

NordGlobal 2019 - 2nd International Joint Conference on Global Change

Quality of Life in an Age of Global Change

Coordinating author:
Ioannis Vatsos

Nord university
Conference report
Bodø 2019



NORD GLOBAL – 2019 –

**NordGlobal 2019 – 2nd International Joint Conference on Global
Change**

Quality of Life in an Age of Global Change

Conference Proceedings

ABSTRACTS

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Preface

In the last decades, we have been witnessing dramatic human-induced earth system changes, the most notable being climate change, but also biodiversity loss, pollution, acidification of the oceans, deforestation and the overexploitation of non-renewable resources. Furthermore, more than half of the world's population currently lives in urban areas. This increasing urbanization has some social and economic advantages, such as better education, health care, sanitation, housing, but also significant consequences on the environment, our lifestyle and well-being. These consequences include development of slums, increased crime rate, fast spread of diseases and management of huge amounts of human wastes.

Despite the seriousness of the problems, most people are still not aware of the effects and consequences. Thus, there is a need to not only increase the awareness of the general public, but also to strengthen the collaboration between the main partners involved in decision making, namely the various governmental bodies, industry and research community.

Acknowledging the importance of global changes, Nord University (NORD) and the University of Veterinary Medicine and Pharmacy (UVMP) in Kosice organized the 1st joint international conference "The impact of global change on the environment, human and animal health" in Košice in May 2017. After completion of this conference, and based on its success, it was decided to strengthen the bilateral collaboration between UVLF and NORD, and continue the dissemination related to global changes by the establishment of a series of relevant bi-annual international conferences.

The 2nd International Joint Conference on Global Change with the title "NordGlobal2019 - Quality of Life in an Age of Global Change" takes place in Bodø, on 21-22 May 2019. The conference has a cross-disciplinary character and while the main focus is on the interactions between human activities, animal health and the environment, there are presentations on the intense urbanization, sustainable bio-economy and the future of energy sources.

I would like to thank all members of the scientific and organising committee, as well as all presenters for their contribution.

Coordinator of the conference

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Associate Professor

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Disclaimer

The printed version of the proceedings contains only the abstracts submitted by May 10, 2019. The authors are responsible for content and quality of figures. The opinions expressed in the abstracts do not necessarily reflect the opinion of the NordGlobal2019 Scientific Committee.

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Scientific Program

Tuesday 21 May 2019

Session 1 - Responsible Sustainable Food production and Global Change

Chairing: Jozef Nagy and Mette Sørensen

09:00-09:20	Opening speeches	
09:20-10:05	Global changes - food security and safety	Jozef Nagy UVMP
10:05-10:30	Welfare Indicators for farmed Atlantic salmon: tools for assessing fish welfare	Martin Haugmo Iversen Nord University
10:30-10:55	Use of microalgae in salmon diets	Mette Sørensen Nord University
11:00-11:15	<i>Coffee Break</i>	
11:15-11:40	Nutrient digestibility and intestinal health of Atlantic salmon fed different combinations of marine and plant	Solveig Lysfjord Sørensen Nord University
11:40-12:05	The potential of plant protein ingredients in diets for juvenile lumpfish (<i>Cyclopterus lumpus</i>)	Florence Perera Nord University
12:05-12:30	Dietary intervention strengthens the skin protective barrier of Atlantic salmon (<i>Salmo salar</i>)	Nimalan Nadanabesan Nord University
12:30-12:55	Storage temperature affects the viability of probiotics in aquafeeds	Adriána Fečkaninová UVMP
13:00-14:00	<i>Lunch Break</i>	

Session 2 - One Health

Chairing: David Rollinson and Jana Mojžišová

14:00-14:45	Global de-worming : progress and challenges	David Rollinson The Natural History Museum, London, UK
14:45-15:10	The effect of global climate change on the survival of some transported animals	Daniela Takáčová UVMP
15:10-15:35	Impact of climate change on the biting midge populations in Slovakia	Alica Kočíšová UVMP
15:35-15:50	<i>Coffee Break</i>	
15:50-16:15	Ocean acidification affects gene expression	Steinar Daae Johansen Nord University
16:15-16:40	Methane from cows – a problem or a resource?	Geir Næss Nord University
16:40-17:05	From understanding adaptive potential to biodiversity conservation and natural resource management	Joost Raeymaekers Nord University

17:05-17:30	Population genomics of freshwater sardines in Central African lakes, and its translation into fisheries policy	Leona Milec <i>Nord University</i>
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Wednesday 22 May 2019

Session 3 - Sustainable Bio-economy / Urbanization Chairing: Atle Midttun, Ove D. Jakobsen and Marina Gørtz

09:00-09:45	Civilizing Capitalism	Atle Midttun <i>Norwegian Business School</i>
09:45-10:10	Anarchism and ecological economics - a transformative approach to a sustainable future	Ove D. Jakobsen <i>Nord University</i>
10:10-10:35	Quality of life in sustainability transitions: the case of Hurdal Ecovillage (Norway)	Amsale K. Temesgen <i>Nord University</i>
10:35-11:00	How can stories from practice contribute to a holistic and dynamic definition of the concept quality	Vivi Marie Lademoen Storsletten <i>Nord University</i>
11:00-11:15	<i>Coffee Break</i>	
11:15-12:00	Green infrastructure: opportunities, challenges and solutions	Marina Gørtz <i>Urban Naturkontakt</i>
12:00-12:25	Waste resource management - how to close the waste loops of the city? – Possibilities and challenges	Bjarne Lindeløv <i>Nordland Research Institute</i>
12:25-12:50	Green campus Bodø	Tanja Ellingsen <i>Nord University</i>
13:00-14:00	<i>Lunch Break</i>	

Session 4 - The future of Energy Chairing: Stig Skreslet and Ana Vassileva Borissova

14:00-14:45	Hydrogen use as a fuel for mobile applications	Ana Vassileva Borissova <i>Nord University</i>
14:45-15:10	Hydropower, fisheries oceanography and cycling of CO2 in Climate Change perspective	Stig Skreslet <i>Nord University</i>
15:10-15:30	<i>Coffee Break</i>	
15:30-15:55	Microbial surfactants – applications for the petroleum industry	Yousri A.A. Abdelhafiz <i>Nord University</i>
15:55-16:10	Closing Speeches	

Key note presentation

GLOBAL CHANGES – FOOD SECURITY AND FOOD SAFETY

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ABSTRACT

Global change and globalization are inexorably interlinked. The process of economic and social globalization through the integration of world markets, exchange of populations and ideas, and through the creation of international institutions has created historically unprecedented opportunities for economic growth and development (Global Change and Globalization, 2019).

Global change does not only include warming, but also population and animal migration, trade in various goods and animals, and thus have epidemiological, zoonotological and socio-economic impacts.

Global warming has serious implications for all aspects of human life, including infectious diseases. The effect of global warming depends on the complex interaction between the human host population and the causative infectious agent (Khasnis & Nettleman, 2005). Climate change is likely to have considerable impacts on food safety, both direct and indirect, placing public health at risk. (Food safety, Climate Change and the Role of WHO, 2008). Climate change affects agriculture and food production in complex ways. It affects food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes, and thus demand for agricultural produce. (Schmidhuber & Tubiello, 2007).

Climate change may have both direct and indirect impact on the occurrence of food safety hazards at various stages of the food production chain (El Samra, 2017). Globalization also poses problems in terms of misleading and deceiving consumers, as well as food counterfeiting.

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WELFARE INDICATORS FOR FARMED ATLANTIC SALMON: TOOLS FOR ASSESSING FISH WELFARE

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ABSTRACT

Fish welfare is a key issue in commercial farming and is central to many key decisions farmers take during their daily husbandry practices and longer term production planning. It is also a prominent topic for NGO's, animal welfare organisations and charities, regulatory bodies, policy makers and consumers. Farmers have long been interested in optimising the welfare of their stock and actively employ strategies that address fish welfare concerns and attempt to minimise fish welfare threats. Independent third party organisations have even developed fish welfare standards and certification schemes for certain aquaculture species (e.g. RSPCA Assured standards for Atlantic salmon). The FISHWELL welfare indicator handbook is the primary output of the Norwegian Seafood Research Fund (Fiskeri - og Havbruksnæringens Forskningsfond, FHF) project «FISHWELL: Kunnskapssammenstilling om fiskevelferd for laks og regnbueørret i oppdrett». The project group included a diverse range of welfare scientists and veterinarians from Nofima, the Institute of Marine Research, Nord University, the Norwegian Veterinary Institute (all Norway) and the University of Stirling (UK). The handbook had three key objectives:

1. Provide the user with an updated scientific summary of the welfare of Atlantic salmon in relation to its welfare needs at different life stages. We also link welfare indicators to specific welfare needs. We describe how each indicator can be used, important parameters or thresholds to look for, the pro's and con's of using it and evaluate whether it's an Operational Welfare Indicator (OWI) or a Laboratory-based Welfare Indicator (LABWI).
2. Provide the user with information on which OWIs and LABWIs are appropriate and fit for purpose in different production systems.
3. Provide the user with information on which OWIs and LABWIs are appropriate and fit for purpose for different husbandry routines and operations.

USE OF MICROALGAE IN SALMON DIETS

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ABSTRACT

Macro and micronutrients in novel marine resources such as microalgae are of interest to the food and feed industry. Microalgae may represent sustainable alternatives to fishmeal and fish oil. Microalgae are primary producers in the marine ecosystem, and these photosynthetic microorganisms make use of light energy, CO₂ and dissolved ions in the water to synthesize complex molecules that constitute their biomass. Microalgal biomass is a source of protein and functional ingredients such as polyunsaturated fatty acids, polysaccharides, pigments, minerals, vitamins, enzymes and bioactive peptides. Several varieties of microalgae are gaining widespread commercial acceptance; they are used in foods and feeds. The aquaculture industry could depend on these new sources of feed ingredients to maintain sustainability. Microalgal meal and oil are perceived as more sustainable than terrestrial plant-derived feed ingredients because microalgae have the ability to grow faster, produce higher nutrient concentration per kg dry matter, have greater photosynthetic efficiency and better CO₂ capture capacity, and they have the ability to grow on non-arable land or in ponds.

Research on microalgae was initiated at Nord University in 2009 to examine the potential of defatted biomass—derived as a co-product of biofuel production—as ingredients in the feeds for fish and shellfish. Ever since, through national and international funding, we have been examining the potential of defatted (*Nanofrustulum* sp., *Desmodesmus* sp. and *Nannochloropsis* sp.) and whole microalgae (*Nannochloropsis* sp., *Tetraselmis* sp. and *Tetraselmis chuii*, *Scenedesmus* sp. and *Phaeodactylum tricornutum*) to be used as components in aquafeeds. Our research so far has shown that microalgae are promising alternates to fishmeal, at moderate inclusion levels (Gong et al., 2018; Kiron et al., 2012; 2016; Sørensen et al., 2016; 2017). Our current efforts are directed towards increasing the utilization of microalgae through disruption of cell walls.

Acknowledgments

Marine algae for salmon feeds, 2016-2019. EU-COFASP/ Research Council of Norway (260190). Our earlier studies were funded by the Department of Energy (DoE), USA (DE-EE0003371).

NUTRIENT DIGESTIBILITY AND INTESTINAL HEALTH OF ATLANTIC SALMON *SALMO SALAR* FED DIFFERENT COMBINATIONS OF MARINE AND PLANT INGREDIENTS

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ABSTRACT

A variety of plant ingredients are used as replacements of fish meal and fish oil in feeds for Atlantic salmon (*Salmo salar*). It is important to understand the effects of decreasing amount of marine ingredients in fish diets on feed utilization and fish health. Intestinal health is critical for nutrient digestion, absorption and growth of the fish. Some plant ingredients, e.g. soybean meal, are known to cause intestinal inflammation in fish. Similarly, plant oils at high inclusion levels when combined with low inclusion levels of marine ingredients may have adverse effects on intestinal health. Intestinal mucins, a critical component of mucus, play vital roles in protection of fish. We hypothesize that feed with different combination of plant proteins, plant oil, fish meal and fish oil may affect the intestinal health and nutrient digestibility of Atlantic salmon.

We examined the effect of five diets (BG1 – fish meal and fish oil; BG2 - fish meal, soybean meal and fish oil; BG3 – fish meal and rapeseed oil; BG4 – mix of plant protein concentrates and fish oil; BG5 – mix of plant protein concentrates, fish meal, rapeseed oil and fish oil) on digestibility, growth and intestinal health of Atlantic salmon post smolt after feeding for 7 weeks.

Significant differences were observed in final body weight, weight gain (Figure 1) and apparent digestibility coefficients (Figure 2) of the feed groups. Soybean meal fed fish had the lowest growth because of intestinal inflammation, as confirmed by histomorphology. The intestinal health of Atlantic salmon was not negatively affected by the other experimental diets. Reduced weight gain in plant protein diets compared to fish meal diets was not caused by intestinal inflammation. Gene expression analysis of health-related genes in distal intestine is currently being conducted, and the results will be presented at the conference.

Acknowledgements:

This study was funded by MABIT and is carried out in collaboration with BioVivo Technology AS.

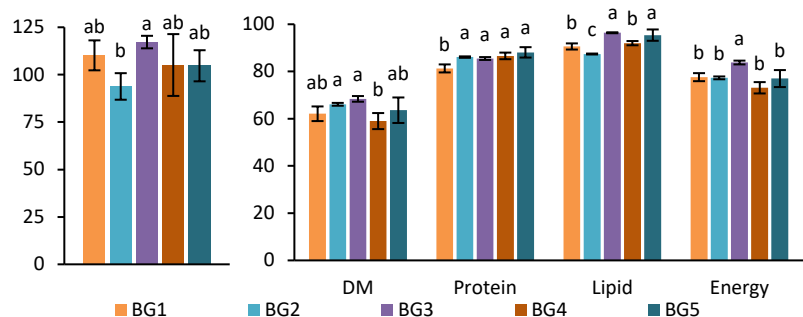


Figure 1: Weight gain (%). Letters indicate significant differences ($p < 0.05$).

Figure 2: Apparent digestibility coefficient (ADC, %) Letters indicate significant differences ($p < 0.05$).

THE POTENTIAL OF PLANT PROTEIN INGREDIENTS IN DIETS FOR JUVENILE LUMPFISH (*CYCLOPTERUS LUMPUS*)

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ABSTRACT

Lumpfish (*Cyclopterus lumpus*) is the second largest aquaculture species in Norway. Commercial production of lumpfish has grown exponentially from 2012 and reached about 12 million juveniles in 2015. Lumpfish is not produced for human consumption, but is currently used as cleaner fish to control salmon lice in salmon (*Salmo salar*) farming. The popularity of lumpfish has increasing due to their advantages over other cleaner fish species, as they continue grazing on sea lice at low temperatures (Nytrø et al. 2014) and can be introduction in salmon farms 4 months post hatching. Other species such as ballan wrasse (*Labrus bergylta*) need approx. 1.5 years (Helland et al. 2014), and they are less efficient louse pickers at sea water temperatures below 6°C (Sayer and Reader, 1996).

Lumpfish is a novel species and there is not much literature published addressing basic biology. Knowledge is needed with respect to digestive physiology, nutrient requirements, fish welfare and robustness of the fish in aquaculture operations. There is an urgent need to improve the knowledge of responses to alternative ingredients and cost effective diets at different development stages. Compared to fishmeal, plant products such as soy protein concentrate (SPC) and pea protein concentrate (PPC) have a higher availability at lower cost. The aim of this study was to investigate growth, digestive physiology and gut health when lumpfish is fed diets where SPC and PPC replace fishmeal.

Four iso-nitrogenous and iso-energetic experimental diets were formulated to contain fishmeal (Control) or a plant protein mix (SPC and PPC; 1:1 ratio) replacing fishmeal at 25%, 50% and 75%. The experiment was carried out in triplicates at Mørkvedbukta research station, Nord University (Bodø, Norway). Juvenile lumpfish of approximately 4g were purchased from a commercial hatchery (Mørkvedbukta AS, Norway). 2400 juvenile fish was randomly allocate to twelve 500L circular tanks with around 206 individuals per tank with continues feeding and dimmed light setting according to best commercial practice. Biometrical data of all fish was be recorded at the beginning and end of the experiment for analyses of growth and organo-somatic indices. In addition, samples for different purposes was taken at the start and after 2.5, 5weeks as well as at the end of the experiment. Analysis for proximate composition, fatty acids, histology (gut and muscle) was performed to study the dietary effects on growth and gut health of juvenile lumpfish. Analysis are currently being carried out and will be presented.

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DIETARY INTERVENTION STRENGTHENS THE SKIN PROTECTIVE BARRIER OF ATLANTIC SALMON (*SALMO SALAR*)

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ABSTRACT

Commercial salmon feeds used in Norway are based on a mixture of plant and marine ingredients. Over the last decades the proportion of the plant ingredients in the feeds have increased while that of the marine components have decreased; the current ratio of plant: marine ingredients is 70:30. Plant proteins in the feeds are generally derived from protein concentrates. Although the antinutritional factors (ANFs) in the plant ingredients are being reduced through various ingredient-processing techniques, 'cocktail' effects of the residual ANFs in different ingredients may have adverse effects on the growth and health of Atlantic salmon. Furthermore, the unfavourable n-3:n-6 ratio in plant lipids does not provide the recommended EPA and DHA to Atlantic salmon. Hence, ingredients in diets may have an effect on fish health. In addition, dietary probiotics can influence the mucosal immune system and strengthen the defence mechanisms in fish. It can be hypothesized that both dietary components and probiotics can affect the health of Atlantic salmon. This study investigated the changes in histomorphology of the skin of Atlantic salmon fed different diets with or without probiotics.

A feeding experiment was conducted with Atlantic salmon; 3 groups of fish were first fed 3 different basal diets, and later the same diets coated with probiotics. The ingredient composition of the diets were Diet 1: fish meal/fish oil, Diet 2: a commercial-like diet with a plant/marine ingredient ratio of 70:30, and Diet 3: a fish meal/fish oil-based diet in which soybean meal was replaced with 20% of fish meal. Dorsal skin samples were collected from 12 fish per treatment and fixed in 4% formalin. Samples were decalcified with 10% formic acid for 5 h. Tissue sections of 4 µm were prepared and stained with H&E and AB-PAS. Images (9/fish, 108/diet) were acquired and quantitative analysis was performed using Image J.

The results did not reveal any differences in the mucous cells area and the mucous cells area per epithelium. However, the number of mucous cells per epithelium area (M/E) was significantly influenced by diet and probiotics. Fish fed Diets 2 and 3 had more M/E compared to the fish that received Diet 1. Addition of probiotics to Diet 1 increased the M/E in the skin, implying a strengthened protective barrier.

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STORAGE TEMPERATURE AFFECTS THE VIABILITY OF PROBIOTICS IN AQUAFEEDS

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ABSTRACT

Antibiotics represent a threat to public health because excessive use of antimicrobials promote the risk of selection, propagation, and persistence of drug-resistant bacterial strains. Today, consumers demand antibiotic-free food and preventive measures are preferred over cure. Probiotics may be a better solution to prevent disease outbreaks in aquaculture (Cruz et al., 2012). Verschuere et al. (2000) defined probiotics in aquaculture as “a live microbial adjunct which has a beneficial effect on the host by modifying the host-associated or ambient microbial community, by ensuring improved use of the feed or enhancing its nutritional value, by enhancing the host response towards disease, or by improving the quality of its ambient environment.” Efficacy of probiotics in feeds is compromised by the high temperature employed in the feed manufacturing process. Probiotics such as *Lactobacillus*, *Bacillus*, and yeasts are functional only when they are viable and present in sufficient amounts in the feed (Markowiak and Śliżewska, 2018). Previous studies have not detailed an effective protocol to add probiotics to aquafeeds without affecting the viability of the microorganisms. The aim of the present study was to develop protocols for supplementation of probiotics to aquafeeds, and to examine their viability in an 8-month shelf life study at different feed storage conditions (refrigerator temperature or room temperature). Two strains of Lactobacilli (LA and LB), with a potential to be used as probiotics in aquaculture, were incorporated in experimental feeds. Overall, 11 groups of probiotic pellets were prepared. LA had better viability in both storage conditions compared to LB that could not withstand room temperature for more than 3 months. The number of bacterial cells of LA dropped from $9.04 \pm 0.14 \log_{10}\text{CFU}\cdot\text{g}^{-1}$ to $8.47 \pm 0.12 \log_{10}\text{CFU}\cdot\text{g}^{-1}$ during the 8-month storage period at 4 °C. Storage in refrigerator helped probiotic bacterial cells to survive in the fish feed. Thus, temperature is considered as a critical factor that influences probiotic viability and survival during the storage period.

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Key note presentation

GLOBAL DE-WORMING: PROGRESS AND CHALLENGES

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ABSTRACT

With over 1 billion people infected globally, particularly in resource-poor settings, the Neglected Tropical Diseases (NTDs) are responsible for considerable human suffering. The NTDs have been formally recognised as a target for global action towards the Sustainable Development Goals (SDG3). However, the complex biology of many parasites causing disease, often involving multiple vectors and hosts, together with their inherent genetic diversity and long evolutionary history make parasites formidable foes. Efforts to control and even eliminate some infections benefit hugely from government-led preventive chemotherapy programmes (facilitated by donations of drugs from the pharmaceutical sector), vector control, improvements in water and sanitation and development of other interventions but many significant challenges lay ahead. We are faced with factors such as climate and environmental change, migration of people, invasion by vectors, loss of biodiversity and emerging drug resistance, all of which threaten to change the disease landscape, often coupled with insufficient resources for treatment of the people in most need. This lecture will highlight current progress in the control of schistosomiasis (bilharzia) and other worm infections, such as the soil transmitted helminths and Guinea worm, in different parts of Africa. The need for a *One Health* approach will be highlighted; firstly by studies on hybridization between schistosome species that normally infect humans and cattle (such hybrid infections commonly occur in West Africa and have recently been identified in Corsica); and secondly, by the finding that Guinea worm infections are being maintained in dogs and the eradication programme will be severely hindered. If global de-worming is to be achieved we must delve more deeply into aspects of parasite life cycles and the tools needed for control.

THE EFFECT OF GLOBAL CLIMATE CHANGE ON THE SURVIVAL OF SOME TRANSPORTED ANIMALS

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ABSTRACT

The recent years there has been a rise in popularity of keeping exotic animals as pets. Different countries have different approaches to the regulations and conducting of these, both when it comes to protecting humans and animals, as well as the biodiversity from various problems related to import, trade and keeping these animals as pets. Some of the most popular exotic pet animals kept in Europe are reptiles and amphibians. By comparing the two different set of regulations and comparison related to the current situation in both Norway and the European Union regarding keeping reptiles and amphibians, we may conclude if the regulations are strict enough to maintain good animal welfare, protect the public health and keep a balanced biodiversity, which may be influenced by altitude, climate, relief, water availability, bedrock but also human intervention. A large proportion of non-traditional pets are sourced through international trade. Both regional and international trade in non-traditional animals for the pet industry have been increasing in the last 25 years (Schuppli, Fraser and Bacon, 2014). There is also a large documented illegal trade in nontraditional pet species (Nijman, 2010). Animals are taken away from their natural habitats, they have to survive during grueling transport conditions and those who do survive are often subject to inadequate care or remain in unsuitable conditions. Without appropriate habitats or rehabilitation, many of these animals will starve or fall victim to the elements or predators. Those who do survive may overpopulate and cause an ecosystem disaster, killing native species. (PETA org., 2019). Climate variability and global change affects animals that have difficulty adapting to changed conditions. Animals are exposed to conditions they are not used to, which can also cause their death. Although it is thought that no species has yet become extinct exclusively because of climate change, many animal species are expected to become extinct in the near future (Weather & Climate, 2018)

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IMPACT OF CLIMATE CHANGE ON THE BITING MIDGE POPULATIONS IN SLOVAKIA

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ABSTRACT

Culicoides biting midges occur throughout major part of inhabited world, where they transmit number of pathogens (viruses and parasites) causing animal diseases of veterinary importance. The Bluetongue Virus (BTV) and the Schmallenberg Virus (SBV) cause great direct as well as indirect financial losses in stockbreeding and sheep breeding in many states of the European Union. A number of factors, in particular the climate change with the most remarkable impact, influence the spread of the viruses and midges. Local populations of biting midges are able to adapt to pathogen transmission in changed climate conditions. Our entomological survey was carried out on the farms in the Košice and Prešov regions using light traps. Individual midge species were determined according to morphological features (Mathieu et al., 2012). The analyses of the relationship between the numbers of collected biting midges and the temperature, humidity, and the air flow was carried out by applying the ANOVA test. Over the past 10 years, we captured 249,376 *Culicoides* belonging to 46 species (Sarvašová et al., 2014; Kočišová et al., 2017). The most prevalent were species from *Obsoletus* and *Pulicaris* complexes. *Culicoides* were active from late April to early November, with the highest activity of *C. obsoletus/C. scoticus* and *C. punctatus* recorded every year from the end of May to the end of July. However, their abundance and species composition have been affected by climatic conditions in individual years. We confirmed a statistically significant dependence of midge occurrence on daytime temperature (positive dependence) and wind velocity (negative dependence). A positive correlation was between temperature and abundance of midges. In the autumn, *Culicoides* were active the external environment at temperatures ranging from -1.5 °C to +9.3 °C. This study confirmed the domination of the *Obsoletus* (*C. obsoletus/C. scoticus*) vectors in animal breeding, indicating the risk potential for virus transmission (BTV, SBV) in Slovakia. The research was supported within the VEGA Project No. 1/0043/19.

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OCEAN ACIDIFICATION AFFECTS GENE EXPRESSION

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ABSTRACT

Carbon dioxide (CO₂) is a critical and essential component of the Earth's atmosphere. Over the recent years a global climate change has been observed due to an increased amount of emitted CO₂. Every day > 25 million tons of CO₂ are absorbed by the oceans, which has resulted in 30% more acidic surface water since the beginning of the industrial revolution.

The impact of ocean acidification to marine life is a major concern to the society, and multidisciplinary research has been initiated to gain new insight. Here, marine CO₂ vents have become 'natural laboratories' for investigating long-term ecosystem effects of ocean acidification.

Sea anemones (*Anemonia viridis*) appear to thrive at ocean acidification conditions at natural CO₂ vents (Suggett et al. 2012). We challenged this observation by full-scale genomic and transcriptomic analyses:

- Mitochondrial genome and whole nuclear genome were sequenced as reference resources (Chi et al. 2018; Urbarova et al. 2018)
- Small regulatory RNAs were determined from specimens sampled at different seawater pH (Urbarova et al. 2018).
- Whole transcriptome from the sea anemone and its algal symbiont were characterized to assess gene expression effects of ocean acidification (Urbarova et al. 2019).

Our findings were unexpected and surprising.

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METHANE FROM COWS – A PROBLEM OR A RESOURCE?

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ABSTRACT

The livestock sector is a major source of food, employment and livelihood and accounts for ~40% of agricultural gross domestic product. In future, this sector will be even more crucial to achieve global food security particularly in light of rising human population and subsequent increase for demands for livestock products. On the other hand, livestock sector is an important contributor of greenhouse gases (GHG) as the global livestock sector represents about ~15% of total anthropogenic GHG emissions including methane (CH₄) as a major GHG produced via enteric fermentation by ruminant animals. The livestock is facing the challenge of being a “criminal to the environment” and thus, minimizing environmental threats while improving animal productivity is one of the biggest challenge of the future livestock sector.

Earlier studies have focused on reducing methane emissions from ruminants using various genetic improvement approaches to select animals with low residual feed intake and improved feed efficiency. Additionally, various dietary or animal nutritional strategies have been attempted aiming to minimize enteric methane production. However, it is yet to identify alternative feeding strategies that are profitable to farmers and can significantly reduce methane emissions without compromising production potential and animal health.

In this context, in collaboration with SINTEF, we here present a novel approach to minimize methane emissions from ruminants by treating the methane as a valuable resource rather than solely a problem. Since methane is ~28 times more potent than CO₂ as GHG (Myhre, G. et al, 2013, s. 73), we aim to convert CH₄ into CO₂ to reduce its impact as GHG and utilize heat as an energy source generated via the a lean combustion technology. The concept is to slightly up-concentrate CH₄ inside the barn. Since CH₄ has a lower density than air, it will rise up to the ceiling. The concentration is therefore expected to be higher under the roof. The air with increased CH₄ content will be led into and burnt in a special designed combustion unit, and the semi-hot, CO₂ containing gas from the combustion could be utilized as water-borne heat to the farm or for food production in green houses. The outcomes of this project would be important not only to minimize immediate methane emissions but design criteria for climate-friendly livestock barns in future.

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FROM UNDERSTANDING ADAPTIVE POTENTIAL TO BIODIVERSITY CONSERVATION AND NATURAL RESOURCE MANAGEMENT

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ABSTRACT

The current days are often referred to as the sixth mass extinction era. The rapid pace of environmental change is particularly alarming since species may not be able to track their environmental optima, and therefore will need to adapt. Adaptive potential is defined as the ability of natural populations to respond to environmental change. Yet, identifying the processes that determine adaptive potential remains a fundamental problem in biology. Notably, species may vary greatly in their capacity to avoid, tolerate or adapt to environmental change. This poses a major challenge for biodiversity conservation and natural resource management. First, anthropogenic impacts on ecosystems often put multiple species at risk, but the least tolerant species may not always benefit from management actions for the most tolerant species. Second, the spatial distribution of adaptive alleles, the genetic material which allows populations to avoid further negative growth and extinction (i.e., evolutionary rescue), may also vary between species. Protecting one area may thus help preserving the adaptive potential of one species, but not of others. Lack of understanding of these issues has triggered the development of multi-taxa approaches that aim at quantifying shared and unique adaptive responses across species within large and ecologically diverse landscapes. We will present an overview of these developments, and illustrate how they support biodiversity conservation and natural resource management.

POPULATION GENOMICS OF FRESHWATER SARDINES IN CENTRAL AFRICAN LAKES, AND ITS TRANSLATION INTO FISHERIES POLICY

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ABSTRACT

Small sardine-like freshwater fishes hold the potential to feed millions of people in the Global South. Yet, the biological mechanisms underlying the adaptation and resilience of these fishes to climate change and fishing pressure are poorly understood. Genetic approaches can provide valuable insights into stock structure, demography and adaptability of fish populations, which can be used to prevent overfishing and stock collapse. Despite the importance of this information, it is often still lacking in fisheries policy. The need for science-based management is particularly pressing in developing countries, as they are on the front lines of climate change, while human populations and food demand continue to grow. In this study, we develop essential genomic resources for the Central-African freshwater sardines *Stolothrissa tanganicae* and *Limnothrissa miodon* through the assembly and characterisation of their genomes. We then perform population genomic analyses in order to understand the genetic structure and adaptation of both fishes within and between Lake Tanganyika, Lake Kivu, Lake Kariba and the Cahora Bassa reservoir. Based on our findings, we convey advice for sustainable fisheries management in the socio-economic context of Sub-Saharan Africa.

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Key note presentation

CIVILIZING CAPITALISM – FOR A SUSTAINABLE MODERNITY

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ABSTRACT

Capitalism as Part of a Winning Formula

The presentation takes as a point of departure that capitalist market economy has been part of a winning formula that spurred exceptional growth in the West since the mid 19th century, that left its traditional peers, China and India, far behind. The mercantilist, and industrial capitalism that spurred the exceptional European economic growth did not, however, initially, trickle down to the common man and woman. Its external, predatory exploitation of colonies was to some extent matched by an internal exploitation of the domestic working class.

The Need for a “Civilizing Project”

To become a force for sustainable modernity, I argue, capitalism needed to be “civilized”, i.e. made socially and environmentally sustainable. Following supportive engagement by socially engaged liberal elites, the rise of organized labour signaled an unprecedented development in the history of European popular protest that eventually led to extensive revision of capitalist practice. The shift came about through a combination of worker engagement and protest, supported by emerging legislation which reflected the rising influence of workers, their rights to vote and the formation of political worker parties.

This development culminated with the welfare state, whose most advanced proponents – the Nordics - have perfected a productive interplay between competition and collaboration. They achieved productivity on par with, or even beyond, liberalist economies, but far surpassed them with respect to fair income distribution. The far less productive communist economies indicated that discarding capitalist market dynamics all together, was hardly a viable path.

Challenges of the 21st Century

Today, the civilizational formula that worked for the 20th century is severely challenged by major shifts in technology, business models, and market evolution. To mention but a few:

- Globalization, which transcends the regulatory boundaries of the nation state, with weak international institutions to cater for the public interest;
- ICT innovation, which creates networks with quasi-monopolistic power, along with new opportunities for undermining the public interest through tax evasion. The same refers to a massive scale up of financial sectors;
- Massive global industrialization, which poses unprecedented ecological challenges as global warming threatens livelihood in many places on earth.

New Models of 21st Century Capitalism?

Given the challenges, what approaches can we take to “civilizing” capitalism for the 21st century? Taking the position that capitalist market economy is essential for innovation and economic efficiency, I argue that, while we cannot discard it, we have to make it socially and environmentally sustainable in the new

conditions:

Some of the components of the 21st century civilizing approach are emerging and include:

- Scaling up regulatory capacity – through federation (EU) and international organizations – and designing approaches to serve the public interest in the novel global digital economy.
- Combining public governance with CSR and endogenous regulation in a ‘partnered governance’ mode.
- Supplementing the traditional political democracy with direct civic engagement, in what John Keane has called ‘Monitory Democracy’
- Pushing Nordic style labour market approach, such as ‘flexicurity’, further towards a de-facto citizen’s wage
- Moving from ‘green austerity’ towards ‘green growth’, while recognizing that welfare needs high material provision, but directed towards ecological balance.

IS ANARCHISM A RELEVANT POLITICAL PLATFORM FOR ECOLOGICAL ECONOMICS?

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ABSTRACT

In order to develop an economy that has positive impact on human well-being and contributes to resilient ecosystems, economists must be aware that we are an integral part of nature, rather than continuing under the illusion that we are a power over and above the natural world. Nature is something we depend upon to meet physical, psychological, cultural and spiritual needs therefore the goal is to develop an economy that create conditions conducive to life in the broadest sense. Freedom in solidarity should be the true ideals in society. This implicates deep changes in economy on systems level, individual level and on practice level.

I argue that such transformation is possible in practice but impossible within the existing ideology, therefore we have to look for alternative political platforms. To do this I critically reflect on communitarian anarchism as a relevant context for an ecological economics. Communitarian anarchism is a political philosophical position which aims to create a society where individual freedom is harmoniously integrated in social networks and natures ecosystems. Anarchist economy focuses on participative associations (Goodwin), mutualism (Proudhon), decentralized networks (Kropotkin), self-organizing systems (Reclus) and free cooperation Kropotkin).

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QUALITY OF LIFE IN SUSTAINABILITY TRANSITIONS: THE CASE OF HURDAL ECOVILLAGE (NORWAY)

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ABSTRACT

Community level initiatives are important in sustainability transitions. Ecovillages are often presented as examples of such initiatives that aim to combine high quality, communal life with low environmental impact. The Global Ecovillage Network (GEN) defines an ecovillage as ‘a rural or urban community that is consciously designed through locally owned, participatory processes in all four dimensions of sustainability (social, culture, ecology and economy) to regenerate their social and natural environments’ (Global Ecovillage Network, n.d.).

This paper focuses on a Norwegian ecovillage, its transformation to a more modern form (by engaging architects and developers) and the impact this transformation has had on the quality of life of its inhabitants by employing needs based workshops. This transformation has been hailed as a success through the lens of transition studies (Westskog et al., 2018) but our findings show that it has had negative consequences for quality of life of the inhabitants.

This paper adopts the definition of quality of life as the satisfaction of fundamental human needs as illustrated by the Human Scale Development (HSD) approach of Manfred Max-Neef and his colleagues (Max-Neef, 1991). We followed the HSD’s approach of implementing a needs based workshop with the help of negative and utopia matrices to identify challenges and opportunities inhabitants see in their ecovillage.

Workshop participants identified individual and collective characteristics that are triggered by the tension and conflict that flared up in the ecovillage. Some of the causes of the tension were structural problems with the houses, dysfunctional smart technology and lack of clarity in the contracts signed by home-buyers. These issues led to breakdown of trust towards the developer and in some cases between groups in the ecovillage. Examples of (individual and collective) characteristics that resulted from the tense situation are insecurity, animosity, and fear. They also identified a lack of an informal and easily accessible meeting place where they could discuss and develop necessary institutions (such as conflict resolution mechanisms) as a shortcoming of their environment.

The ideal ecovillage they envisage is a place where there is a sense of security and safety (in personal relationships, economy, technology and physical structure). People are friendly, supportive, and working for their community. They make a living working within their community (instead of commuting long distances). They have more time for their family, community and for experiencing nature as individuals and in groups. For this, they envisaged inexpensive houses with lower ambitions in terms of comfort and technology (the current standard has made the houses expensive).

To move to this ideal they suggested working to establish good systems of conflict resolution and participatory decision making. They identified courses and workshops to cultivate the characteristics of trust, friendliness, respect and tolerance (for example, mindfulness courses to better understand oneself and each other). They would work towards creating an easily accessible meeting place in the ecovillage. They can then arrange regular meetings, idea-forums, vision seminars and the like in this meeting place. They will also work to create an umbrella organization that would be responsible for developing a unifying vision (important in developing a collective identity that would encompass everyone in the ecovillage) and create opportunities for ecovillage inhabitants to be involved in various capacities and work for their community.

These concrete steps reveal the considerable potential the ecovillage and the inhabitants possess to improve their quality of life by working on the structural and institutional organization of the ecovillage. Although the paper focuses on the transition process of an ecovillage in Norway, the lessons learned from this process can inform other social experiments and movements particularly those that would like to experiment by combining business interests with social and environmental goals in their process of transformation.

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HOW CAN STORIES FROM PRACTICE CONTRIBUTE TO A HOLISTIC AND DYNAMIC DEFINITION OF THE CONCEPT QUALITY?

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ABSTRACT

In the age of quality where quality is something all of us want to have and want to offer, the dominating view of quality is that it is a thing, objective and real, ready “to be discovered and measured by experts” (Dahlberg et al., 2013 p. 5-6). In ecological economics a change in focus from quantitative growth to qualitative development, necessitates a shift where quality is contextualized in time and space and where cultural diversities are taken into account. According to Costanza et.al a basic characteristic of ecological economics is the “shift from merely growth to ‘development’ in the real sense of improvement in sustainable human well-being, recognizing that growth has significant negative by-products” (Costanza et.al 2012 p. 2). Continuous quantitative growth is impossible because “the economy is sustained and contained by the global ecosystem” (Daly and Farley, 2011, p. 406). An appropriate goal is instead to enhance quality of life or in the words of Georgescu-Roegen (1971) to increase ‘enjoyment-of-life’. It is important to notice that this change in focus not necessarily mean that quality substitutes quantity, but rather requires a switch in context. That means that economic growth is an aspect of quality of life and not vice versa.

In this perspective, quality is not something individual, or a thing, static and objective, it is rather anchored in relations. In other words, quality is dynamic based on interconnectedness. How can the individualistic concept of quality be developed to be relevant within ecological economics as a holistic, dynamic and transdisciplinary field of science? To answer this I study quality in kindergartens as ‘living organisms’ on different interconnected levels, micro, meso and macro.

The purpose of this paper is to get a deeper understanding of the concept of quality with relevance for ecological economics by applying a narrative research method in three Norwegian kindergartens. I clarify key topics and characteristics in the narratives based upon stories from the field of Norwegian kindergartens. I focus on some implications in relation to ecological economics. I summarize the main principles for a holistic understanding of quality in ecological economics as a transdisciplinary field of science.

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Key note presentation

GREEN INFRASTRUCTURE - OPPORTUNITIES, CHALLENGES AND SOLUTIONS

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ABSTRACT

How we look at cities and live in them will come to be important in the challenge of climate change, quality of life and a globally sustainable future.

There are many opportunities for cities to create great living quality with the help of green infrastructure. Looking at urban life in the future, the closeness to natural elements is an important element in health, climate change adaptation, food production, clean water and social communities. Urban agriculture, urban wastelands and biodiversity are some elements which can create livable cities in the future. Many projects around the world show how green infrastructure has the ability to build bridges between humans and the living environment, as well as to raise awareness of their social responsibility towards the planet.

However, parts of green infrastructure come with many challenges too. Problems and needs such as security, allergies, housing and aesthetics are some which must be addressed. Solutions on how we can overcome these challenges and create life quality in future cities come with compromises and innovative projects, ideas and design.

Since more and more people are moving into cities, we should ensure that cities develop in a way that gives us health, joy and harmony. By starting to use green infrastructure strategies, and promote urban nature, we can enhance life quality for both humans and non-humans.

WASTE RESOURCE MANAGEMENT - HOW TO CLOSE THE WASTE LOOPS OF THE CITY? – POSSIBILITIES AND CHALLENGES

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Abstract

Waste management is about how to promote and help the transition to a circular economy and to facilitate to close the loops of urban material and resource flows. This is often called urban metabolism but can also be described as urban mining. As the term urban mining indicates waste management contributes substantial to replace virgin natural resource by reusing and recycling waste resources into new processes and products. Doing this waste management have great impact on environmental footprint.

Effective transition toward a more circular metabolism will require a thorough understanding of all relevant resource flows entering and waste and emission flows exiting within the city's boundaries, assessing nexuses between these flows. One way to approach waste management is to take the point of departure in waste hierarchy of Lansink's Ladder.



Focus of this presentation is threefold:

1. Who to explore the potential of waste management
2. Who to reuse waste looking into the example of reusing construction waste
3. Who to make use of waste towards energy.

According our first focus one of the challenges to explore the potential of waste management and to organise the flows of waste deals with our ability to obtain information and statistics of volumes of waste produced a geographic area as a city. This is about how waste management are organised and how economical transaction and regulations encourage to use waste as a resource of the city area.

However, exact and reliable statistical information on waste at the local level is not easy to achieve. Waste statistics are most developed related to household level but is relatively poor on business waste volumes. It's therefor difficult to get a picture of total volume of waste production of the level of municipality. This problem increases because what is register as household waste respectively business waste is unclear and floating and because several companies are involved in waste management.

Towards our second focus it is acknowledge the construction waste of the city have huge potential of been recycled. Most of these materials hold promising potentials, but only small volumes are currently

recycled. Construction waste is to a large extent reused as backfilling or use as road base – often referred to as downcycling. The reuse of building components, such as wall, floor segments and bricks are thus very limited. Reasons to this is institutional barriers and a lack of incentives or regulation to support on-site or local reuse.

Our third focus is who to make use of waste to energy. This is a focus that deals with the ambition to make the city a net producer of energy. District heating systems using waste as a resource might be an example of this. Bodø has developed this system within the last five years. Here the district heating system produces heating of buildings complexes within city center and uses biomass from waste wood that is generated in the region. The bio fuel plant has a renewable part of 86 %. To operate the energy plant efficiently it was important to have long-term agreement with suppliers of the biomass, with predictable prices. In the first place the selection of suppliers happened through a public bidding process. The waste management company Østbø was chosen as main supplier. In this process IRIS Salten the municipal waste company lost the competition, which had as consequence that IRIS was forced to transport its waste wood volumes to combustions plants in Southern Sweden. This is an example how the marked institution generate suboptimality on the expense of climate and environment goal obtainment.

GREEN CAMPUS BODØ

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ABSTRACT

Climate change is probably the biggest environmental challenge we face today and according to the latest report from IPCC (2018) it says that in order to limit global warming to 1.5 degrees, the reduction of climate gases has to be around 40-50 percent within 2030. This demands a number of changes in various sectors - including higher education and research (Stern 2006), a perspective that our newly elected minister within research and higher education here in Norway, Iselin Nybø, recently shared. Universities play an important part in addressing environmental problems and building sustainable societies based both on educational programs, their research as well as their collaboration with external actors. (Ferrer-Balas et al. 2008; Tilbury et al. 2005). Lately, some even say that universities also have a special responsibility to “green up”, in terms of their own administrative and organizational practices (Ryan et al. 2010). Based on an increasing awareness of their own environmental footprint and waste, a growing number of universities have the last decade initiated policies to reduce their carbon footprint (Tilbury et al. 2005; Wals and Blewitt 2010). A few years back this issue also started to gain attention in Norway, and today both NTNU, NMBU, UiO and UiB have clearly defined ambitions for reducing their carbon footprint on campus.

Our project - Green Campus Bodø - is a pilot study with the aim of reducing the carbon footprint at Nord University. Being the largest campus in Nordland region with approximately 12,000 students, and as one of the largest employers with around 1,200 employees, the expectations of Nord university in terms of environmental performance are high. Currently Nord university has nine campuses in Nordland and Trøndelag. Campus Bodø Mørkved as the largest of these is of course of particular importance in terms of contributing to the total carbon footprint of the university. By mapping the current and actual carbon footprint on Campus Bodø - in terms of both administrative and organizational practices, as well as behavioural and attitudinal practises, we analyze the situation and propose effective ways of how to reduce the carbon footprint at Nord university in the years ahead using the Responsible Research and Innovation (RRI) approach.

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Key note presentation

HYDROGEN USE AS A FUEL FOR MOBILE APPLICATIONS

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ABSTRACT

Progressively raising of the population and exhausting the natural resources causes that the humanity needs more energy for every day's life. As most of energy still comes from burning of the traditional carbon-based fuels, which produces the greenhouse gas carbon dioxide, the content of this gas in the atmosphere is constantly rising. This is the main contribution to the climate change that the humanity experience over the last decades. One possible solution is implementation of the environmental friendly sources which turns to be one of the main urgent task nowadays.

Hydrogen as energy carrier has already consider a nice alternative. It's highly abundant forming water and is obtained via well-known and controlled process such as electrolysis. Moreover, obtained hydrogen can be used through direct combustion in an engine, but also electrochemically (with oxygen from air) in a fuel cell, which produces electricity and drives an electric engine. In both cases the final product is water. This cycle is known as hydrogen cycle and does not generate any harmful emissions. Hydrogen has a high gravimetric energy not only compare to batteries, it's even 3 times higher than of the traditional fuels like coal, oil and natural gas. For instance, a car that needs 6 kg petrol per 100 km, requires just 2 kg hydrogen by direct combustion and only 1 kg by using a fuel cell and electric engine.

Although all the advantages described above, the practical utilization of hydrogen is still impeded, especially in commercial use of hydrogen driven vehicles. What kind the problems scientist face in implementation of hydrogen in every days life?

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HYDROPOWER, FISHERIES OCEANOGRAPHY AND CYCLING OF CO₂ IN CLIMATE CHANGE PERSPECTIVE

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ABSTRACT

Global Climate Change raises demands for renewable energies that replace burning of fossil energy resources and reduce accumulation of atmospheric CO₂. Hydroelectric power is reputed to be clean in this respect and therefore environmentally friendly, termed “green”. This may be false because hydropower production interferes with the natural annual cycle of coastal marine biological production in marine recipients.

Seasonal fluctuation in natural river flow makes hydropower production depend on freshwater storage reservoirs by construction of dams and out of season marketing of electricity to industries, public logistics and households. It reduces the seasonality of natural freshwater discharge which contrasts the phenology of ecological processes in biota established by biological evolution, which applies to all oceanographic regions of freshwater influence, from tropical to polar latitudes.

Until 1962 the Norwegian storage capacity was low, and the abundance of juveniles recruiting to the exploited stock of North-East Arctic Cod (NEA Cod) in the Barents Sea correlated positively with natural vernal river discharge to the Norwegian Coastal Current (NCC) some years in advance. Theoretical considerations supported by empirical evidence from coastal waters in Canada and Norway, led to a conceptual trophodynamic model working on large spatial and temporal scales in the Norwegian and Barents Seas. The model explains how interannual variability in freshwater discharge to the NCC during summer may influence planktonic primary and secondary production that forces bottom up survival of juvenile NEA Cod. An implicit hypothetic understanding of the model is that hydropower production interferes with mortality rates during the first weeks of life in NEA Cod generations.

A new data set provided by the Norwegian Water Resources and Energy Directorate (NVE) summarizes natural and regulated river discharge to the NCC in 1979-2015. It allows correlation tests with official demographic parameters on NEA Cod updated in 2018 by the International Council for Exploration of the Sea (ICES). In 1983-2010, recruitment of NEA Cod did not correlate with freshwater discharge from Møre-Trøndelag in May-June, contrary to positive correlation in 1949-1974. The results suggest that biological productivity in the NCC during summer did no longer sustain high reproduction rates of NEA Cod, resulting from industrial storage of vernal meltwater discharge. After 2008, modern fisheries management advised by ICES has increased the NEA Cod spawning stock to a historic maximum mode in 2011-15. However, the survival rates of juvenile NEA Cod decreased to a historic minimum in the same period. It coincided with low freshwater discharge in May-June which indicates that management measures may rest on unsustainable ecological premises.

The present international growth in hydropower production may not only reduce regional marine primary production and associated fisheries. Reduced assimilation of CO₂ by marine algae in regions of freshwater

outflow contributes globally to maintain high levels of atmospheric CO₂ and increases the acidity of ocean water. In Norway, developing off-shore production of electricity from wind and wave generators during winter may allow shifting hydropower production from winter to the summer season. It may facilitate a new power production regime compatible with politics aiming for increased production of fisheries resources as well as nature conservancy ambitions for reducing atmospheric green-house warming and ocean acidification.

MICROBIAL SURFACTANTS – APPLICATIONS FOR THE PETROLEUM INDUSTRY

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ABSTRACT

Petroleum hydrocarbons are one of the important energy resources and they form raw materials for the chemical industry. We depend on them for our essential needs; for heating, lighting and transportation. To meet the world energy demand, it is estimated that a 1.7% annual increase in production (the number of oil barrels) is required, and the annual oil consumption is expected to reach 15.3 billion tons by 2030. However, petroleum is also a major environmental pollutant. Spillage of oil can often lead to both immediate and long-term environmental damage. Biosurfactants have been extensively used in the remediation of water and soil, as well as in the main stages of the oil production chain, such as extraction, transportation, and storage. As compared to other strategies adopted to treat petroleum contamination, microbial remediation is effective, eco-friendly and inexpensive (De Almeida et al., 2016, Patowary et al., 2017). Here, we report the characterization of a novel biosurfactant producing bacterial strain UMX-103 which was isolated from a hydrocarbon- contaminated site in Terengganu, Malaysia. Integrating both genomics and biochemical approaches we analysed the biosurfactant production by the strain UMX-103; using five assays, namely hemolytic assay, oil-spreading test, drop-collapse assay, emulsification assay and surface tension measurements. Whole genome sequence analysis revealed the genetic contents and genes involved in biosurfactant production. Moreover, functional annotation analysis revealed the presence of a surfactin biosynthetic gene cluster. This gene cluster belongs to the non-ribosomal peptide synthetase family, which is one of the microbial surfactant groups (Abdelhafiz et al., 2017a). Biosurfactant produced by UMX-103 is a potential molecule for oil biotechnology and bioremediation applications (Abdelhafiz et al., 2017b).

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THE IMPACT OF GLOBAL CHANGES ON THE INCIDENCE OF NEW INFECTIOUS DISEASES OF ANIMALS IN CENTRAL EUROPE

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ABSTRACT

Human intervention into the natural habitat by population expansion and tourism brings new relations in ecological conditions and provides an opportunity for the application of new pathogens. Environmental changes have a huge impact on the emergence and reemergence of certain infectious diseases, mostly in countries with high biodiversity and serious unresolved environmental, social, and economic issues (Nava et al. 2017). Climate changes have an essential impact on human health either directly, associated with high or low temperatures (extreme summers and winters), or indirectly as a result of these changes. The latest observations point to the fact that climate changes affect the occurrence of a number of infectious and parasitic diseases in animals and humans (Wu et al. 2016) e.g. Bluetongue, Lumpy skin disease, Peste des petits ruminants, Rift Valley fever, West Nile fever etc.

According to the World Health Organization, environmental threats to human health at global and regional levels include: “climate change, stratospheric ozone depletion, changes in ecosystems due to loss of biodiversity, changes in hydrological systems and supplies of freshwater, land degradation, urbanization, and stress on food-producing systems” (WHO 2017). Rapid social and environmental changes are occurring globally, affecting both low-income countries and the largest advanced economies. Travel and transportation are the greatest risk factors of the increase in the rapid spread of infectious diseases (Jaffry et al. 2009).

Emerging, re-emerging infectious diseases are increasingly recognized as a global threat, with major concerns on their rapid global spread (Johnson et al. 2015). To effectively design prevention and control programs, the complex and fluid relationships among multi-host and multi-pathogen systems, environmental change, and human populations must be thoroughly understood (Morse et al. 2012). The interactions among wildlife, domestic animals, and humans can be present in different landscapes and are implicated as potential causes of important outbreaks globally (Murray and Daszak 2013). Improved and targeted surveillance systems will provide better knowledge for analysis of the specific risks of disease emergence (Loh et al. 2016). Active surveillance is indispensable in preventing disease emergence by identifying areas of risk before they become a threat to human and animal health.

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SEAWEEDS AS AN ANIMAL FEED: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

With rise in global population, lower availability of agricultural land and fresh water, increased demands for animal protein, and higher competition between human and animals for foods, the livestock sector is globally facing challenges to identify novel sustainable resources for future livestock feeds. In coastal countries like Norway, aquatic biomass such as seaweeds could potentially serve as a future animal feedstuff. In fact, previous studies indicate that various seaweed species comprise chemical properties and nutritive values of interest for optimal livestock growth and performance, and some red seaweeds have shown to lower rumen methane production. Additionally, some seaweed species, particularly brown, contain different bioactive compounds that possess antimicrobial, immuno-modulatory and metabolic properties potentially leading to positive impacts on the gut health and immune function of the production animals. On the other hand, seaweeds contain various anti-nutrient compounds that can hinder the nutrient digestibility and uptake. Chemical composition and nutritive values of seaweeds are influenced by various intrinsic and external factors such as seaweed types (brown or green or red), species, growing seasons, habitat etc. In this context, future studies are required to identify applications and safe inclusion limits of different seaweeds types and species as novel feedstuffs without compromising the livestock health, metabolic function and production. Additionally, researches are lacking in regards to potential pre-treatment techniques that can be utilized to diminish different antinutritional elements present in the seaweeds and whether seaweeds can be preserved for a longer-term without deteriorating their chemical, bio-chemical and nutritive properties. In conclusion, the seaweed biomass has a potential for a future livestock feedstuff due to their nutritive values and bioactive properties, but further studies are required to be able to commercially formulate livestock species-specific diets in future.

GROWTH AND LC-PUFA PRODUCTION OF THE COLD-ADAPTED MICROALGAE *KOLIELLA ANTARCTICA* IN PHOTOBIOREACTORS

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ABSTRACT

Microalgae are excellent source of long-chain polyunsaturated fatty acids (LC-PUFAs), yet bioprospecting and optimization of strains that are able to grow at low temperatures has only recently been initiated. In this work, the cold-adapted microalga *Koliella antarctica* (Trebouxiophyceae) was cultivated at 15 °C to optimize growth and PUFA production in bubble-tube and flat-plate photobioreactors. The effect of nitrogen starvation, phosphorus starvation, salinity, and light intensity on the growth, fatty acids, and protein content was studied. *Koliella antarctica* exhibited a maximum biomass productivity of 2.37 g L⁻¹ day⁻¹ after culture optimization, and tolerated a broad range of salinities. Nitrogen and phosphorus starvation strongly induced neutral lipid accumulation, up to 90.3% of total fatty acid, which mostly consisted of the monounsaturated fatty acid C18:1n-9. PUFAs were also abundant and together accounted for 30.3–45.8% of total neutral lipids. Phosphorus starvation was an effective strategy to obtain high total fatty acid yields (mg L⁻¹) while maintaining the protein, total PUFA, and omega-3 fatty acid contents. The strong growth of *K. antarctica* concurrent with its favorable biochemical composition, containing LCPUFAs, could make this strain efficient PUFA producers and possibly offer the opportunity for cultivation in cooler climates or during winter in temperate regions.

REINFORCING REINFORCEMENT REINFORCEMENT IN *FUCUS DISTICHUS* AND *FUCUS SERRATUS*

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ABSTRACT

Originating in the North Pacific, *Fucus* colonized the North Atlantic after the opening of the Bering Strait (4.1-7.4 Myr BP), where it radiated into two distinct lineages that diverged 0.9-2.25 Myr BP.

Three hybrid zones between *F. distichus* and *F. serratus* have been identified in the Central/East Atlantic: Northern Norway:

Natural with around 10,000 years of sympatry.

No F1 hybrids are found.

Kattegat:

F. distichus was introduced with around 100 years sympatry.

Around 3.7% of the population are F1 hybrids.

Iceland:

F. serratus was introduced with around 100 years of sympatry.

Around 8.3% of the population are F1 hybrids.

Reinforcement results in the evolution of prezygotic reproductive isolation, which can be caused by reduced hybrid fitness. As a result of reinforcement we should see a reduction in hybridisation between the two *Fucus* species.

The central aim of this project is to understand how reproductive isolation mechanisms evolve in the *Fucus* speciation continuum, from local adaptation to complete reproductive isolation.