Council of Norway projects MixRisk (RCN-268294) and EXPECT (RCN-315969), the EU-HEU project PARC (#101057014), and NIVA's Computational Toxicology Program, NCTP (RCN-342628).

PH-7 – Development of a Pyrolysis-GCxGC-TOF method to analyze microplastic pollution in water, food sources, and humans in the Arctic

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Abstract: The Arctic acts as a sink for both legacy and emerging pollutants, including micro- and nanoplastics (MNPs) transported from long distances and emitted locally. To address the challenges of Arctic pollution, a comprehensive "One Health" approach is necessary to account for the close interlinkages between environment, wildlife, and human health. Priority pollutants of interest include MNPs and additives that may leach from these materials into the surroundings. Quantification of MNPs is challenging due to method validation issues and the risk of contamination at every step of analysis. Pressurized liquid extraction (PLE) for sample preparation is useful for extraction of polymers from a closed cell, reducing contamination risks. Extracts are further analyzed using Pyrolysis-gas chromatography (Py-GC) in combination with time of flight (TOF) mass spectrometry. A two-shot analysis uses the same sample to first thermally desorb (remove) chemical additives and organic matrix at lower temperature, then subsequently pyrolyze the polymers for quantitative analysis without interferences. Two-dimensional gas chromatography (GCxGC) may be applied in cases where ultra high-resolution chromatography is required for improved separation and screening of additives. Preliminary results will be presented, with implication for environmental fate investigations and risk assessment for MNP exposure (including additives) to humans and the environment.

Keywords: One Health, Nanoplastics, Pyrolysis, Method development, Plastic additives

PH-8 – A Novel Secondary Treatment Step for Tunnel Wash Water: Impact on Retention and Toxicity of Tire and Road Wear Particles, Tire Leachates, and Metals

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Abstract: Urban expansion and increasing vehicular traffic have significantly intensified road related pollution in recent decades. Among the emerging contributors to environmental degradation are tire and road wear particles (TRWPs) and tire-derived chemicals (TDCs), which represent a growing source of microplastic and chemical contamination. These pollutants enter ecosystems through air deposition and surface runoff. A particularly concentrated source is tunnel wash water (TWW), generated during the maintenance of road tunnels. In Norway, this water is frequently discharged into adjacent rivers and fjords without adequate treatment. This study aimed to investigate the impacts a novel secondary treatment step for TWW may have on retention and toxicity of TRWPs, TDCs and metals taking into account the contaminant fluxes and seasonal variations by using the Ekeberg Tunnel as a case. A two-step treatment system, consisting of a 21-day sedimentation phase followed by filtration with Leca Filtralite HMR, was evaluated by testing the effectiveness of sedimentation alone and in combination with filtration for reducing key contaminants. Fieldwork was carried out during spring and autumn of 2024 to capture seasonal differences, with samples collected before and after each treatment stage. Metal samples were filtered through a 0.45 µm membrane to distinguish between particle bound and dissolved fractions. All samples were subsequently analyzed for metals, TRWPs, and TDCs using Agilent 8800 ICP-MS QQQ, Py-GC/MS, and UPLC-TOFMS. A 14-day leaching test also evaluated metal release from particles retained before treatment. Acute toxicity was assessed using Daphnia magna at each TWW treatment stage, including detergent only exposures. Additional measurements included dissolved organic carbon, anions, and other water quality parameters. Results revealed that TWW contains a complex, seasonally variable contaminant mix. Higher concentrations of TRWP, TDCs and metals were observed in spring, due to winter accumulation. The treatment system effectively reduced particle bound metals (Al, Fe, Cu, Pb), TRWP and some TDCs like 6PPD and DPPD. However, dissolved metals (Zn, Mo, As) and water soluble TDCs such as HMMM, TMQ, and MTBT were not effectively removed, with some increasing post treatment. Biological assays showed that D. magna ingested particles in all treatments, but acute toxicity was observed only in untreated autumn samples at a 50% sample concentration. Microscopic analysis revealed that particles adhered to appendages and exoskeletons, causing immobilization through physical obstruction. The

leaching test confirmed that retained TWW particles also release metals such as iron (30.0 µg/L), zinc (9.32 µg/L), and copper (2.00 µg/L) over time. This study confirms that TWW from the Ekeberg Tunnel poses considerable environmental risks, particularly during the spring season. While the two step treatment system effectively reduced coarse, particle bound pollutants, it was less capable of removing some dissolved metals and water soluble TDCs. The combination of high concentrations of untreated TRWPs, TDCs, and metals along with evidence of particle ingestion, mechanical interference, and gradual metal leaching, raises concerns for aquatic life and water quality. These findings highlight the importance of effective treatment in reducing environmental risks, while also showing the need to improve the removal of finer particles and certain dissolved pollutants. Ongoing monitoring is essential to protect sensitive ecosystems like the Oslofjord.

PH-9 – Combined Effects of Climate Change and Insecticide Stress on Non-Target Insects in European Freshwater Habitats

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Abstract: Climate change impacts biodiversity, especially in Central Europe's freshwater ecosystems. Rising temperatures affect macroinvertebrate populations, altering community composition and ecological interactions. Resilient taxa like Odonata, Chironomidae, and Baetidae adapt well to higher temperatures, leading to shifts toward these species. In contrast, taxa such as Trichoptera, Plecoptera, and Ephemeroptera face substantial declines, raising concerns about ecosystem stability and functionality. Warmer temperatures are allowing insect pests to expand their geographic ranges (e.g., Dendroctonus frontalis).

Anthropogenic factors like the use of insecticides (e.g., thiacloprid) worsen these changes by hindering the emergence of various aquatic insects. Some insecticides exhibit increased toxicity at higher temperatures (e.g., diazinon, indoxacarb), while others lose efficacy at higher temperatures (i.e., bendiocarb). Interactive effects of climate change and insecticides can lead to complex changes in population dynamics, e.g., alterations in the timing of insect life cycles, making them more vulnerable to insecticide exposure during critical stages such as emergence.

Additionally, increasing temperatures may increase the persistence and toxicity of insecticides; for instance, warmer water holds less dissolved oxygen (DO), which may slow chemical and biological degradation processes. Temperature fluctuations influence water pH, affecting the hydrolysis rates and ionization states of insecticides, altering their solubility and sorption to sediment or organic matter. Increased algal blooms can diminish water clarity and hinder the photolysis of insecticides. Rising temperatures also lead to increased vapor pressures of insecticides, resulting in increased volatilization. PORs (probabilities of reoccurrence) indicate that 19.6% of insecticides (44.4% of approved insecticides) occur in long-term recurring peaks, despite their often not persistent nature: only 1 out of 22 intermittently occurring insecticides is persistent (thiacloprid; DT50 > 40 days).

Understanding these dynamics is crucial for informing conservation strategies and mitigating climate change and chemical pollutant impacts on aquatic ecosystems. Agricultural practices must evolve, prioritizing reduced pesticide use and integrated pest management (IPM) strategies. Risk assessments should incorporate climate forecasts to improve predictions regarding the impacts of insecticides and climate change.

PH-10 – Empowering Researchers Through Tailored Scientific and Professional Capacity Development

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Abstract: BEE Solutions and Consultancy Services is a female-owned, African-led consultancy founded on the principles of sustainability, integrity, and community empowerment. With over 55 years of combined experience in academia, research, and community engagement, our team delivers tailored scientific and professional training programmes for postgraduate students, early-career researchers, and academic institutions across Africa and beyond. We specialise in designing and delivering context-specific workshops, masterclasses, and mentoring programmes—both virtual and in-person—addressing identified skills gaps in research development, academic writing, proposal preparation, literature review, and research ethics. Our approach blends mainstream scientific methodologies with indigenous knowledge systems to produce holistic, human-centred outcomes. Our offerings also extend to academic programme development, community-based project facilitation, and strategic collaborations with research institutions and NGOs. Rooted in the metaphor of the beehive, our work is built on the philosophy of interdependence and collective growth, where every stakeholder plays a vital role in achieving sustainable impact. This presentation will highlight our unique service model, successful case examples, and collaborative potential with universities, development agencies, and donor-funded projects seeking effective capacity development solutions in the Global South.

PH-11 – A Closer Look: Tracking Sertraline-Induced Visual Impairments in Zebrafish with ZebEyeTrack

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Abstract: As global life expectancy increases, so does pharmaceutical use, raising concerns about their unintended release into aquatic ecosystems. Designed to act at low concentrations, even trace levels of pharmaceuticals can cause biological effects. Antidepressants, particularly selective serotonin reuptake inhibitors like sertraline, are frequently detected in wastewater effluents. This study aims to investigate the sublethal effects of sertraline (1–1000 μg/L) on zebrafish embryos' (96 hours post-fertilization, hpf) visual performance using an optokinetic response (OKR) assay (manually and using ZebEyeTrack) and quantitative PCR (qPCR, at 48 and 96 hpf) to identify molecular disruptions in vision-related pathways.

ZebEyeTrack measures saccade amplitude, timing, and frequency, corrects for habituation/fatigue and human bias/error, and can reveal subtle impairments such as microsaccades and eye twitching, which are often missed by manual counting.

OKR assays revealed significant impairments in visual function at 100 and 1000 μg/L. ZebEyeTrack confirmed a higher frequency of eye twitching in exposed larvae, and qPCR detected gene expression alterations at environmentally relevant concentrations (1 μg/L), confirming sertraline's impact on visual development and emphasizing the need to regulate SSRI pollution in aquatic environments. The present findings provide new insights into how sertraline affects visual development and function in fish.

Keywords: antidepressant, emerging contaminants, wastewater discharge, behaviour.

PH-12 – SENSITIVITY OF LESSER SANDEEL (AMMODYTES MARINUS) LARVAE TO CRUDE OIL EXPOSURE

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Abstract: Marine ecosystems are increasingly impacted by expanding energy production activities, including offshore petroleum, windfarms, and carbon capture projects. This expansion increases cumulative pollution and the risk of both chronic and accidental oil spills, while seabed disturbances may intensify local contamination. The lesser sandeel, a key prey species in the North Sea, is especially vulnerable due to its reproductive strategy—spawning on sandy seabeds where adhesive eggs attach to the substrate. After hatching, larvae drift for three months before settling. This study assessed the sensitivity of sandeel larvae to dispersed oil (0–300 µg/L) during two developmental phases: newly hatched and pre-schooling. We analyzed hydrocarbon concentrations in water and tissues, cyp1a gene expression, lipid distribution, and sublethal deformities. Larvae showed higher sensitivity than embryos, with dose-dependent abnormalities including impaired jaw and eyes. Visual acuity and performance were assessed using optomotor responses, revealing potential impaired vision at higher exposures, which may reduce prey/predator detection and schooling behavior. Although embryos were more resilient than other marine fish (e.g., cod, haddock), increased post-hatching sensitivity underscores the ecological risk of oil exposure. Incorporating vision-related endpoints in risk assessments can enhance ecological impact predictions and inform conservation strategies for this ecologically and economically vital species.

Keywords: newly hatched, preschooling larvae, vision acuity, petroleum, risk assessment.

PH-13 – Assessing effects of antifouling copper on Atlantic salmon (*Salmo salar*) using transcriptome analysis

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Abstract: Copper-based antifouling coatings are commonly applied to aquaculture net pens to prevent growth of unwanted organisms. However, the coatings can release copper into the surrounding water, particularly from new coatings or during cleaning, potentially exposing fish to transient high concentrations. Here, we assess acute effects of copper in salmon. Fish were divided into control (0), low (20 µg/L), medium (60 µg/L) and high (120 µg/L) copper concentration groups and exposed for one week. Various analyses including gene expression, histology, chemical analysis and oxidative stress assays were performed. Accumulation of copper was observed in the gills, but not in the liver. In the gills the exposure affected several genes and pathways including oxidative stress responses, lipid metabolism and cell cycle related pathways, particularly in the high concentration group. Oxidative stress assays also showed significant effects in the gills, but not in the liver. In the liver, milder effects were observed on genes and pathways such as lipid metabolism and cell cycle. The findings indicate that short-term exposure to copper levels used here can significantly perturb many cellular pathways, particularly in the gills. Further research is warranted to assess long-term consequences of copper exposure from net pens on the fish health.

Acknowledgements: The CAPS project is funded by the Research Council of Norway (project number: 325849).

Keywords: aquaculture, gills, liver, oxidative stress

Poster presentations

P-1 – KnowSandeel. Realistic assessment of the effects of anthropogenic offshore activity on the habitats of a keystone ecological and commercial fish species

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Abstract: Marine ecosystems are increasingly pressured by the expansion of offshore energy production, including petroleum, wind, and carbon capture projects. This growth contributes to cumulative pollution and heightens the risk of oil spills, with climate change further amplifying environmental stress. A major obstacle to sustainable offshore development is the lack of dynamic data pipelines that would allow scientific knowledge to inform spatial planning tools.

One critical gap lies in understanding the early life stages of key species like the lesser sandeel, an essential link in marine food webs between plankton and top predators. Although adult sandeel are protected, there is limited knowledge of larval behavior, dispersal, and sensitivity to stressors, particularly from the petroleum industry. These gaps hinder effective regulation, especially in regions such as the North Sea and along the Norwegian coast. Current Norwegian risk assessment models consider general larval dispersion but lack species-specific insights into drift patterns and vulnerabilities. The **KnowSandeel** project addresses this by integrating behavioral data and realism-based larval drift models, and by developing an operational forecast tool for sandeel larvae. This effort supports more accurate, science-informed decision-making in offshore spatial planning and promotes the sustainable coexistence of ecological protection and industrial development.

Keywords: *Ammodytes marinus*, anthropogenic stressors, risk assessment models, offshore energy production, marine ecosystems

P-2 – An assessment of the toxicity of nanogold containing SARS CoV-2 rapid test kits on *Daphnia pulex and Danio rerio*

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Abstract: The global deployment of SARS-CoV-2 rapid diagnostic kits, many of which make use of colloidal nanogold (nAu), has raised concerns about potential environmental risks associated with improper disposal. This study assessed the acute toxicity of nAu leachates from these test kits on *Daphnia pulex*, a freshwater invertebrate, and *Danio rerio* embryos, both recognized bioindicator species. Two exposure methods were evaluated: continuous submersion of test strips and a stock solution prepared after 15 minutes of leaching. Immobilization assays conducted over 24 and 48 hours revealed a time-dependent increase in toxicity, with LC50 values declining significantly over prolonged exposure. Characterization using Fourier Transform Infrared Spectroscopy (FTIR) and Dynamic Light Scattering (DLS) identified the presence of organic stabilizers and confirmed an average nAu size of 100 nm. Dark-field hyperspectral microscopy confirmed accumulation of nAu in the digestive tract of *D. pulex*, suggesting ingestion as a primary exposure pathway. The findings underscore the need for thorough environmental risk assessments of nanomaterial-based diagnostic kits and highlight potential ecological implications, particularly in aquatic environments. Further studies on chronic effects and mitigation strategies are essential to inform responsible nanomaterial use and disposal.

Keywords: nanogold, SARS-CoV-2 diagnostics, *Daphnia pulex*, *Danio rerio*, aquatic toxicity, environmental safety

P-3 – The effects of Emamectin Benzoate on Early Life Stages of the European Lobster (*Homarus gammarus*)

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Abstract: Emamectin benzoate (EMB) is widely used in salmonid aquaculture as an in-feed treatment to control sea lice infestations. Although designed for targeted delivery, EMB is excreted by farmed fish and can accumulate in surrounding sediments, raising concerns about its impact on non-target benthic species. The European lobster (*Homarus gammarus*), a species of ecological and commercial importance, may be especially vulnerable during early life stages spent in shallow coastal waters near aquaculture sites. This study evaluates the acute and sublethal toxicity of EMB in *H. gammarus* larvae and post-larvae following controlled laboratory exposures. Biological endpoints assessed include survival, paralysis, developmental progress, and behavioral changes relevant to predator avoidance and settlement.

Keywords: Emamectin benzoate, European lobster, early life stages, aquaculture, ecotoxicology, crustacean larvae, sediment contamination

P-4 – Molting inhibition in *Calanus finmarchicus* after exposure to the chitin synthesis inhibitor teflubenzuron

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Abstract: Chemotherapeutics, such as the chitin synthesis inhibitor teflubenzuron, are widely used in marine aquaculture to control parasitic salmon lice. However, these compounds may also harm non-target species like *Calanus finmarchicus*, a keystone copepod in Arctic and boreal ecosystems. With growing environmental stress from climate change and pollution, it is critical to understand the mechanisms behind such impacts to improve ecological risk assessments.

This study explored the effects of teflubenzuron on *C. finmarchicus*, using Adverse Outcome Pathway (AOP) 360, "Inhibition of chitin synthase 1 leading to increased mortality," as a knowledge organizing framework. Over a seven-day exposure, we assessed mortality, development, morphology, and gene expression linked to molting processes in the copepod. Teflubenzuron exposure at ≥0.012 µg/L caused significant mortality, disrupted development, and led to visible deformities. It also altered the expression of genes involved in molting and chitin metabolism. However, no significant changes in chs1 gene expression were detected at concentrations between 0.001 and 0.012 µg/L. Thus, we could not directly link chs1 inhibition to the observed effects as described in AOP 360. Further studies are needed to clarify the molecular mechanisms related to teflubenzuron toxicity and validate AOP 360's relevance for *C. finmarchicus*.

Keywords: Aquaculture medicine, salmon lice, non-target effects, toxicity

Acknowledgements: This work was supported by the Research Council of Norway project EXPECT (RCN-315969), EU-HEU project PARC (#101057014), and NIVA's Computational Toxicology Program, NCTP (RCN-342628). We thank the EMBRC-ERIC Laboratory for Low Level Trophic Interactions at NTNU SeaLab for access to the *Calanus finmarchicus* culture.

P-5 – Is it clean? Analyzing environmental contaminants from novel aquaculture feed sources in a salmon feeding trial

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Abstract: Global seafood consumption is projected to rise significantly, being aquaculture the primary contributor. A major challenge is cost and quality of aquafeed. Utilizing low-trophic mesopelagic species has gained attention. There are concerns about their safety for animal and human consumption. This project's aim was to identify environmental contaminants in feed formulated from these novel ingredients and track their distribution and concentration in two salmon (*Salmo salar*) tissues of commercial interest. Four experimental diets of processed *Maurolicus muelleri* and 1 control were fed to salmon smolt for 11 weeks where they fourfold their body weight. Muscle and liver from salmon and diets were analyzed to quantify levels of environmental contaminants. 11 BFRs, 20 PCBs (including Dutch 7), 22 OCPs and 35 PFAS were analyzed. For toxic metals everything was at least 6 times under the EU established limits in feed and food. Consistent with previous studies on raw material itself. POPs analyses are ongoing. The short duration of the feeding experiment and the controlled diet, enable identification of the transfer of contaminants from experimental feed to tissues. Future work will expand to other contaminants, such as microplastics, plastic additives, and personal care products (PCPs).

Keywords: low-trophic mesopelagic species, Heavy metals, BFRs, PCBs, Dutch7, OCPs, PFAS.

Acknowledgments: Funding was provided by the Research Council of Norway. The Centre for Research-Based Innovation (SFI) Harvest. Mesopelagic ingredients were produced and provided by Nofima with financing from "MEESO" (EU H2020 research and innovation program, Grant Agreement No 817669) and the "Mesopelagic processing project, 15574" (IMR, Norway), while the tissue samples for contaminant analysis were collected from a salmon feeding trial run by Nofima with financing from SFI Harvest.

P-6 – Veterinary pharmaceuticals in African aquatic systems: One-health approach as a driver of SDG14 (Life Below Water)

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Abstract: Emerging contaminants are ubiquitous in African aquatic ecosystems. Pollution of African waterbodies is largely driven poor waste management, ageing wastewater treatment, culture of materialism, corruption, curricular gaps, scarcity of skills, technical infrastructure, lack of public awareness. Water pollution and climate change are two of the top ten planetary crises. The study of intersection between intersection between man, animals and the environment is therefore urgent and critical. A case study of agriculture as a pathway of pharmaceutical residues will be presented. In the study, pharmaceutical cocktails exerted significant observable effects on the growth and yield of *Pseudokircheneriella subcapitata* relative to controls. Neonates of *Daphna magna* exposed to environmental concentrations of pharmaceutical compounds had 100% mortality in undiluted and 1:2 dilutions after 48 h. Mutagenicity was 6 to 8-times the natural background rate; low carcinogenic risk was observed for 17β-estradiol (2.4 µg/L) especially, via possible accidental ingestion during recreational activities. The piggery effluent and the pharmaceutical cocktail mixtures had potential toxicological effects on the freshwater ecosystem. Cattle and poultry farms effluents were mutagenic, piggery, sheep farm effluents were oestrogenic, and the piggery effluent had the highest toxicity. Recommendations for the research entities continued and potential roles for global impacts will be provided.

Keywords: Emerging contaminants, ecological health, human health, collaborative interventions

P-7 – Non-target screening: a tool for environmental pollution analysis

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Abstract: The planetary boundary for novel entities (pollutants) has, according to the Stockholm Resilience Center, been transgressed because "the rate of chemical production and release into the environment far outpaces society's capacity to assess and monitor their safety", thus, putting the Earth's system, and particularly vulnerable ocean ecosystems, at risk. Traditional environmental monitoring focuses exclusively on known and regulated substances, so there is a critical need for screening methods to assess the presence and impacts of unknown and unregulated chemical cocktails in the environment.

Non-target screening (NTS) methods typically couples gas/liquid chromatography with high-resolution mass spectrometry (GC/LC-HRMS) and can detect thousands of unknown substances in environmental matrices, identify chemical patterns, suspect compounds and previously unrecognized pollutants. NTS can also be used to support retrospective analyses and investigations as new concerning compounds emerge. NTS based peak picking algorithms may also facilitate an automated pipeline for suspect compound identification.

Examples of where NTS already has been used: MicroLeach, PW-Exposed, Nurdletrack, plastic projects, MPRI/PETROTOX, Toxigen

Keywords: GC×GC-HRMS, Suspect compound identification, Retrospectiv analyses

P-8 – Plastic-related chemicals associated with polymers and their effects on thyroid hormones in fledglings of Northern fulmars (*Fulmarus glacialis*) from Svalbard

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Abstract: Northern fulmars (Fulmarus glacialis) are seabirds prone to ingest plastics. This study investigated the occurrence of plastic-related chemicals (PRCs) in relation to the type of plastic polymers ingested, and their potential endocrine disrupting effects on thyroid hormones in fulmar fledglings from Kongsfjorden, Svalbard. Liver concentrations of polybrominated diphenyl ethers (PBDE) and per- and polyfluorinated substances (PFAS), and plasma concentrations of tri-iodothyronine and thyroxine were measured. Plastic particles from the gastrointestinal tract were quantified, weighed and their polymer type identified using Fourier Transform Infrared spectroscopy (FTIR) in a previous study (Marhaug, 2024). Spearman correlation matrices were used to investigate the relationships between PRCs and plastic polymers, as well as between PRCs and thyroid hormones. ΣPBDE, ΣPFCA and ΣPFSA showed no correlation with plastic mass or quantity, none of these PRCs appear to be reliable proxies for plastic ingestion. Likewise, none of the plastic polymers showed any significant patterns related to PRCs. However, polyurethane, polyamide and polyhydroxybutyrate showed a tendency toward positive associations with several PRCs, suggesting these polymers may accumulate certain chemicals more readily. PBDE-209, ΣPBDE and 7:3 FTCA showed significant positive correlations with TT3 and TT3:FT3. While PFNA, PFDA, PFUnDA, PFDoDA and ΣPFCA showed significant negative correlations with TT4:FT4. These findings may indicate a thyroid disrupting effect of plastic-related chemicals.

Keywords: Plastic ingestion; PBDE; PFAS; Endocrine disruption

P-9 – An Aggregate Exposure Pathway for Copper in Norway

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Abstract: Copper is both a vital nutrient and material in biota and industry, and a classical contaminant of a wide range of sites. The Green Shift will increase demand for copper, but the implications for copper pollution are unclear. Aggregate Exposure Pathways (AEPs) are a conceptual framework that links stressor sources through transport and fate to target site exposure in organisms. Although copper pollution in Norway is well studied, an overall assessment of copper pollution has not been conducted. AEPs are well suited to mapping the profile of copper pollution in Norway with the aim of understanding trends. We will present our work on developing an AEP for copper pollution and exposure to wildlife in the Norwegian sea, a key marine ecosystem. We assess sources, receiving compartments, transport, and biota exposure to copper in our qualitative based mapping. We further analyse 30 years of environmental monitoring data from the Vannmiljø database to assess history and patterns. Our work advances the understanding of copper pollution in Scandinavia and the AEP concept. Additionally, it will serve as the basis for quantification and modelling of copper fate that can be used for environmental risk assessment as part of the Source to Outcome Pathway concept.

Keywords: exposure, Aggregate Exposure Pathway, copper, Norway, Source to Outcome Pathway, aquatic, wildlife, heavy metal

P-10 – Alterations in behaviour after exposure to nanogold leachate from SARS CoV-2 colloidal gold test strips in *Danio rerio* (zebrafish)

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Abstract: Nanogold (nAu) is used in biomedicine due to its inert nature and biocompatibility. Its applications include improved imaging, cancer treatment, real time detection with rapid antigen test kits for various scenarios. While some researchers claim that nAu is safe, others claim that it bioaccumulates in several tissue types and is capable of inducing cell death by causing mitochondrial damage. Zebrafish share many genetic similarities with humans and other mammals, making them useful models for studying behavioural changes induced by different toxins. Since they are highly social zebrafish can be used to assess memory with the incorporation of social interactions as a reward. The species display anxious behaviours like those of humans which are regulated by the hypothalamic-pituitary-interrenal (HPI) axis. To confirm the leaching of nAu from SARS CoV-2 colloidal gold rapid test kits into the environment, scanning electron microscopy (SEM) and energy dispersive X ray spectroscopy (EDS), and UV-Vis spectroscopy was used, and attenuated total reflectance Fourier transform infrared spectroscopy (FTIR-ATR) was then used to test for other chemical species present on the test strips. Embryo activity was assessed at 24 and 48 hours using DanioScope software and ViewPoint behaviour software was then used together with a novel tank diving test (NTDT) to assess the baseline behaviour of the experimental adult fish prior to conducting maze training. Maze training consisted of two sessions lasting 10 minutes, in which each fish was individually netted into a 3D-printed T-maze with conspecifics in one zone of the maze as a visual reward. This was done such that the fish would only be familiar with two of the three zones of the maze, and the behaviour of the fish was analysed using ViewPoint behaviour software. Following exposure to nAu leachate in two groups for 24 h, the behaviour of the fish was again recorded and quantified after removing the conspecifics from the maze and tracking the swimming behaviour of the individual fish with no social reward. An alarm substance (AS) from donor fish was placed in the maze during recordings in two groups. The final exposure groups (n=10) were control- no AS, control-AS, nAu-no AS, nAu-AS. Prior to exposure, the control group displayed risk-taking behaviours in the NTDT which remained consistent upon the removal of the social conspecifics from the maze. The fish exposed to leachate, alarm substance, and a combination of both displayed increased risk-

averse/anxiety-like behaviours in comparison to the control group and did not freely explore the unfamiliar zone of the maze. There were statistically significant differences between the overall time spent moving or distance travelled in specific zones within the maze compared between exposure groups. This study highlights that further research is required in the safe development of commercially available products containing advanced materials.

P-11 – Automated identification of histological lesions in fish liver for environmental assessment

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Abstract: Histopathological assessment of tissue change is a cornerstone of environmental monitoring, but it is time- and resource-intensive. Machine learning (ML)-based digital histopathology offers a promising solution to handle ever-increasing data volumes. Here, we assessed liver lesions in two bioindicator fish species: Atlantic cod (*Gadus morhua*) and common dab (*Limanda limanda*). Liver samples were processed into whole-slide images (WSIs), and annotated by trained histopathologists for lesion types relevant to pollution monitoring: steatosis, melano-macrophage aggregates (MMAs), leucocyte infiltration, and granulomas. WSIs were processed using QuPath software, using manually annotated subsamples to train ML models. Random forest classifiers and watershed algorithms were employed to detect and quantify lesions, and results were statistically compared to scores from trained pathologists. ML models successfully identified and quantified lesions. Comparative accuracy exceeded 80% for all lesions and surpassed 95% for MMAs and granulomas, aligning with diagnostic standards in medical ML. Discrepancies between model outputs and traditional scoring highlighted the limitations of subjective grading and the need for biologically-defined thresholds. This study demonstrates the feasibility of ML-based digital histopathology in environmental monitoring. Further development of this method will lead to more objective, scalable, and reproducible workflows for tissue analysis, available to a broad community of scientists.

Keywords: artificial intelligence, histopathology, image analysis, automated histomorphometry, environmental monitoring

P-12 – MULTI-OMICS AND BIOMARKER ASSESSMENT OF REPRODUCTIVE TOXICITY IN POLAR COD (*BOREOGADUS SAIDA*) EXPOSED TO CRUDE OIL

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Abstract: Understanding how crude oil exposure affects fish reproduction is essential for assessing the ecological risks of oil spills in Arctic ecosystems. We exposed polar cod (*Boreogadus saida*) to water-soluble fractions (WSF) of weathered crude oil during late vitellogenesis and monitored the fish until spawning, using an integrated multiomics and biomarker approach. Oil-derived compounds (naphthalenes, substituted monoaromatics, and PAHs) accumulated in brain, gonad, and liver tissues. Hepatic EROD activity showed a dosedependent induction followed by a rapid decline post-exposure, confirming exposure and biotransformation. In contrast, PAH metabolites in bile remained elevated, suggesting persistent metabolic processing of accumulated compounds. WSF exposure advanced spawning by up to 20 days and reduced fertilized egg diameter at the highest dose. Transcriptomic analysis revealed early upregulation of detoxification genes in liver and disruption of lipid metabolism pathways in gonads. Lipidomic and proteomic analyses of spawned eggs confirmed altered lipid composition, reduced triglyceride synthesis, and compromised protein metabolism. In spawning-active females, the strongest transcriptomic responses occurred in gonads with activation of signaling pathways involved in cellular stress and apoptosis, and with distinct gene regulation patterns across doses, suggesting differential mechanisms. Finally, pituitary and liver showed an overweight of down-regulated genes. These findings highlight molecular disruptions along the pituitary–gonad–liver axis and provide insights into how crude oil exposure can impair reproductive success in Arctic fish species.

Keywords: Endocrine disruption, vitellogenesis, PAH metabolites, EROD activity, Transcriptomics

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P-13 – Toxicity screening of crude oil fractions using reporter gene assay for Atlantic cod receptors

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Abstract: Crude oil and its water accommodated fractions (WAF) are complex mixtures, with chronic toxicity historically assigned to effects of polycyclic aromatic hydrocarbons (PAHs) through the aryl hydrocarbon receptor (Ahr) pathway. However less is known regarding the toxicity of the other constituents of crude oil. Here we investigated the toxicity of specific chemical fractions of WAF using a reporter gene assay to assess how these compounds can modulate the activity of cod nuclear receptors linked to detoxification pathways and reproduction. Previously established *in vitro* luciferase reporter gene assays for receptors linked to detoxification pathways (Ahr, aryl hydrocarbon receptor; Pxr, pregnane X receptor), energy metabolism (Ppar, peroxisome proliferator-activated receptor), and reproduction (Er, estrogen receptor) were used to investigate receptor activation by WAF fractions and extract. Preliminary results of WAF extract exposure shown activation of Ahr2a and Pxr. This result validates the data obtained by RT-qPCR, which showed significant increase in *cyp1a* expression in liver slices exposed to the total WAF extract and resin fraction, which may suggest the presence of Ahr agonists. Ultimately, this *in vitro* approach will help identify toxicity pathways of chemical components of crude-oil, which may be linked to adverse outcomes such as reproductive success, fitness, and survival.

Keywords: water-soluble fractions, polycyclic aromatic hydrocarbons, detoxification pathways

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P-14 – Using precision-cut liver slices for assessing hepatic toxicity of components of crude oil on Atlantic cod (*Gadus morhua*)

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Abstract: Increased oil activity in the Arctic poses significant risks to marine ecosystems and key species like polar cod (*Boreogadus saida*) and Atlantic cod (*Gadus morhua*). Crude oil and its water-accommodated fractions (WAFs) are complex mixtures, with toxicity often linked to polycyclic aromatic hydrocarbons (PAHs) acting through the aryl hydrocarbon receptor (Ahr) pathway. This study aimed to investigate the toxicity pathways of specific chemical fractions of a crude oil WAF using cod precision-cut liver slices (PCLS) as *ex vivo* exposure method. Five WAF fractions—saturates, monoaromatics, naphthalenes, PAHs, and resins—along with total WAF extract were tested. Liver slices from male and female cod were exposed for 48 hours to dilutions of each fraction. The mRNA levels of genes related to the xenobiotic metabolism and reproduction (i.e. *cyp1a* and *vtg*, respectively) were quantified by RT-qPCR. *Cyp1a* expression increased dose-dependently in the total WAF (20-fold), and resin (5-fold) fractions, suggesting Ahr activation. Chemical analysis identified abundant compounds such as 7-methyl-1-indanone and anthrone in the resin fraction. Other fractions, including PAHs, showed limited effects, likely due to low concentrations or weak Ahr agonists like phenanthrene. This study is highly important to elucidate the mixture toxicity of crude oil WAF and its main drivers.

Keywords: water-soluble fractions, polycyclic aromatic hydrocarbons, detoxification pathways

Acknowledgements: Research Council of Norway (Toxigen project no. 334541)

P-15 – Omics and Insights: Bioinformatics-driven environmental analysis of the red alga *Palmaria palmata*

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Abstract: Bioinformatics is an essential tool in environmental research, and often it encounters the studying of species that play important roles in ecosystems but lack detailed genetic information. Among these is *Palmaria palmata*, a red seaweed with significant ecological and commercial relevance in North Atlantic. At present, no genome annotation has been performed, limiting the understanding of research findings. In this case study, we are reporting the first genome annotation of *P. palmata*, which is supported by a comprehensive set of transcriptomes. The goal was to capture as many active genes as possible to aid accurate gene model prediction. To achieve this, transcriptomic data were obtained from four seasons on non-reproductive individuals. The diverse dataset enhanced gene model accuracy prediction and completeness using tools like RepeatModeler, RepeatMasker, HISAT2, AUGUSTUS, BUSCO, and InterProScan with integrated transcript and protein evidence. The resulting annotation can now serve as a foundation for future studies of *P. palmata*, enabling better insight into its functional biology. Furthermore, this study highlights how bioinformatics enhances genomic resources for non-model marine organisms, and also opens new opportunities for advancing environmental research.

Keywords: genome annotation, transcriptomics, environmental genomics

P-16 – Physically Based Pharmacokinetic (PBPK) model for the Arctic fish species *Atlantic halibut*

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Abstract: The reduction of sea ice in the Arctic has opened previously inaccessible areas to commercial activity, increasing anthropogenic pressure on this pristine environment. Climate change and rising emissions are introducing new substances into Arctic waters, threatening marine life and human consumers of fish. Due to the vast number of chemicals, it is not feasible to test all substances on all species, highlighting the need for predictive tools in environmental exposure, hazard and risk assessment. Physiologically based pharmacokinetic (PBPK) models are foreseen to play a key role in characterization of absorption, distribution, metabolism, and excretion (ADME) of pollutants and aid *in vitro* to *in vivo* extrapolation (IVIVE) in Next Generation Risk Assessment (NGRA).

This work aimed to support PBPK model development for a key Arctic species, the Atlantic halibut (*Hippoglossus hippoglossus*), by characterizing relevant physiological parameters. A multi-compartment PBPK model was established based on existing fish PBPK models. Each compartment was defined by volume, lipid and water content, and blood flow. Parameters were obtained through measurements in halibut and literature reviews. The data lays the foundation for Arctic-relevant PBPK models in general, a halibut PBPK in particular, and support future NGRA of chemical exposures to Arctic marine fish species.

Keywords: ADME, in vitro to in vivo extrapolation, bioaccumulation, next generation risk assessment (NGRA).

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P-17 – Swimming behaviour and respiration rate of two North Atlantic deep-sea amphipods (*T. cicada* and *O. obtusa*, Lysianassidae) under temperature stress

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Abstract: Climate change and the steady hunt for oil and mineral resources put increasing pressure on yet widely unexplored deep-sea ecosystems. Relevant ecophysiological studies on the consequences of these pressures are scarce, as many deep-sea species are difficult to collect unscathed. The lysianassid amphipods *Tmetonyx cicada* and *Orchomenella obtusa* take a key role as recyclers in deep-water ecosystems. Both species are relatively sturdy, occur over a broader bathymetric range, and can be easily collected using baited traps. This makes them ideal candidates for exploring anthropogenic impacts on deep-sea organisms under laboratory conditions.

For both species baseline physiological and behavioural data are still lacking. Thus, we separated them into two size-ranges and investigated their swimming behaviour and respiration rates under a preferred (7°C) and raised (11°C) temperature regime. Moreover, we examined the effect of the experimental unit size on the behavioural endpoints.

Our results indicate species-specific sensitivity to raised temperature and emphasize the interplay of specimen size and the experimental unit in shaping behavioural patterns. Further research on the different amphipod stages could assist in discriminating size- from stage- (and species-)specific responses. Overall, our findings provide an experimental basis for follow-up studies that seek to explore stress responses in deep-sea scavenging amphipods.

P-18 – STRESS-DEPENDENT SHIFTS IN GENOTOXIC SENSITIVITY OF ARCTIC ZOOPLANKTON

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Abstract: The Arctic Ocean is increasingly exposed to multiple stressors, including rising temperatures and metal pollution. Zooplankton, as central components of the Arctic food web, exhibit varying sensitivities to these stressors depending on their ecological niches. This study compares acute and sublethal genotoxic responses of two ecologically distinct Arctic zooplankton species; surface-dwelling *Acartia longiremis* and deeper-dwelling *Calanus spp*.; to combined copper (Cu) and temperature stress. Morphological analysis (antenna colour) and DNA barcoding revealed the *Calanus spp*. assemblage was dominated by *C. finmarchicus* (74.3%) with fewer *C. glacialis* (25.7%). Acute exposure to elevated temperature (11 °C) or Cu (20 µg/L) resulted in greater mortality in *A. longiremis* than in *Calanus spp.* Sublethal exposure to the individual and combined stress for 24 h showed a contrasting pattern as revealed by DNA damage analysis and targeted gene expression. Genotoxicity appeared linked to oxidative stress, DNA damage through strand breaks and cross-links, and impaired defense and repair mechanisms with species-specific differences in stress response pathways. *A. longiremis* showed higher acute sensitivity, while *Calanus spp.* were more susceptible to sublethal genotoxic effects. These findings highlight that zooplankton from distinct microhabitats within the same Arctic ecosystem can exhibit different vulnerabilities and mechanistic defences to co-occurring stressors.

Keywords: Copepods, multi-stress, DNA damage, copper, warming