AQUACULTURE ASSOCIATION OF CANADA

ASSOCIATION AQUACOLE DU CANADA

Book of Abstracts

presented at

The abstracts are listed in alphabetical order, by the presenter's last name. Abstracts have been formatted to fit the standardized template. Oral presentations are listed first with Poster presentations following, as noted in the header. Only abstracts presented at the conference are included; submitted abstracts that were not presented are excluded.

List of Presenters

ALBRIGHT, L.

CRACKING THE CODE FOR PROFITABLY FARMING SOCKEYE FARMING AS A FOODFISH

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Many attempts to profitably culture Sockeye salmon (*Oncorhynchus* nerka) in commercially significant quantities to a minimum 3 lb slaughter weight have been attempted. And, to our knowledge all have failed. Farmers have found that this species exhibits 1. High mortalities from ponding of ca. 0.12 g fry through to slaughter of 2 lb market fish 2. Slow growth rates at all life stages. 3. A limited slaughter window of only May/June each year when the fish are at their maximum 2 lb size. 4. And high sensitivity to manipulations within their growth containers. We report here on our success in profitably culturing this species to sizes of 3 lb each, or more.

We have radically modified our cultural practices and equipment so that in raceways, ponds or tanks, from fry to fingerlings, growth rates are good and total mortalities are <0.5 % of total numbers. And, a radical modification of cultural practices to grow the fish from fingerlings to 3 - 4 lb slaughter weight limits total mortalities over the life cycle to 4 % or less.

The use of light in the second winter of culture forces vegetative growth and delays year 3 maturation to the 4th year of culture. As a result we harvest 3 - 4 lb Sockeye from November of the 3rd year of culture to June of the following year. Ca. 96 % survival from fry entry. Therapeutants, including antibiotics, are not used.

ALLEN, M

GENOMIC ARCHITECTURE OF SEA LICE RESISTANCE IN ATLANTIC SALMON AT DIFFERENT THERMAL PROFILES

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Rising coastal ocean temperatures associated with global climate change pose numerous risks to marine cage aquaculture. In particular for salmon and other cold water species, increasing temperatures can push production sites into suboptimal physiological conditions for the fish, while also exacerbating abundance and development of marine ectoparasites. In this study, genomic regions associated with the susceptibility of Atlantic salmon (*Salmo salar*) to sea louse (*Lepeophtheirus salmonis*) infection at different thermal profiles was investigated. Two thermal treatment groups of 10ºC and 20ºC were exposed to sea lice and parasites allowed to develop to the adult stage. Fish were sampled and total lice counts determined for each individual at larval chalimus stages and at the end of the experiment. A total of 425 animals were genotyped using two SNP arrays; the 130K *S. salar* Axiom Array and the 50K North American Atlantic Salmon Axiom SNP array. Genome-Wide Association Analyses (GWAS) was carried out to search for SNPs associated with sea lice susceptibility in the differing thermal environments. Chromosomes Ssal9 and Ssal10 were identified as the major regions of interest associated with lice resistance in the 10ºC degree treatment group, while chromosomes Ssal2 and Ssal10 were identified as the major regions of interest associated with lice resistance in the 20ºC degree treatment group. A follow-up validation study was conducted to confirm these associations across different families.

BAKER, C

THE EFFECT OF DIETARY ASTAXANTHIN ON ACUTE HYPOXIA AND THERMAL TOLERANCE IN TRIPLOID AND DIPLOID BROOK CHARR *Salvelinus fontinalis.*

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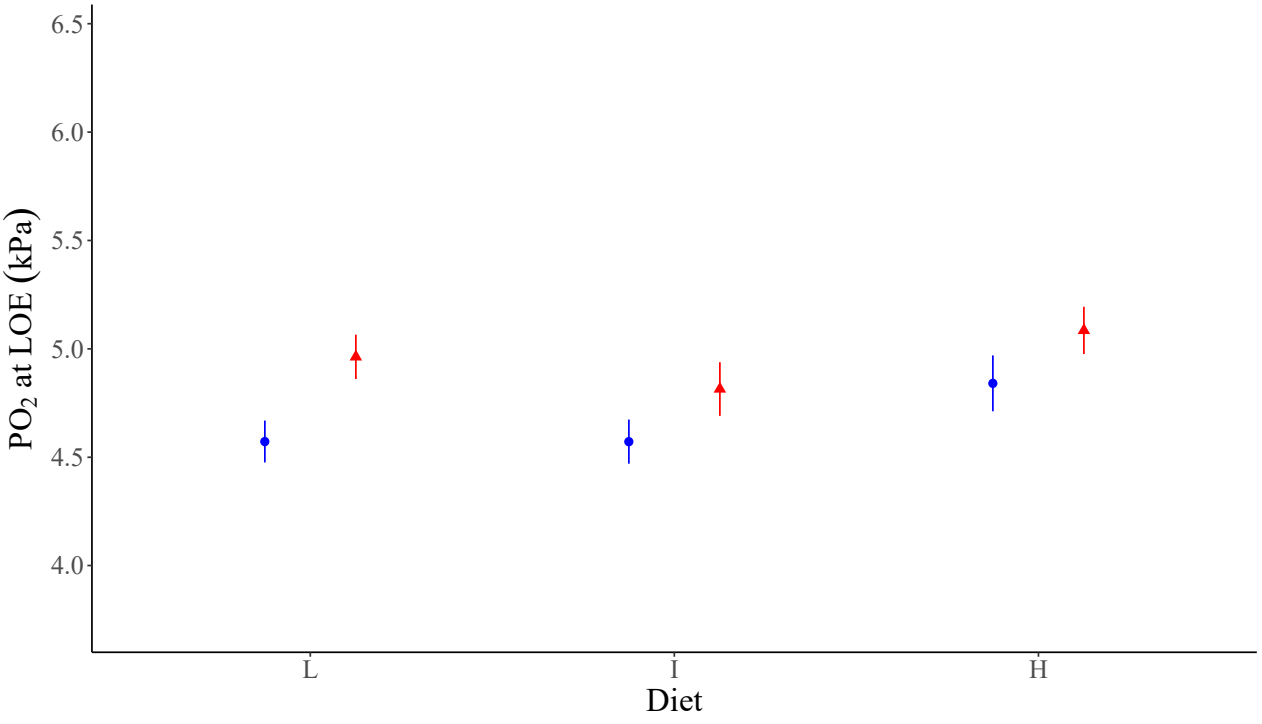
Triploid fish could be beneficial for increasing aquaculture sustainability due to their reproductive sterility which prevents the risk of interbreeding between wild and escaped farmed fish. However, research has shown that they are less tolerant than diploids of environmental stressors such as high temperatures and low dissolved oxygen. This study investigated whether dietary supplementation with the carotenoid astaxanthin (AX) improves the acute hypoxia and temperature tolerance of both triploid and diploid brook charr (*Salvelinus fontinalis*). Fish were fed diets with three levels of AX supplementation (17, 80, 190 mg/kg) for 8 weeks and then assessed for acute hypoxia tolerance by rapidly reducing oxygen content of the water and then determining the oxygen concentration at loss of equilibrium (LOE) and time taken to reach LOE. Using a similar approach, I then determined critical thermal maximum (CTmax) tolerance of different groups of triploid and diploid charr fed the same AX diets by rapidly increasing the temperature of the water and then determining the temperature at LOE and time taken to reach LOE. Triploids were less hypoxia tolerant then diploids, but ploidy did not affect CTmax, and AX supplementation also did not affect either hypoxia tolerance or CTmax



BARREDA, D

DYNAMIC TEMPERATURE IMPROVES PATHOGEN CLEARANCE, INFLAMMATION CONTROL, AND TISSUE REPAIR IN INFECTED FISH

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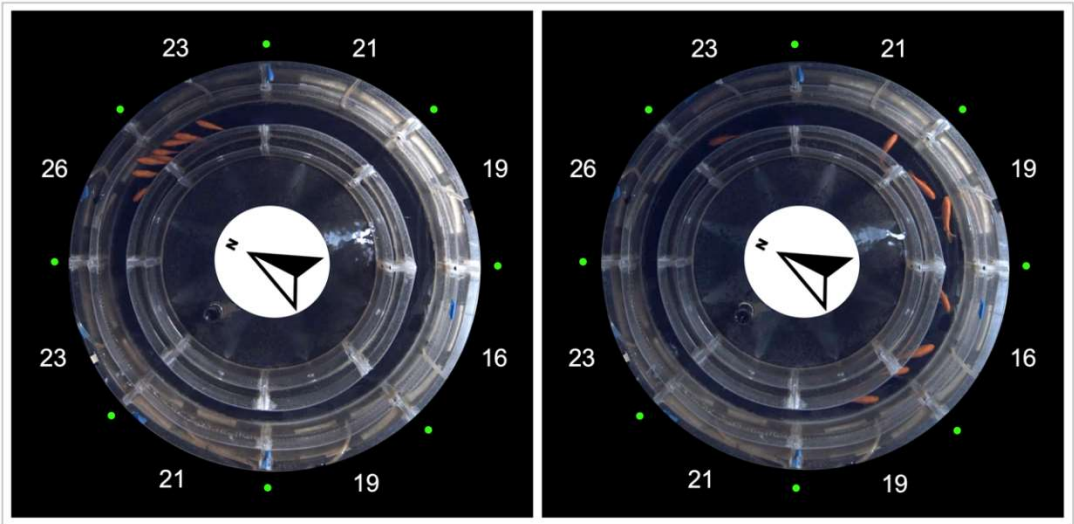
Fish have a natural ability to thermoregulate upon infection. Examination of infected fish using high-fidelity quantitative positional tracking shows remarkable consistency in fish behavioural thermoregulation (BTR). Our most recent work (*eLife* **12**:e83644) shows that BTR engages pyrogenic cytokine gene programs in the CNS, increases efficiency of leukocyte recruitment into the immune challenge site, and markedly improves pathogen clearance *in vivo*, even when an infecting bacterium grows better at higher temperatures.

This is achieved through a combination of earlier, tailored defenses that are quickly followed by efficient inflammation control and improved wound repair. This allows for both enhanced antimicrobial protection as well as efficient use of energy resources. This is a novel and significant asset for fish health, production efficiency and overall performance. Together, this represents a paradigm shift in our understanding of fish immunity and offers an opportunity to promote aquaculture health and performance using a natural, drug-free and energy-wise sustainable strategy.



Infected fish show remarkable consistency in their selection of environmental temperatures that drive fever responses (left). In contrast, healthy fish display varied selection at a lower temperature range (right). Image credit: Farah Haddad and Daniel Barreda.

BENFEY, T

PHENOTYPIC PREDICTORS AND HERITABILITY FOR THERMAL TOLERANCE IN FARMED ATLANTIC SALMON *Salmo salar*

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As part of a program to adapt farmed Atlantic salmon to climate change, we have been investigating phenotypic correlates with thermal tolerance (critical and incremental thermal maximum; CTmax and ITmax, respectively) and determining their heritability within multiple year-classes of a family-based breeding program. Our focus has been on characteristics that are easy to measure and are based on physiological principles, i.e., body size (mass, fork length, and condition factor), ventricle size, and hematocrit as proxies for energy reserves, cardiac output, and oxygen carrying capacity of the blood, respectively. The two test protocols both require a steady temperature increase (rapid for CTmax, slower for ITmax) but have different endpoints (loss of equilibrium and mortality, respectively). While CTmax and ITmax are both heritable traits, heritability estimates vary among year-classes. Furthermore, an individual's performance in one test does not predict its performance in a subsequent test, i.e., an individual's pre-smolt CTmax does not predict its post-smolt CTmax, and its post-smolt CTmax does not predict its ITmax. Body mass and fork length are excellent predictors of post-smolt CTmax (although with a negative correlation, i.e., smaller post-smolts have higher CTmax) but poor predictors of ITmax. Ventricle mass (both absolute and relative to body mass) is a good predictor of temperature tolerance, but with a negative correlation for CTmax and positive correlation for ITmax. Hematocrit could only be assessed for CTmax fish and did not yield consistent results between year-classes. While our results confirm that selective breeding can be used to improve thermal tolerance in farmed salmon, they also show that the physiological determinants of thermal tolerance are dependent on the thermal challenge used for assessment.

BRACELAND, M

TENACIBACULOSIS IN GLOBAL ATLANTIC SALMON (*Salmo salar* L.) AQUACULTURE

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Tenacibaculosis is a significant welfare and economic concern in multiple bivalve and fin fish species. The aetiological agents of the disease, Tenacibaculum spp. (previously classified as Flexibacter) are filamentous, motile, gram-negative bacteria which exhibit biofilm formation, high diversity, and potential lack of host specificity. While the disease has been a primary concern for Atlantic salmon (*Salmo salar* L.) BC for decades, incidences of outbreaks in other regions globally appear to be increasing. This presentation will examine several causes for this, and examine other key aspects of the disease e.g., risk factors, diagnostics, association with other bacterial pathogens, and current knowledge gaps.

BRITNEY, S

MINIMUM INHIBITORY CONCENTRATION OF FLORFENICOL FOR CANADIAN *Tenacibaculum dicentrarchi* FIELD ISOLATES

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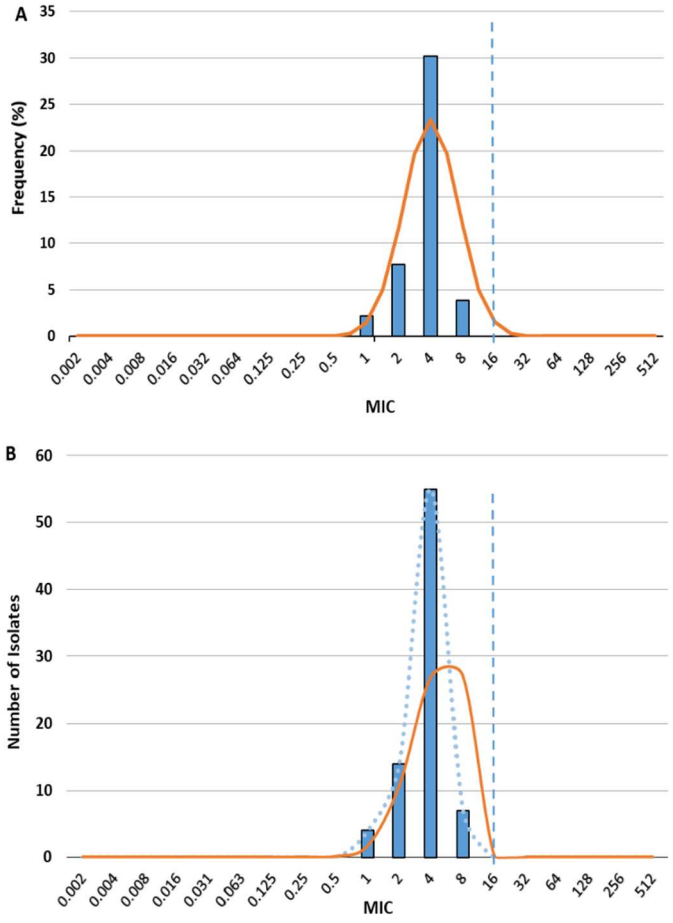
Tenacibaculum is an etiological agent of tenacibaculosis, a disease which causes extensive mortality in farmed Atlantic salmon (Salmo salar L.) worldwide. Outbreaks of this disease in British Columbia (Canada) are primarily treated using per os florfenicol (FFC) with no vaccine currently available for Atlantic salmon. As there are no standardized epidemiological cut-off values defined for any Tenacibaculum, establishing localized cut-off values for wildtype (COWT) isolates of requisite species is essential for identifying emerging trends in antibiotic resistance. The minimum inhibitory concentration (MIC) of FFC for 80 isolates of T. dicentrarchi was determined using microdilution.
Samples were collected during 2018-2021 from Atlantic salmon netpen sites surrounding Vancouver Island, British Columbia experiencing outbreaks of tenacibaculosis.



The COWT values for T. dicentrarchi were determined to be ≤ 16 µg ml-1 for FFC over the 4 years assessed by NRI analysis (Figure 1.A) and ECOFFinder (Figure 1.B), with individual years displaying cut offs at either 8 µg ml-1 or 16 µg ml-1. The MIC results were unimodal and all isolates were classified as wildtype. Regular monitoring of Tenacibaculum isolates for MIC and the development of epidemiological cut-off values is necessary for informing treatment efficacy and to identify emerging trends in antibiotic resistance.

CABALLERO-SOLARES, A

TRANSCRIPTOME RESPONSE OF RAINBOW TROUT GILL EPITHELIAL CELLS TO *Aurelia aurita* VENOM

Albert Caballero-Solares*, Sara L. Purcell, Salvatore Frasca Jr., Matthew L. Rise, and Mark D. Fast

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Jellyfish are one of the multiple risk factors causing damage to gill epithelia in fish farmed in open-cage systems. The present study profiled the changes in the transcriptome of rainbow trout epithelial cells (RTgill-W1) harvested 24 h after exposure to a filter-sterilized *Aurelia aurita* homogenate. A salmonid 44K oligonucleotide microarray platform was used for the transcriptome profiling. The microarray analysis identified 675 up-regulated and 977 down-regulated probes at a False Discovery Rate of 1% and a 1.5-fold-change threshold (Fig. 1). Based on the functional enrichment analysis of the microarray-identified genes, exposure to the jellyfish homogenate prompted an immune and stress defense response in the cells and induced cell cycle arrest, apoptosis, and cell migration (Fig. 2). Twenty-four genes with putative roles in these biological processes have been selected for RT-qPCR validation of the microarray results and analysis of their regulation at 0, 3, 6, 24, and 72h post-challenge. This study is the first to explore the transcriptomic response of fish gill epithelial cells to jellyfish (*A. aurita*) venom, a crucial step toward developing strategies to reduce the negative impact of jellyfish on aquaculture.

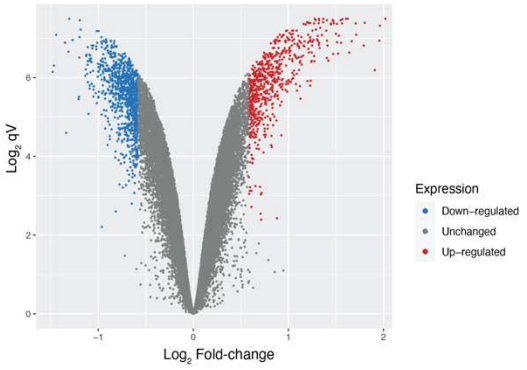

Fig.1 Volcano plot showing FDR-corrected p-values (qV) against log_2-transformed (exposed vs. non-exposed cells) fold-changes

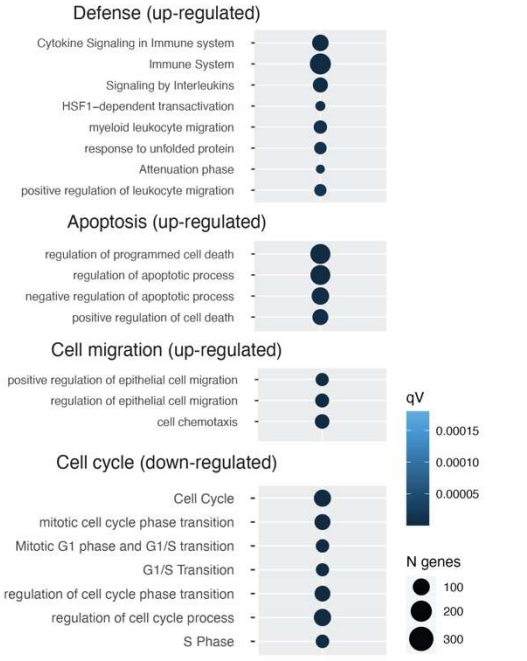

Fig. 2 List of most significantly over-represented Gene Ontology biological processes and Reactome pathways (qV < 0.01)

CANNON, C

THE CANADIAN ORGANIC AQUACULTURE STANDARD / PERSPECTIVES FROM THE FIRST SALMON FARM TO CERTIFY

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Published in May 2012 by the Canadian General Standards Board under approval of the Standards Council of Canada, and more recently coming under the regulatory authority of the Canadian Food Inspection Agency, the Canadian Organic Aquaculture Standard is a lesser known certification for the aquaculture sector in Canada. Encompassing health and welfare, feed ingredients, density, permitted and prohibited substances as well as many other subjects, the goal of the organic standard is to develop enterprises that are sustainable and harmonious with the environment. The principles of the standard aim to increase the quality and durability of the environment through specific management and production methods. Certified in December 2013, Creative Salmon Company Ltd. in Tofino is nearing 10 years of production under the organic standard.

CLARK, L (replaced COOK, S as speaker)

SOURCING, CERTIFICATION AND WHAT MAKES A SUSTAINABLE FEED

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In recent years, there has been a growing concern about the environmental impact of fish production and the sustainability of feed manufacturing. The sourcing of raw materials for feed production is one of the critical factors that impact the sustainability of the industry. Feed manufacturers must ensure that the raw materials used are sustainably sourced to reduce the environmental impact of their product and operations. Beyond raw materials, feed manufacturers must develop new technologies to mitigate feed waste, improve nutritional content or uptake of existing raw materials and innovate ways to produce more fish, using fewer finite materials.

This talk will focus on the sustainability and sourcing policies of raw materials for feed manufacturing. The environmental impact of these raw materials and the various sustainability certifications can help feed manufacturers ensure that their sourcing practices are environmentally responsible. The use of byproducts, waste materials and expanding the ingredient basket for feed production to help reduce the environmental impacts of the industry, while also reducing costs, will be explored.

I hope to provide insight into what commercial feed manufacturers are doing to increase sustainable sourcing of raw materials and improve the sustainability of aqua feeds. Through continued improvement in sourcing and production policies we aim to reduce the environmental impact of feed and contribute to a more sustainable, food secure, future.

COLOMBO, S

ATLANTIC SALMON ADAPT TO LOW DIETARY n-3 PUFA AND WARMER WATER TEMPERATURES BY INCREASING FEED INTAKE AND EXPRESSION OF n-3 BIOSYNTHESIS-RELATED TRANSCRIPTS

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Climate change can have cascading impacts on biochemical reactions in aquatic ecosystems. Fish can adapt to surrounding temperatures by using long chain (LC) polyunsaturated fatty acids (PUFA) to maintain cell membrane fluidity. In warming waters, less LC-PUFA is needed to maintain fluidity. This study determined the impact of low dietary LC-PUFA and warm water temperature on growth, PUFA storage, and expression of lipid metabolism-related transcripts in Atlantic salmon. Salmon (141 g) were fed two diets (high or low LC-PUFA) at either 12°C or 16°C for 16 weeks. Salmon weighed more and consumed more food at 16°C and when fed the low LC-PUFA diet. Liver and muscle FA mostly depended on diet rather than temperature. DHA in muscle was higher at 16°C and in salmon fed the high LC-PUFA diet. Levels of FA desaturation transcripts were more highly expressed at 16°C and in salmon fed the low LC-PUFA diet, which suggests synthesis of LC-PUFA. Overall, with slow, chronic temperature increases, salmon may adapt to low dietary LC-PUFA by synthesizing more when required.

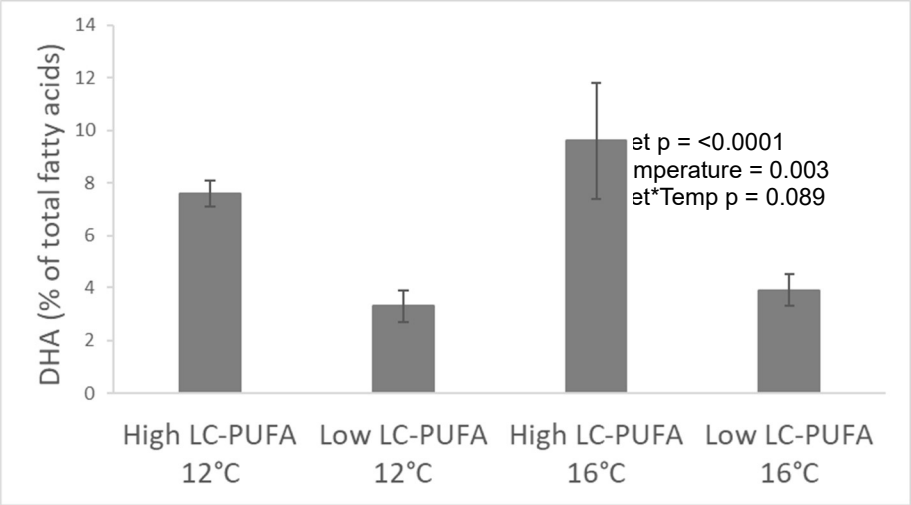

Figure 1. Fatty acid content (% total fatty acids) of docosahexaenoic acid (DHA) in the muscle of salmon fed either a high or low LC-PUFA diet raised at either 12°C or 16°C.

COUTURIER, C

CONSUMPTION AND REMOVAL OF ORGANIC PARTICLES FROM FINFISH FARMS BY THE ORANGE-FOOTED SEA CUCUMBER *CUCUMARIA FRONDOSA*

Cyr Couturier*, Dylan Mahon, Elizabeth Tucker, Kevin Wright, Lukas Hetzler, Tyler Butt

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Marine invertebrates have been postulated as contributing to organic waste removal from marine finfish farms, thereby providing ecosystem services. Earlier studies on the orange-footed sea cucumber showed some capacity to remove and absorb these particles when fed solely on the organic waste. We were interested in whether or not the presence of natural plankton would enhance the consumption and absorption of salmonid waste, as might be the case in the natural environment. Trials were undertaken at two different temperatures (6°C and 10°C) to evaluate the feeding rate and absorption efficiency of salmonid faeces, feed particles, and phytoplankton, alone or in combination. Tentacle Insertion Rate (TIR) increased with temperature, as expected, however was not influenced significantly by the presence or absence of phytoplankton in the diet. Absorption Efficiency (AE) however was higher in the combo diet (algae and waste) vs. algae or waste alone. Thus, in a natural situation it is expected that this species of cucumber should be able to consume and remove more of the organic waste from finfish farms, than previously thought.

DUHAIME, J

AQUACULTURE MONITORING PROGRAM, FISHERIES AND OCEANS CANADA

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Finfish and shellfish aquaculture activities can be associated with environmental variations induced by the release of compounds (e.g., organic matter, trace metals, drugs, pesticides) and pelagic depletions (e.g., phytoplankton and zooplankton). These effects are better characterized near and within aquaculture lease areas but less is known about environmental variation induced in the far-field. Fisheries and Oceans Canada initiated the Aquaculture Monitoring Program (AMP) in 2017 to conduct long-term monitoring outside of aquaculture lease areas. AMP includes data collection, sampling, and analysis with the objective to detect, monitor, and model aquaculture-related changes to the benthic and pelagic environment near select coastal aquaculture locations. Parameters measured include sediment grain size, organic matter, trace metals, sulfides, infauna communities, drugs, seston, phytoplankton, and zooplankton. A national database is being developed to store data from sampling activities. Information from this program is being used to support research initiatives and will be used to inform decision making. The program is also allowing for the development of nationally consistent methods for sample collection, sample analysis, and statistical design as well as research on new innovative monitoring approaches. AMP is now progressing towards the establishment of consistent long-term data collection and monitoring.

DUMAS, A

NUTRIENT DIGESTIBILITY OF AQUEOUS-PROCESSED CANOLA PROTEIN CONCENTRATE IN DIETS OF POST-SMOLT ATLANTIC SALMON *Salmo salar*

André Dumas*, Van Pham Thi Ha To, Ivan Tankovski, John Brennan, Jason Hargreaves, David Dzisiak

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The nutrient digestibility of canola protein concentrate (CPC, 76.9% crude protein) obtained through liquid extraction of soluble proteins from defatted canola meal was estimated in post-smolt Atlantic salmon (227.0 ± 4.1 g) over an eight-week study. Four digestibility diets containing 0 (Reference, Diet A), 10 (Diet B), 20 (Diets C) and 30 % (Diets D) CPC were randomly allocated to 16 750-liter tanks at 40 fish per tank.

The apparent digestibility coefficients (ADCs) of dry matter (70.6-73.4%), crude lipid (95.4-96.4%), crude protein (90.2-91.9%) and essential amino acids (90.6-95.7%) did not differ significantly between digestibility diets (P≥0.05), indicating CPC sustained high nutrient digestibility regardless of its inclusion level in this study. The mean ADC values of dry matter and crude protein were 88.6% and 95.7%, respectively (Table 1). ADC of amino acids varied between 91.4 and 98.9%. These results make CPC a valuable and strategic alternative protein source for Atlantic salmon.

Table 1. Nutrient apparent digestibility coefficients (ADCs) of canola protein concentrate (CPC) in post smolt Atlantic salmon. Data are means ± SEM. Means within a row with no superscript in common differ significantly (P<0.05) based on one-way ANOVA followed by Tukey test.

ADC	Test ingredient				P-value
(% dry matter)	10% CPC	20% CPC	30% CPC	Mean	
Dry matter	96.3 (7.4)	89.7 (4.7)	79.9 (5.9)	88.6 (4.8)	***0.2277***
Crude protein	95.5 (1.9)	97.2 (1.2)	94.3 (1.2)	95.7 (0.8)	***0.4733***
Arginine	98.4 (1.6)	98.9 (0.5)	96.9 (0.8)	98.0 (0.6)	***0.4966***
Histidine	97.8 (1.0)	98.2 (0.6)	96.0 (0.6)	97.3 (0.7)	***0.1994***
Isoleucine	93.7 (1.4)	96.2 (0.7)	92.5 (1.0)	94.1 (1.1)	***0.152***
Leucine	95.0 (1.4)	96.9 (0.7)	93.6 (0.9)	95.1 (0.9)	***0.1865***
Lysine	96.1 (1.3)	96.7 (0.6)	94.6 (0.9)	95.8 (0.6)	***0.4266***
Methionine	97.3 (1.1)	98.7 (0.6)	95.7 (0.7)	97.2 (0.9)	***0.1298***
Phenylalanine	95.5 (1.6)	98.0 (0.9)	94.1 (1.0)	95.9 (1.1)	***0.1849***
Threonine	93.9 (1.5)	94.9 (0.9)	92.7 (1.1)	93.9 (0.6)	***0.5146***
Tryptophan	91.4 (1.0)[b]	97.4 (0.5)[a]	96.6 (0.6)[a]	95.1 (1.9)	***0.0011***
Valine	94.6 (1.4)	96.8 (0.6)	93.3 (1.0)	94.9 (1.0)	***0.1817***
Mean amino acids	**95.4**	**97.3**	**94.6**	**95.7**	

FRASER, B

A SYNOPSIS OF MARINE MAMMAL MANAGEMENT AT BC FISH FARMS

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Since the early days of fish farming in British Columbia, operators have been required to manage interactions between their facilities and marine mammals. Though interactions with a variety of marine mammals has occurred, it is primarily pinnipeds that interact with farms, often attempting to predate fish and causing damage to farm infrastructure. Predation and farm damage can cause significant economic losses to operators and their attempts at gaining access to fish can increase risk of those animals entangling in infrastructure. In 2010, DFO took over management of the industry and soon after, the number of pinniped fatalities at farms decreased dramatically. Improved infrastructure increased regulatory requirements, adoption of third party certifications and better farm practices have all contributed to a significant reduction in pinniped deaths. Despite a reduction in deaths, interactions between farms and animals appear to be increasing in some areas. The focus of this talk is the historical context of pinniped interactions with fish farms in BC and the ongoing work between industry and DFO to manage these adept animals. Deterrents and their usage, licence conditions and noteworthy animal behaviour around farms will all be discussed.

GALLARDI, D

BLUE MUSSEL ECOLOGICAL CARRYING CAPACITY IN NEWFOUNDLAND: WHERE ARE WE AT?

Daria Gallardi*, Sebastien Donnet, Olivia Gibb, Andry Ratsimandresy, and Thomas Guyondet

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Newfoundland is a significant producer of cultured blue mussel (*Mytilus edulis*) in Canada, with about 50 active sites, the majority located in Notre Dame Bay. To ensure sustainability of mussel aquaculture and to support new sites application and expansion, there is a need to evaluate ecological carrying capacity, defined as the density of a cultured organism above which unacceptable environmental and ecosystem effects are shown. While other Canadian Regions have completed several bivalve carrying capacity studies, no studies have evaluated carrying capacity in Newfoundland and Labrador. This study builds on existing models and aims to inform siting decisions and to address knowledge gaps in understanding cultured bivalve environmental impact. South Arm (Notre Dame Bay), a site with active mussel culture, was sampled from June 2021 to July 2022. Three stations were sampled monthly for physical, chemical and biological water parameters; at the same time blue mussels from the aquaculture site were sampled for growth and condition; oceanographic moorings were placed at two stations for a full year. Results of analyses and current state of carrying capacity model development will be discussed.

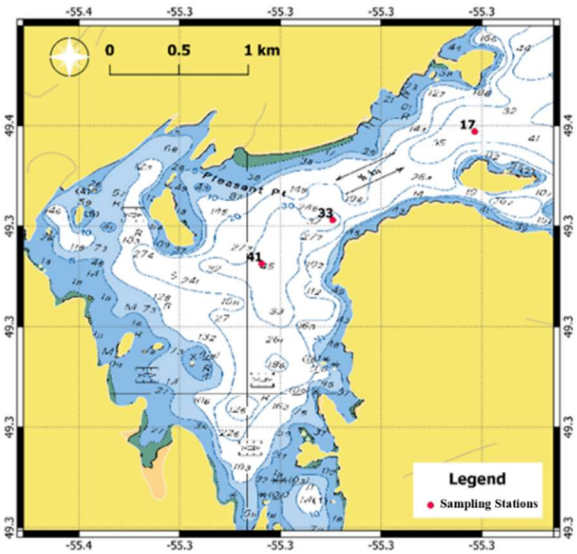

Figure: Map of South Arm, Notre Dame Bay, Newfoundland and Labrador; red dots represent sampling stations.

GALLARDI, D

IMPACT OF ORIGIN (WILD VS. FARMED) AND SEA LICE (*Lepeophtheirus salmonis*) INFESTATION ON GENE EXPRESSION IN ATLANTIC SALMON (*Salmo salar*) HEAD KIDNEY AND LIVER

Daria Gallardi*, Xi Xue, Dounia Hamoutene, and Mathew L. Rise

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The parasitic copepod salmon louse (*Lepeophtheirus salmonis*) is a cause of concern for Atlantic salmon aquaculture due to economic losses, ecological impacts and negative influence on public opinion. Sea lice have the potential to spread between farmed and wild salmon. It is fundamental to understand susceptibility to *L. salmonis* within wild and farmed salmon populations, to manage interactions between farmed and wild fish. Two distinct wild salmon populations from rivers adjacent to aquaculture operations (Garnish River and Conne River, Newfoundland) and one farmed population were challenged with *L. salmonis*. Head kidney and liver samples of non-infested, low-infested (≤ 7 lice) and high-infested (≥ 17 lice) salmon were analyzed by qPCR for the expression of 17 (head kidney) and 19 (liver) genes. Wild and farmed infested salmon presented lice load-responsive regulation of key genes in both tissues (up-regulation: *CTL-A*, *LECT2;* down-regulation: *ALAD, HBB*). Independently from lice infestation, the two wild populations presented down-regulated *LECT2* (both tissues) and *HPDG* (head kidney), and up-regulated *TCRA* (head kidney), *ABCB4, MHCII, CD3E and IGFBP1A* (liver) transcripts, compared to farmed ones. These results suggest differences in systemic immune function between wild and farmed salmon, as previously suggested by Gallardi et al. (2019; Aquaculture 499, 306-315).

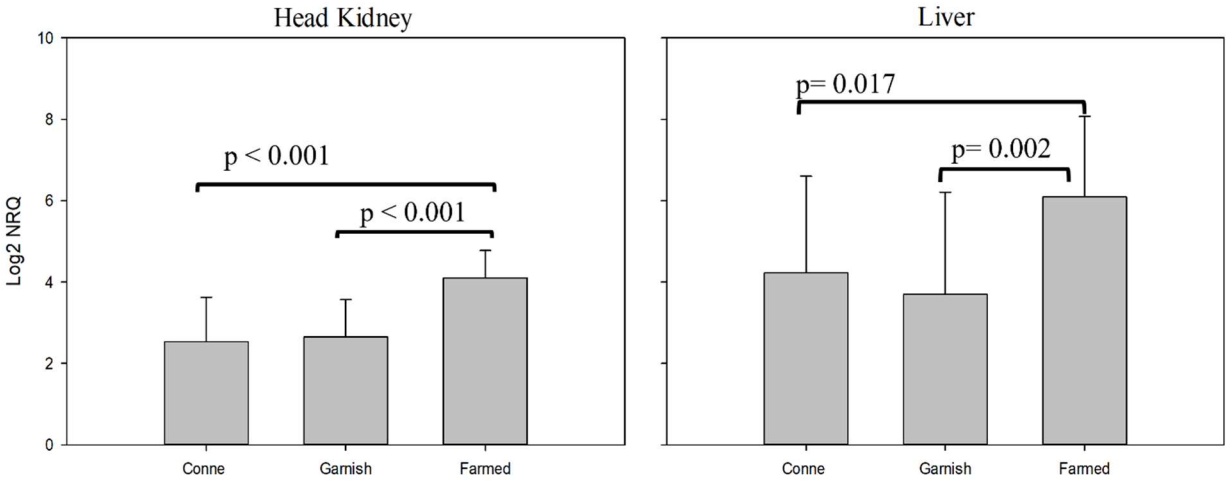

Figure: Down-regulation of Leucocyte cell-derived chemotaxin 2 (LECT2), a neutrophil attractant Type 2 T helper cell (Th2) response marker, in wild populations compared to farmed in head kidney and liver tissue.

GAM, L

PRODUCING A LARGER SMOLT: IMPACTS OF PHOTOPERIOD MANIPULATION ON ION-OSMOREGULATION AND GILL NA^+/K^+ ATPASE ACTIVITY IN ATLANTIC SALMON *Salmo Salar* TRANSFERRED TO SEAWATER AT THREE SIZES (~200G, ~500G, ~1200G)

Le Thi Hong Gam*, Daniel Montgomery, Rachael Mackinnon, Benjamin Negrete Jr, Daniel Laronde, Jeffrey G. Richards and Colin J. Brauner

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Large Atlantic salmon smolts can be generated by photoperiod manipulation in recirculating aquaculture systems. Fish were reared from hatching to one of three sizes (~230 g, ~500 g or ~1200 g) in fresh water (FW; 3 ppt) under continuous light (24L:0D). Once fish reached the desired sizes, a group of salmon were maintained at 24L:0D (non-photoperiod manipulated controls; NonPT). A second group of salmon were exposed to 8 weeks of 12L:12D, followed by 4 weeks of 24L:0D (photoperiod manipulated; PT). Blood and gills were sampled in FW, and after 24 h and 1 month in seawater (SW). There was no mortality found during the experimentation. Plasma ions and osmolality, and gill Na^+/K^+ activity (NKA) all significantly increased at 24 h SW in all size groups. There were no significant differences in plasma sodium and chloride between PT and NonPT manipulated salmon; however, at 24 h SW gill NKA (in all sizes) and muscle water (in 500g salmon) were significantly higher in PT relative to NonPT manipulated salmon indicating some beneficial effects of PT manipulation on SW transfer.

GARBER, A

PHENOTYPIC AND GENOMIC INSIGHTS FROM AN ATLANTIC SALMON BREEDING PROGRAM

Amber F. Garber*, Serap Gonen, Panya Sae-Lim, Susan E. Hodkinson, Philip G. Wiper, Michael M. Murray and Christopher J. Bridger

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The main traits of interest, such as seawater growth, sea lice resistance and fillet quality traits, have remained at the forefront of an Atlantic salmon breeding program managed exclusively using family-based phenotypic measurements. Some traits were initially important but subsequently removed from the program and selection, such as bacterial kidney disease resistance. Other traits have been added with controlled challenges, such as warming seawater tolerance, or to provide increased descriptive value during assessments, such as sea lice damage during harvest evaluations.

Fin clipping has continued to occur during each evaluation and challenge since the initial 2010 fertilized year class to create an extensive biobank and support eventual genomic selection first implemented to create the 2022 fertilized year class. We are now transitioning to a genomics-based, precision aquaculture selection with increased accuracy and efficiency using genome-wide association analyses (GWAS) for the most important traits of interest. Genomics will continue to be augmented through multi-faceted challenge development and comprehensive evaluations, which will also assess a multitude of additional traits and weighing their potential importance for inclusion as new traits or as proxies to important traits that prove difficult to measure directly. This presentation will overview our 12-year journey to date.

GHANIZDEH-KAZEROUNI, E

REGENERATION OF GILL FILAMENTS IN LABORATORY-REARED ATLANTIC SALMON (*SALMO SALAR*)

Ensiyeh Ghanizadeh-Kazerouni*, Phillip R. Morrison, Simon R. M. Jones, Colin J. Brauner

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Complex gill disorder causes physical damage to gill filaments of marine farmed Atlantic salmon and compromises gill physiological functions. The purpose of this study was to assess the regenerative capacity of Atlantic salmon gill tissue following damage. We conducted 3 levels of gill resection in salmon held in freshwater and monitored whether the level of tissue-loss, or age and size of the fish influenced regeneration.

Fish were divided between two groups: group-1 (1.5-year old, average size:580g) were subjected to 30% and 50% filament resection and group-2 (2-year old, average size:1816g) to 50% and 75% filament resection. Each level of gill resection was conducted on 16 filaments on first gill arch. Changes in filament length were measured over a period of 20-week post-resection.

On average, 38% of resected filament length was regenerated in both 30% and 50% resection in group-1 and 30% was regenerated in 50% resected filaments in group-2. There were no significant differences between groups 1 and 2, indicating minimal effects of age and body mass on regeneration rate. However, only 9% of resected filament length was regenerated in 75% resection group indicating limited capacity for regeneration with more severe damage. The regenerated tissue recovered its physiological functions.

GRAY, S

JUVENILE PACIFIC OYSTERS IN A CHANGING OCEAN: TEASING OUT THE IMPACTS OF CO-OCCURRING CLIMATE STRESSORS AND THE POTENTIAL BENEFITS OF CLIMATE BIO-MITIGATION (IMTA)

Sierra Gray*, Christopher Pearce, Clara Mackenzie, Emaline Montgomery, Chen Walker, Monique Raap, Helen Gurney-Smith, Amanda Bates

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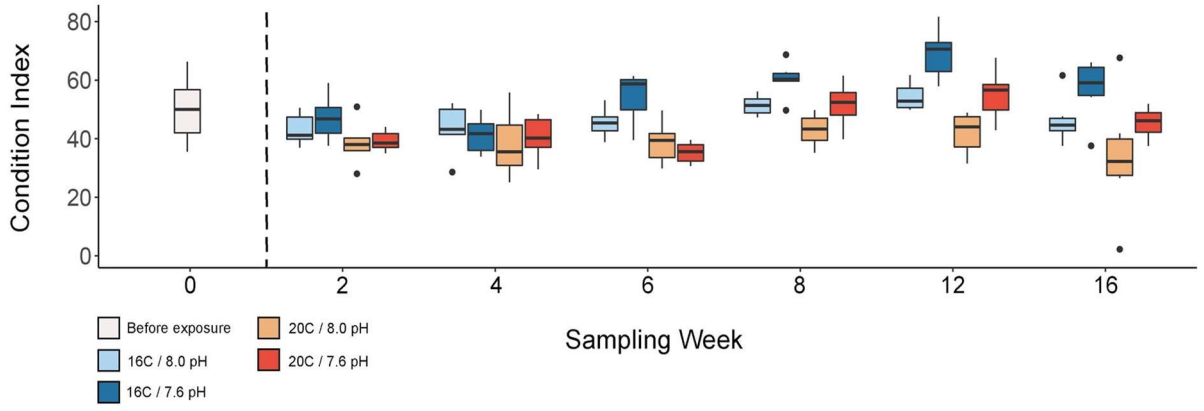
Climate change, driven by increasing anthropogenic greenhouse gas emissions, is leading to increases in global atmospheric and oceanic temperatures with coinciding rises in oceanic carbon dioxide (pCO_2) and ocean acidification (OA). Bivalves (*e.g.* oysters, mussels, clams), are negatively impacted by heat and OA in isolation, but the combined effects of elevated temperature and pCO_2 on bivalves is still widely unknown. Here we experimentally tested for independent (one stressor) and co-occurring (two stressors) climate exposure effects and quantified biological, physiological, and genomic responses of juvenile Pacific oysters (*Crassostrea gigas*). Two factors (pCO_2 and temperature) at two levels were included in a fully crossed experimental design. Oysters were sampled at bimonthly/monthly intervals over 16 weeks to examine shell biometrics, condition index and gene expression. Condition index analysis showed an inflection point around week 6; indicating higher temperatures affected oyster responses regardless of pCO_2 level, further analysis is needed. We are following up this initial experiment with a second experiment investigating potential benefits of integrated multi-trophic aquaculture (IMTA). Our results combining condition index, gene expression, and carbonate chemistry in response to multiple stressors advance our predictions for climate change ecology and sustainable aquaculture systems in mono-culture and integrated multi-trophic aquaculture production systems.



GREEN, T

GENETIC SELECTION FOR RESISTANCE TO OCEAN ACIDIFICATION IN LARVAE IS PASSED ONTO THE ADULT LIFE-HISTORY STAGE IN THE PACIFIC OYSTER *Crassostrea gigas*

Timothy Green*, Brooke Chapman, Marissa Wright-LeGreca, Andrew Loudon, Chris Pearce, Clara Mackenzie

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Ocean acidification (OA) resulting from the absorption of carbon dioxide into seawater is reducing the availability of calcium carbonate that marine bivalves use to form their shells. Despite genetic variation observed for shell formation in bivalve populations exposed to OA, the biomineralization processes enabling shell formation is poorly characterised. Early- and adult-life history stages of the Pacific oyster produce their shells out of aragonite and calcite, respectively. This ontogenic shift in calcium carbonate polymorph coincides with separate gene repertoires for constructing larval and adult shell, raising the question of whether the mechanism for OA-resistance transfers across life-history stage. To answer this question, we bred OA-resistant and -susceptible linages of oysters and evaluated the effect of low pH and elevated temperature, alone and in combination, on the growth rate of these oysters. We observed OA-resistant lineages grew faster as larvae and adults in OA conditions ($p < 0.05$). Although we observed genetic differences in the transcription of 17 shell matrix proteins in mantle tissue from the different lineages of oysters, the patterns of expression did not explain the phenotypic differences in resistance to OA. Instead, a putative HCO_3^- transporter (SLC26) was strongly upregulated in OA-resistant lineages. Overall, the biological process for OA-resistance in the oyster appears to be transferred from larval to adult life-stage, and cellular transport processes could be targeted by aquaculture breeding programs to mitigate the socioeconomic consequences of climate change on the oyster farming industry.

HAMEL, R

THE IMPORTANCE OF FISH WELARE IN SUSTAINABILTY CERTIFICATION

Katherine Dolmage, and Renee Hamel*

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Animal welfare is increasingly considered a key factor in defining 'responsible' production and determining the social acceptability of farming systems. Welfare also can convey both real and perceived impacts on product quality.

Through its Farm Standard alignment process, the ASC is working with technical working groups to develop a robust set of requirements for fish welfare that span species and production systems. These elements will include comprehensive best practice indicators, relying on extensive research.

Rather than dictate specific metric limits for certain parameters, the ASC Farm Standard will use fish welfare indices to ensure that production is supportive of good health and welfare. For example, the Standard will not set strict limits on density. Rather, by careful monitoring of fish behaviour, water quality, and other considerations, farms can ensure that the density is not at a level where impact may occur.

HASTEY, J

RE-DESIGNING OYSTER FARMING: APPLYING INNOVATION AND COLLABORATION TO IMPROVE PRODUCTIVITY, ECONOMIC STABILITY AND ENVIRONMENTAL PERFORMANCE OF PACIFIC OYSTER CULTURE

JP Hastey

Mariculture LP, Nova Harvest Ltd and Huuy-ay-aht First Nations Group of Businesses
100 Pachena Road, Bamfield B.C., Canada V0R 1B0
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Lessons learned and outcomes of a British Columbia Salmon Restoration and Innovation Fund (BCSRIF) project, where local oyster company, *Nova Harvest Ltd*., forms a joint venture partnership, *Mariculture LP,* with local First Nations partners, *Huuy-ay-aht First Nations Group of Businesses*, in a remote west coast community with the goal of developing an oyster farming model that is scalable and sustainable.

The group is developing an economically sustainable oyster farm model through adaptation/adoption of technology, automation, and mechanization, with emphasis on innovation and efficacy.

Project activities include: Designing a new, innovative oyster tray that improves handling efficiency, allows automations and reduces probability of marine plastic debris. Applying automation and streamlining processes to improve overall oyster handling efficiency by 75%. Adopting alternative power generation technology to reduce our reliance on fossil fuels by 83%. Building an Eco work platform using construction material made of recycled plastic drinking bottles. Fostering collaborations with academia in partnership with the *Bamfield Marine Sciences Centre* and industry.

HIRCH, A

FUTURE FARM: HOW TECHNOLOGY IS TRANSFORMING AQUACULTURE TODAY … AND TOMORROW

Allan Hirsch

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Artificial Intelligence and machine learning are helping to evolve the aquaculture industry by taking environmental, biological and physical monitoring to new levels so operators can make data-driven decisions in real time. Advanced aquaculture intelligence solutions like Innovasea's Realfish Pro provide unparalleled visibility into every aspect of fish farming to safeguard fish stocks, optimize production and enable producers to practice "precision aquaculture." Find out more about the innovative tools being used today as well as some of the new technologies that are on the horizon.

HOLDER, J

A PROVEN ECONOMICAL RAS – DESIGNED IN CANADA AND USED GLOBABLY

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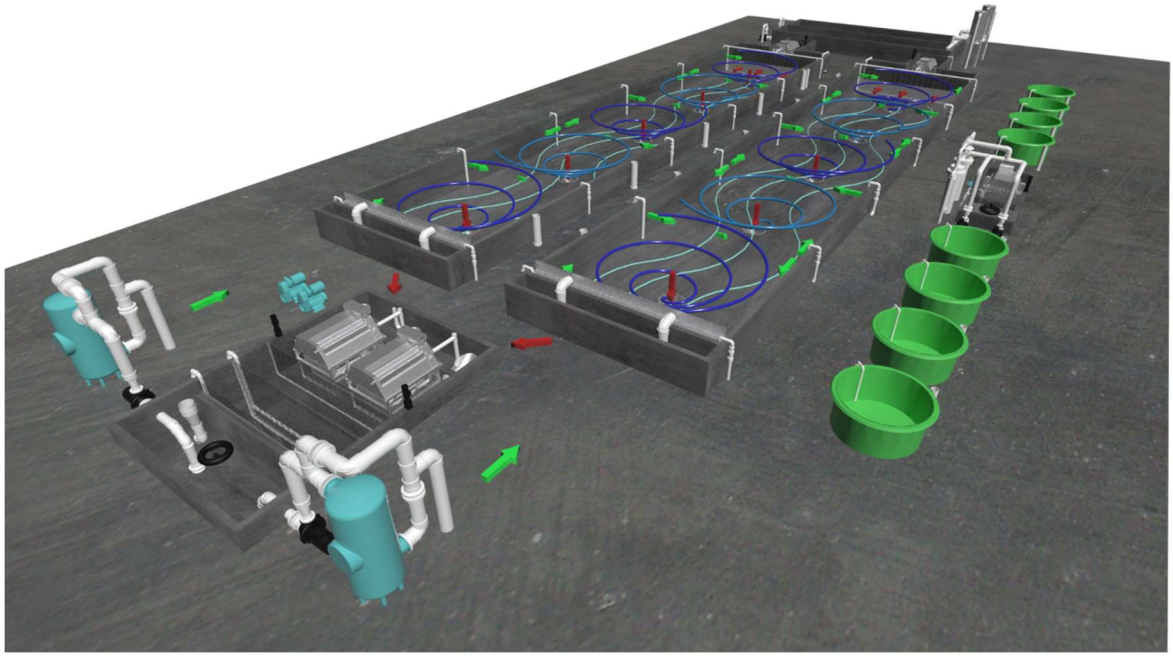
In this era of high energy and capital costs the aquaculture industry needs a low cost, low energy system to produce land-based fish. The system which will be described has a proven track record for salmonids and warm water fishes.

The electricity used varies between 2.3 kWs/kg up to 3.8 kWs/kg produced depending on species and the capital cost to construct is approximately 2/3 of a conventional round tank system.



The RASWay

HORI, T

A FULLY PHASED GENOME ASSEMBLY FOR *Mytilus edulis* UNVEILS A HIGH DEGREE OF PRESENCE-ABSENCE VARIANCE BETWEEN MUSSEL POPULATIONS.

Tiago S. Hori*, Shelby Clarke, Ramon Filgueira

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Mussels belonging to the *Mytilus* species complex are cultivated worldwide, and PEI produces 80% of the mussels sold in North America. Bivalve genomes are complex and contain many paralogous regions that can confound the separation of all types of variants in a genome. The mussel genome is also highly repetitive and heterozygous.

To overcome the challenges imposed by these characteristics, we used a hybrid assembly approach combining PacBio CLR sequencing, Dovetail Omni-seq scaffolding, PacBio Hi-Fi sequencing and PacBio IsoSeq. We present a fully-phased chromosome level assembly of the mussel's genome that enabled the genome-wide evaluation of presence-absence variance in *Mytilus edulis*.

Length and contiguity metrics were: number of scaffolds = 347; N50 = 105 Mb, NG50 = 150 Mb, Total Length = 1.58 Gb. Quality Values and completeness generated using Merqury indicated that each haplotype individually only contains ~65% of the kmers present in the raw HiFi reads. Combined haplotypes contain ~99% of the kmers present in the raw reads.

In conclusion, we presented a road map to producing high-quality chromosome-level phased assemblies for mussels. We also demonstrated the value of haplotype-resolved assemblies for genomic analysis in blue mussels and showed evidence of significant PAV among different mussel individuals.

	CLR + wtdb2 +Hi-Rise 190X	Hi-Fi + HiAsm Primary	Hap 1	Hap 2	Hi-Fi +Hifiasm + SALSA Primary - (30X)	Hi-Fi +Hiasm + Pins Primary - (30X)
# of Contigs	1119	670	905	670	394	670
Total Length (Gb)	1.651	1.64	1.64	1.64	1.58	1.64
Longest Contig (Mb)	143.8	86.4	86.4	86.4	203.1	86.4
N50 (Mb)	116.5	166.4	166.4	166.4	77.6†	166.4
NG50 (Mb)	116.5	NA	NA	NA	77.6	NA
L90	13	118	118	118	34†	118
LG90	13	NA	NA	NA	34	NA
GC (%)	32.3	32.4	32.4	32.4	32.4	32.4
Complete BUSCOS (%)	88.24	95.5	93.7	95.5	95.1	95.5
Partial BUSCOS (%)	1.23	0.33	0.66	0.33	0.33	0.33
Merqry (C_{90}, QV)	83,59, 30	83,50, 50.2	99.0*, 50.1		83,50, 50.2	83,50, 50.2

* Combined Haplotypes

Table 1. Comparative Assembly Statistics

IGNATZ, E

APPLICATION OF GENOMIC TOOLS TO STUDY AND IMPROVE THE UPPER THERMAL TOLERANCE OF FARMED ATLANTIC SALMON

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The Atlantic salmon (*Salmo salar*) aquaculture industry must mitigate the impacts of rising ocean temperatures and the increased prevalence/severity of heat waves. Therefore, we investigated the genomic architecture responsible for determining a salmon's upper thermal tolerance. Twenty salmon families were given an incremental temperature (IT_{Max}) challenge (+0.2°C day^{-1} from 12°C) to mimic natural summer sea-cage conditions. IT_{Max} ranged from 23.3 to 25.0°C among families, and a genome-wide association study (GWAS) was conducted using fin clips from these fish (n = 265) and the North American 50K SNP chip. IT_{Max} was a highly polygenic trait (with chromosomes 16 and 18 being major regions of interest) that had moderate heritability (SNP-based $h^2 = 0.198 \pm 0.207$; pedigree-based $h^2 = 0.249 \pm 0.111$). RNA-seq analyses of liver samples (n=5-6 $family^{-1}$ $temperature^{-1}$) collected from the 4 most and 4 least tolerant families at 10 and 20°C were also used to provide insights into potential mechanisms modulating this species' thermal tolerance. The expression of transcripts related to cholesterol metabolism (e.g., *lpl*, *cyp27a1*), inflammation (e.g., *epx*, *elf3*, *ccl20*) and apoptosis (e.g., *htra1b*, *anxa5b*, *angl4*) differed significantly between the most and least thermally tolerant families. These studies provide several relevant biomarkers of upper thermal tolerance in salmon that could prove valuable in helping the industry develop more temperature tolerant fish.

JIA, B

RISK FACTORS OF COMPLEX GILL DISEASE IN FARMED ATLANTIC SALMON IN BRITISH COLUMBIA, CANADA

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Gill diseases challenge the growth performance and survival of salmon aquaculture and often have multifactorial or complex etiologies. Our study was to explore the risk factors that are associated with the occurrence and severity of complex gill disease (CGD) in farmed Atlantic salmon in British Columbia (BC) using data provided by two major farming companies. Our multiple-site analysis showed spatial clustering of gill scores (measured on a scale of 0-3) both related to the frequency and the severity of lesions. Following mechanical (thermal) delousing, higher gill scores were observed, and often concurrent with post treatment mortality spikes. This was particularly evident in the summer months. And that based on one field study, gill health related mortality was reduced using a functional feed, which was potentially influenced by fish genetic background. Based on our findings, we propose the primary risk factors associated with the CGD in BC include frequent mechanical delousing, site location, and time of year. The study also looks at the role that feed may play in controlling CGD related morbidity and mortality. Our current findings provided support for further investigation on mitigation measure of gill health.

KNIFFEN, T (replaced FLINN, A as speaker)

DNA TRACEBACK®: TRACEABILITY PLATFORM BASED ON DNA TECHNOLOGY – APPLICATIONS & BENEFITS WITHIN THE SALMON PRODUCTION SUPPLY CHAIN

Allison Flinn DVM*

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Merck Animal Health is a leader in traceability solutions for salmon producers, processors, and retailers with the DNA TraceBack® platform – the most advanced meat traceability technology on the market. Using Nature's Barcode – DNA and data analytics, DNA TraceBack® supports supply chain integrity by verifying production claims of meat and seafood products and supplying an evidence-based traceability solution verifiable from farm-to-table.

Consumers are demanding transparency from the food value chain to make informed decisions they feel good about when buying animal protein. In a recent Merck Animal Health *Transparency in Animal Protein* research study, two-thirds of consumers reported transparency in animal protein is extremely or very important, and 53 percent want to know the origins of the fish they purchase[2]. Globally, 59 percent of consumers want to know where their food comes from and how it was produced[1], and they also expect more in terms of sustainability, animal welfare promises, proof of provenance and quality assurance. The information on the label must match the story behind the product, and DNA TraceBack® provides an evidence-based solution enabling salmon supply chain stakeholders to tell consumers the rich story of where their salmon comes from and how it was raised.

[1] FAO – Food and Agriculture Organisation of the United Nations 2020 & Innova Consumer Survey 2020.

KNOWLER, D

PROSPECTS FOR INTERGRATED MULTI-TROPHIC AQUACULTURE IN CANADA: AN ECONOMIC PERSPECTIVE

Duncan Knowler*, Mark Carras, Stefan Crampton, Kimberly Irwin, Winnie Yip and Rober Martinez-Espineira

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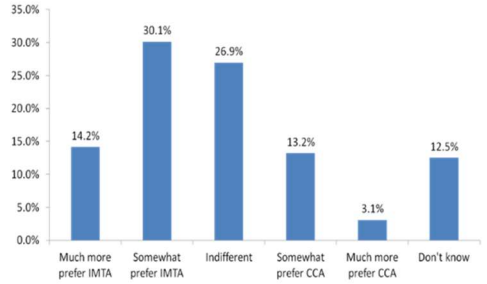
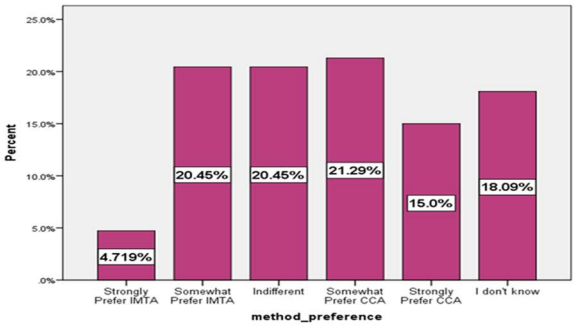
Conflicts in coastal areas are intensifying and, as a result, there are increasing demands for new ways of doing things that reduce environmental and social impacts. Canada's coastline is subject to contested uses such as aquaculture, including salmon farming and shellfish aquaculture. One potentially fruitful avenue is the promotion of alternative aquaculture technologies that can lesson, if not eliminate, the impacts of concern. We consider one such technology Integrated Multi-trophic Aquaculture (IMTA), that holds promise and report on a 5-year research program to assess the economic potential for IMTA in Canada. IMTA is placed in the wider context of technological options for salmon farming, such as Closed Containment Aquaculture (CCA), in both the "consuming" and "producing" regions. We argue that definitive conclusions regarding the attractiveness of IMTA as an alternative production technology for farmed salmon are elusive. Despite some indication of potential profitability for IMTA, there are barriers to the adoption of this alternative production system. In part, this observation stems from its untested status at full commercial scale. Moreover, there are few private financial incentives (and even some disincentives) encourages producers to adopt a new technology such as IMTA, as the biomitigation services it provides are not rewarded and recent changes in the regulatory regime make it even more challenging to adopt.

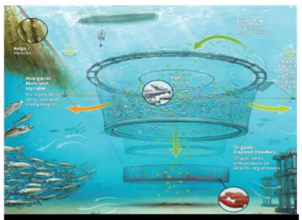
Preferences for IMTA vs. CCA in the Farmed Salmon "Consuming" Region (West Coast, USA)



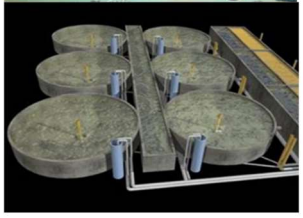
Preferences for IMTA vs. CCA in the Farmed Salmon "Producing" Region (West Coast, Canada)



Integrated multi-trophic aquaculture



Closed-containment aquaculture



KORUS, K

HARMFUL ALGAE BLOOM MONITORING ON SALMON AQUACULTURE FARMS IN THE FACE OF CLIMATE CHANGE

Jennie Korus* & Tyler Sclodnick

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Harmful algae blooms present an ongoing challenge on aquaculture farms due to their complex and unpredictable nature. The impacts of climate can lead to more intense algae blooms, and this presents operational challenges that farmers must navigate to protect their livestock that must be overcome to ensure they are achieving more efficient and sustainable production cycles.

The complex nature of the effects of different groups of phytoplankton means that producers must be able track and analyze trends at the species level. Producers must therefore be diligent in their data collection and management strategies both for the real time care of their fish and in the analysis of changes over time.

A data management and visualization system specifically for aquaculture farmers helps derive educated insights from the environmental and water quality data that farms collect. This helps farmers to discover species-specific trends, explore the relationship between environmental data and algae concentrations and better understand environmental trends like water currents that might carry species between farms. Sophisticated, map-based visualization software is intuitive and data analytics can lead to forecasting trends and predictions in the future which can help farmers better manage plankton issues on farms.

KRAUGERUD, M

HISTOPATHOLOGY AS A TOOL FOR ASSESSING GENERAL HEALTH CONDITION PRIOR TO HANDLING

Marianne Kraugerud*, Hege Hellberg, Kai-Inge Lie, Helene Wisløff, Liv Ostevik, Marta Alarcon, William Reed, Mette Hofossæter and Anne Katrine Reed

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Histopathology has been a cornerstone method in medical diagnostics for several decades. Together with PCR and microbiology, it has also been widely used for disease investigation and research in the Aquaculture Industry. PHARMAQ Analytiq has more than 20 years of experience with fish histopathology and 17 veterinary pathologists dedicated to fish diagnostics globally. PHARMAQ Analytiq is planning to launch a commercial histopathology service in Western Canada in 2023.

In contrast to PCR and microbiology, where samples are investigated with specific pathogens in mind, a histopathological investigation of common organs in a representable number of individuals, gives a good overview of the health status. In addition to detection of infectious disease, histopathology can be used for detecting non-infectious diseases, such as nephrocalcinosis and hemorrhagic-smolt syndrome. Histopathology can reveal the extent, severity and duration of tissue damage and can help in the decision-making process regarding operations that may be stressful to the fish.

Gill histopathology has been a valuable tool for assessing gill health prior to operations such as non-medicinal delousing. For example, fish with severe gill pathology due to harmful algae are expected to have a reduced tolerance to stressful operations and adaptations in the treatment regime can be made (Figure 1).

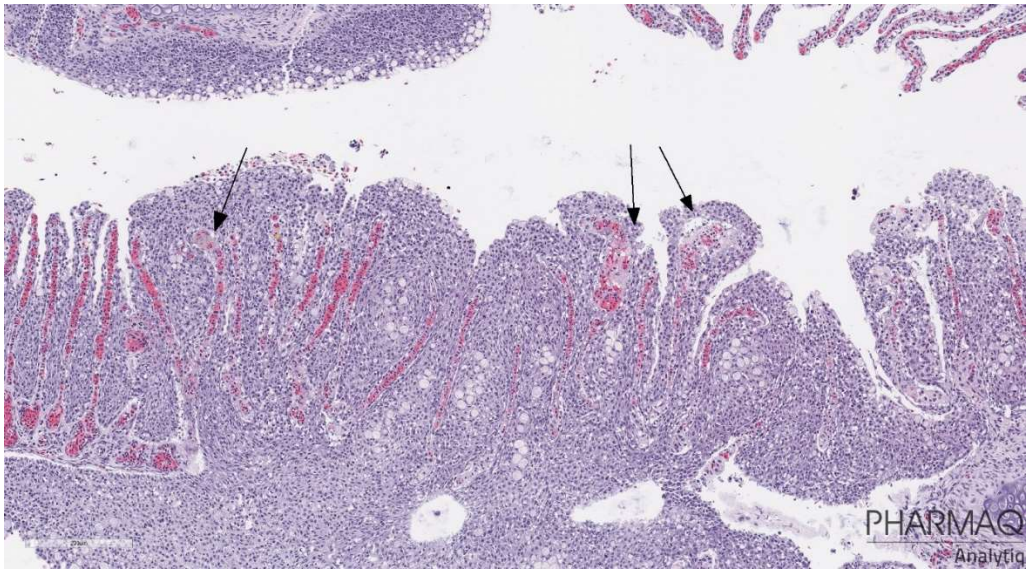

Figure 1: Gill from Atlantic salmon with vascular lesions due to previous exposure to harmful algae.

LUMSDEN, J

PARTIAL CHARACTERIZATION AND SUSCEPTIBILITY TO VHSV, IPNV, FV3, AND CSV OF A NOVEL CELL LINE FROM JUVENILE LINED SEAHORSES *Hippocampus erectus*

Lumsden, J. S.*, Kecheliev, D., Pham, P. H., Carr, D., Millar, Z. D.

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Seahorse are protected species and their aquaculture has expanded significantly to supply the natural medicine and hobby industries. Seahorse aquaculture experiences a severe bottleneck with juveniles due to nutritional issues and numerous pathogens. Viral agents are suspected causes of mortality (from electron microscopy) but have not yet been identified. A novel seahorse cell line (SH3-fin) from *Hippocampus erectus* was utilized to investigate viral susceptibility. Optimal temperature and concentration of fetal bovine serum (FBS) in Leibovitz's L-15 growth medium were examined with alamar blue cell viability assays on day 28 and 1, 14, and 28, respectively. SH3-fin cell viability was highest at 26 ˚C (Figure 1), with ideal FBS concentration of 20 % (Figure 2). Cell culture supernatant was collected from viral hemorrhagic septicemia virus IVb (VHSV), frog virus 3 (FV3), infectious pancreatic necrosis virus (IPNV), and chum salmon reovirus (CSV) infection trials. Quantitative reverse transcription polymerase chain reaction and tissue culture infectious dose 50 was performed for all viruses to confirm replication. The cell line was highly susceptible to VHSV IVb and FV3; whereas IPNV and CSV were unable to effectively kill SH3-fin cells over the course of the 10-d sampling period.

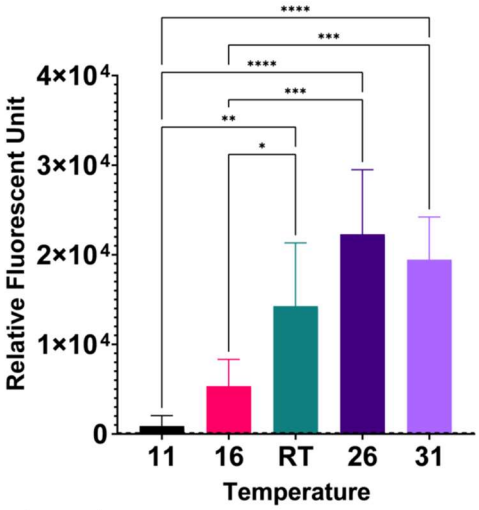

Figure 1

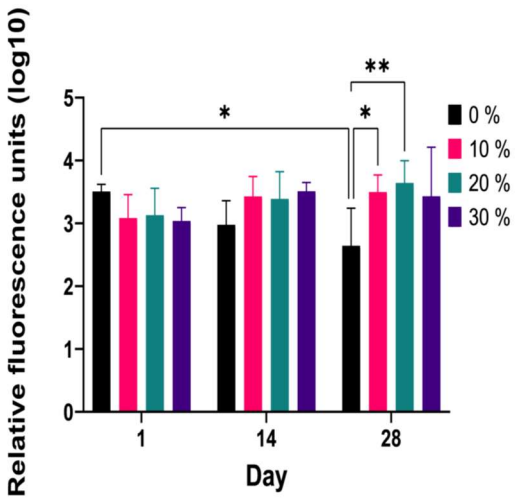

Figure 2

LUMSDEN, J

REGENERATION OF SCLERACTINIAN CORALS

Lumsden, J. S.*Millar, Z. D., Wagler, B., Pham, P. H., Kecheliev, D.

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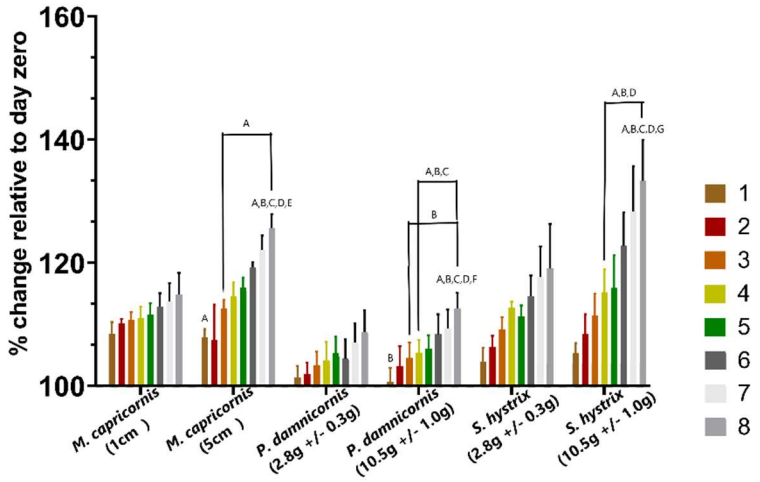
Scleractinian corals build coral reefs and are highly popular in the aquarium industry. Understanding regeneration in corals assists with coral reef restoration, increases the viability of captive coral propagation, which simultaneously increases profitability and reduces collection pressure. We investigated regeneration in three common species of Scleractinian coral, *Montipora capricornis*, *Pocillopora damnicornis* and *Seriatopora hystrix*. All species were fragmented at Day 0, producing small and large corals, and photographs and colony weights were taken weekly post-fragmentation. Corals were also sampled multiple times over a month for histology and proteomics. Large *S. hystrix* corals had a significantly greater percent change in weight relative to Day 0 compared to the other two species ($p<0.0001$). Small *S. hystrix* continued to grow, however, weight was not significantly different compared to other coral species. Faster growth in *S. hystrix* was expected since it has a weedy life history strategy in contrast to the other two species, which are competitive strategists. Histology revealed that at early timepoints following fragmentation all corals had a discontinuous epithelium and copious necrosis. As regeneration progressed a continuous, but undifferentiated epithelium, was reformed in all species, followed by reorganization and establishment of normal morphology. All corals had completely regenerated by Day 56.



Percent change weekly relative to Day 0, between the mean weight of the large coral fragments. Letters indicate significant ($\alpha<0.05$) percent changes between large fragments of different species.

MACKENZIE, C

A NATURE-BASED SOLUTION FOR MITIGATION OF PACIFIC OYSTER SUMMER MORTALITY: USE OF THE INTERTIDAL ZONE TO IMPROVE RESILIENCE TO ENVIRONMENTAL STRESSORS

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In recent years, Pacific oyster growers have experienced devastating losses due to summer mortality syndrome, a complex interaction of environmental and biological factors that results in mass mortality events. Anecdotal evidence from farmers and previous research suggests that intertidally-grown oysters may fare better during mass mortality events as compared to counterparts in deep-water culture conditions. This may be due to varying physical conditions and/or altered oyster physiologies associated with both types of culture site. However, there remains a lack of research effort examining how such factors may promote or reduce the severity of summer mortality events.

To address this, we compared growth, condition, histology, reproductive status, and survival between intertidally- and deep-water-cultured oysters over a full growth cycle (*i.e.*, 2 years). Additionally, we tested the use of the intertidal zone as a mechanism for promotion of physiological resilience prior to deep-water deployment via a reciprocal transplant between sites (Figure 1). Finally, we compared site-based responses to specific summer mortality stressors via temperature and pathogen challenge experiments.

Results will contribute to an improved understanding of Pacific oyster summer mortality and advance the development of practical mitigation strategies in order to safeguard this important global resource.

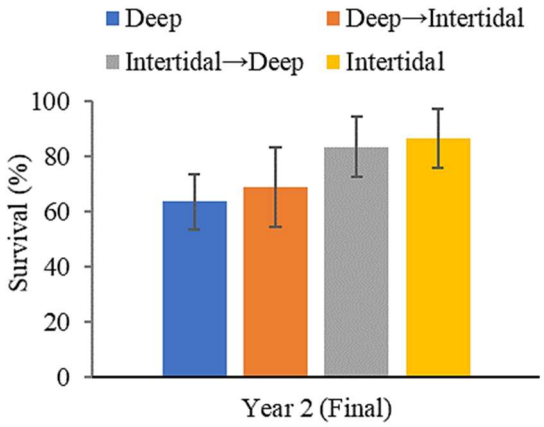

Figure 1. Mean survival (%) ± SD in Pacific oysters following two years of culture in the intertidal zone (Intertidal), deep-water (Deep) or a combination of both via reciprocal transplant (Deep→Intertidal, Intertidal→Deep).

MAITLAND, D

DEVELOPING KOI FEEDS FOR IMPROVED FISH AND PLANT GROWTH IN AQUAPONICS

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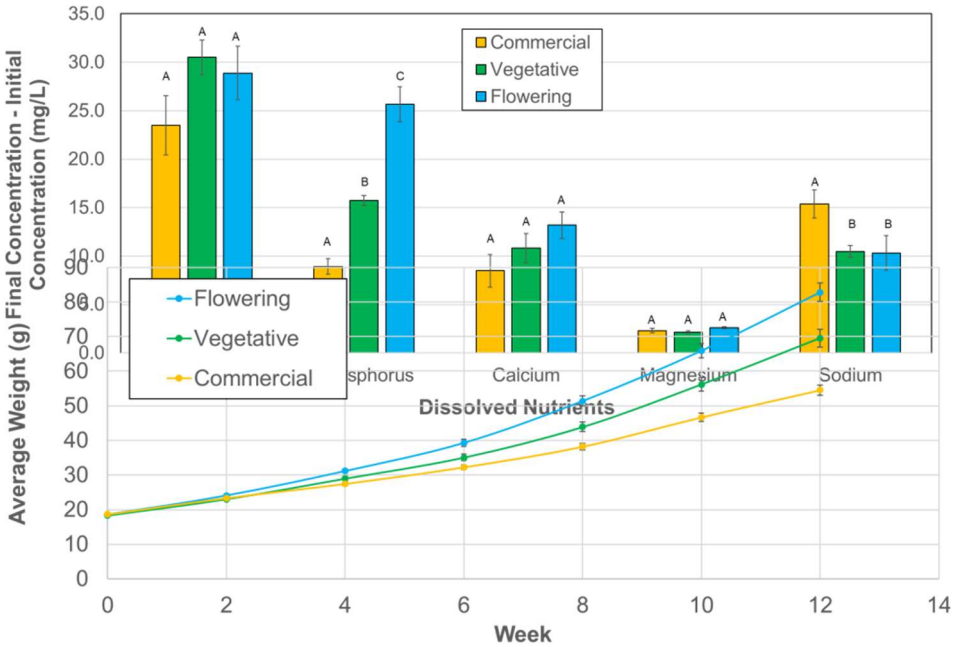
Aquaponics combines aquaculture and hydroponics in an engineered ecosystem where the nutrients generated from fish production are used to grow plants.

As an emerging, sustainable food production method, a primary hurdle to the optimization and commercial-scale success of aquaponics is the difficulty encountered trying to balance the quality and concentration of natural fertilizers produced by the fish with the plants' macro- and micro-nutrient needs. One contributing factor to these deficiencies is that currently available aquaculture feeds have been designed over several decades to limit the nutrients released by farmed fish to decrease the environmental impact of traditional fish farming. This is especially true for the phosphorus content of fish feed.

We developed two koi diets with the goal of creating nutrient solutions targeted at vegetative and flowering crop phases. We compared nutrient generation and fish growth to a commercially available koi diet. The "aquaponic" diets demonstrated greater fish growth and lower FCRs compared to the commercial diet, while also producing improved phosphorus, nitrogen, calcium, and sodium profiles in the resulting nutrient solutions.



MANN, J

A PRACTICAL OVERVIEW OF NOVEL INGREDIENTS FOR AQUACULTURE DIETS

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In recent years, several new fish feed ingredients have been developing in North America. These novel raw materials are targeting the replacement of marine ingredients, fishmeal and fish oil and, possibly, other alternative ingredients already in use.

Feed mills and fish nutritionists are met with many choices of ingredients for potential use. However, due to mill space limitations, impact on recipe costs or milling attributes, a short-list must be made as all available materials cannot be used concurrently.

A practical description of interesting novel ingredients and how they may play a role in aqua feeds will be discussed by a practical industry fish nutritionist, thinking on behalf of all parts of the supply chain. Ingredients which will be described will include black soldier fly meal, algae oil, camelina oil, specialty soy protein and natural astaxanthin.

Key desirable attributes of finfish raised by fish farmers include healthy animals having good growth, fish processed with a high yield, and providing consumers with a healthy flesh that has a nice taste, texture, scent and colour. Feed ingredients can have an impact on these characteristics.

MASHOOD, Z

EFFECTS OF FISH MEAL DIETARY REPLACEMENT WITH *Hermetia illucens* AND *Tenebrio molitor* LARVAL MEALS ON THE GROWTH PERFORMANCE AND ENVIROMENTAL SUSTAINABILITY OF *Leuciscus idus*

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Leuciscus idus, is a freshwater cyprinid rheophilic fish species native to Europe. The ide is a popular game fish prized for its sport fishing qualities. The wild population of ide have been reported to show local declines and this can be attributed to a variety of factors, including habitat destruction, overfishing, and pollution. Conservation efforts most importantly restocking are crucial to mitigate these threats and promote the recovery and growth of ide populations. This study aimed to evaluate the effects of including different insect meals as a component in the diet of *Leuciscus idus* on their growth performance, environmental sustainability, feed physical properties and utilization. Four diets were formulated: three with insect meals, HI–with 20% *Hermetia illucens* meal, TM–with 20% *Tenebrio molitor* meal, and ZM–with 20% *Zophobas morio* meal, and the control group diet, CON–fish meal with no insect component. The effects of the various diets on the efficiency of rearing ide were assessed based on fish growth, feed utilization, and environmental sustainability parameters in 60 days long trial. The highest increase in percent weight gain and the specific growth rate was observed in the TM groups, while the lowest values were observed in the CON and ZM groups. Similar outcomes were observed for the feed conversion ratio, which was most advantageous in the HI and TM groups and increased in the ZM group. The result showed that the use of back soldier fly meal and mealworm meal has a positive effect on the growth performance of *Leuciscus idus*.

TABLE 1: GROWTH PERFORMANCE AND FEED UTILIZATION OF EXPERIMENTAL FEEDS BY *Leuciscus idus*

	Diets					
Day	CON	HI	TM	ZM	SEM	p-value
			Mean individual body weight (g^{-1})			
60	40.38	45.23	45.50	44.20	0.8562	0.1160
			Mean individual body weight gain (g^{-1})			
1-60	10.94^{b}	15.86^{a}	16.05^{a}	13.94^{ab}	0.7577	0.0447
			Specific growth rate (SGR. % day^{-1})			
1-60	0.52^{b}	0.71^{a}	0.73^{a}	0.63^{ab}	0.0279	0.0240
			Percent weight gain (PWG. %)			
1-60	37.1^{b}	53.8^{a}	54.6^{a}	46.2^{ab}	2.5036	0.0302
			Feed conversion ratio (FCR)			
1-60	2.88^{a}	2.26^{b}	2.25^{b}	2.68^{ab}	0.1027	0.0463
			Protein efficiency ratio (PER)			
1-60	0.84	1.07	1.08	0.91	0.0394	0.0611
			Survivability (%)			
1-60	100	100	100	100		

TABLE 2: PHYSICAL PROPERTIES OF EXPERIMENTAL FEEDS

	Treatments				
CON	HI	TM	ZM	SEM	p-value
		Density (g/dm^3)			
434.4^{b}	394.3^{c}	502.3^{a}	447.5^{b}	6.3701	< 0.0001
		Sinking time (s/100 cm)			
36.35^{a}	38.60^{a}	17.34^{b}	22.35^{b}	1.7753	< 0.0001
		Water stability (%)			
98.87^{a}	98.62^{a}	83.57^{b}	77.65^{b}	1.5017	< 0.0001

TABLE 3: ENVIRONMENTAL SUSTAINABILTY OF *Leuciscus idus* REARING WITH EXPERIMENTAL DIETS

	Diets				
CON	HI	TM	ZM	SEM	p-value
		FMU (g/ 1kg of fish production)			
863^{a}	339^{b}	337^{b}	402^{ab}	53.0831	0.0075
		FOU (g/ 1kg of fish production)			
175.48^{a}	112.97^{ab}	33.68^{bc}	0.00^{c}	16.0334	0.0004
		FIFO			
3.78^{a}	1.64^{ab}	1.35^{b}	1.46^{b}	0.2402	0.0056
		Survivability (%)			
0.35	0.45	0.45	0.39	0.0163	0.0745

CON – control diet based on fishmeal, without insect meal; HI – diet with 20% inclusion of black soldier fly meal; TM – diet with 20% inclusion of mealworm meal; ZM – diet with 20% inclusion of superworm meal. FMU – fish meal use; FOU – fish oil use; FIFO – fish-in fish-out ratio; FCE – feed conversion efficiency.

This research was funded by the project entitled "Innovative feed components in the nutrition of rheophilic fish–optimizing and increasing the efficiency of rearing juvenile stages" No. 00001-6521.1-OR1500001/17/19, Task 2.1 "Innovations" according to EU Regulation No. 508/2014, Priority 2—"Supporting environmentally sustainable, resource-efficient, innovative, competitive and knowledge-based aquaculture" realized in the Operational Program "Fisheries and Sea".

MCGOWAN, A

THE FISHERIES AND AQUACULTURE CLEAN TECHNOLOGY ADOPTION PROGRAM

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In 2017, Fisheries and Oceans Canada launched the Fisheries and Aquaculture Clean Technology Adoption Program (FACTAP) to assist Canada's fish and seafood sectors incorporate clean technologies and sustainable practices into their day-to-day operations to improve their environmental performance.

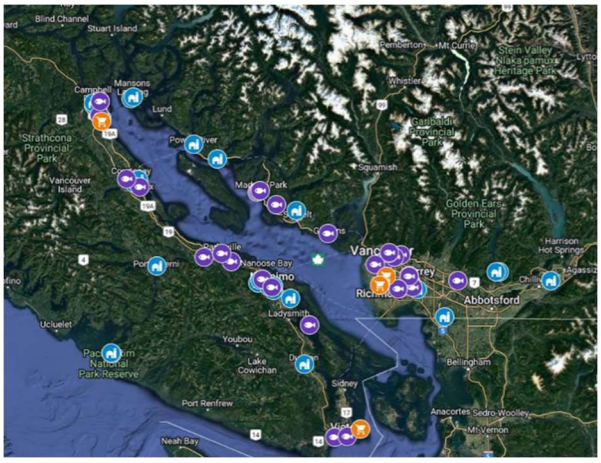

Figure 1: 73 FACTAP projects across BC (totaling $ 9.6 million); 38 fisheries, 30 aquaculture; 5 processing

Commercial fisheries and aquaculture are important contributors to Canada's economy and provide significant social, cultural and economic benefits to First Nations and coastal communities. Clean technology and innovation are key components of the federal government's approach to protect aquatic environments and promote sustainable growth of Canada's fishery and aquaculture industries. Between 2017-2023, the FACTAP has signed 195 contribution agreements totaling $30M across Canada.

Figure 2: Semi-Closed Containment System

This oral presentation will showcase the FACTAP and how it has contributed to the adoption of innovative and clean technologies for the aquaculture industry nationally, highlighting projects that others might consider adopting in the future. Some notable projects in British Columbia (BC) include the first ever pilot-testing of a semi-enclosed containment salmon production system and an industry-wide project to replace 2,600 cubic metres of degraded Styrofoam floatation with non-polluting air-filled flotation.

MILLER, J

CHANGE IMPACTS ON MARICULTURE

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Climate change is leading to more severe and frequent deoxygenation, acidification, harmful algal blooms, and extreme heatwaves in the oceans, all of which will impact mariculture and wild capture fisheries. However, impacts, including growth and survival of harvested species, will not be equally distributed. Variation in spatial and temporal patterns of impacts will influence how businesses, governments, and other ocean user groups will need to adapt. Yet, most climate models are not at a resolution necessary to help plan for such changes. Here we present how we use rapid, high-resolution ocean climate data to create species-specific projections for the future growth and survival of key mariculture species. We anticipate changes in the frequency and intensity of marine heat waves and consequences for species survival. Our analyses demonstrate how future conditions at a hypothetical aquaculture site in British Colombia will affect select species of bivalves and seaweed. These kinds of data can then be used to inform species and site selection given local conditions.

MONTGOMERY, D

PRODUCING A LARGER SMOLT: IMPACTS OF PHOTOPERIOD MANIPULATION ON SEAWATER GROWTH RATE, METABOLIC RATE, AND HYPOXIA TOLERANCE OF ATLANTIC SALMON *Salmo salar* TRANSFERRED TO SEAWATER AT THREE SIZES (~200g, ~500g, ~1200g)

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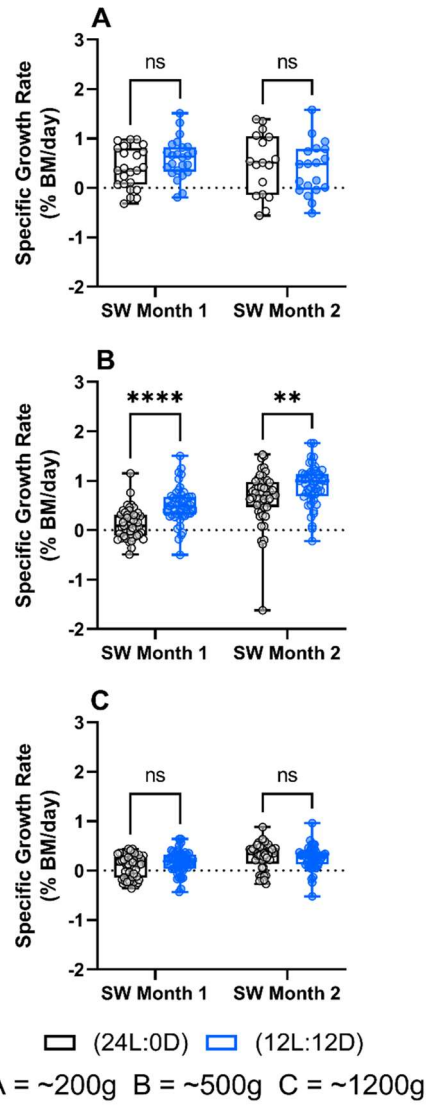
A goal of salmon aquaculture is to produce larger, physiologically robust smolts to reduce time spent in marine net pens. However, little is known about whether standard processes to induce smoltification provide benefits in the production of large smolts. In Atlantic salmon reared under continuous light (24L:0D) we applied an artificial photoperiod manipulation (8 weeks of 12L:12D) followed by 4 weeks of 24L:0D before sweater transfer) at three sizes to produce fish of ~200g, ~500g and ~1200g at seawater transfer. Performance of these presumptive large smolts was compared to fish maintained in constant light until seawater transfer.

Photoperiod manipulation increased growth rate of ~500g fish during the first two months following seawater transfer by 0.32% body mass/day but had no significant effect for ~200 or ~1200g fish. Photoperiod manipulation increased basal energetic costs (MO_{2min}) or salmon of all sizes by ~13 but did not alter the effect of seawater transfer on metabolic rate. Additionally, photoperiod manipulation decreased hypoxia tolerance of 00g and 200g fish at seawater transfer. Overall, our results suggest standard photoperiod manipulations can successfully improve growth after seawater transfer of 00g salmon but may cause trade-offs which increase base energetic costs and reduce hypoxia tolerance.



MONTGOMERY, E

BIOLOGICAL BIOFOULING CONTROL OF SALMON NET PENS USING THE GIANT RED SEA CUCUMBER *Apostichopus californicus*

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Biofouling of aquaculture infrastructure is a universal challenge faced by both shellfish and finfish growers. Biofouling organisms such as algae, tunicates, sponges, hydroids, and mussels can add significant weight to nets and cages, which must be regularly cleaned to maintain optimal water flow and integrity of these structures. The need to regularly clean biofouling is a time consuming and often expensive process that can be a constraint to industry. Modern cleaning techniques are highly variable and range from direct infrastructure swapping to industrialized power washing that uses high-pressure water to remove the biofouling. The latter is a popular technique in the finfish industry due to its efficacy of removing biofouling, but it is time consuming, costly, and may have negative fish-gill-health consequences that are just being recognized. Development of alternative practices to prevent and control biofouling in finfish net pens is therefore warranted to help offset the time, financial, and potential fish-health costs of current cleaning technologies.

Sea cucumbers like *Apostichopus californicus* have long been recognized for their co-culture potential due to their natural ability to recycle organic-rich sediments into nutrient poor faeces, but little research has examined their ability to control biofouling. We tested the ability of *A. californicus* to consume biofouling material on nets at two organic Chinook (*Oncorhynchus tshawytscha*) farm sites using four treatments: pens with (1) fish and sea cucumbers (SC); (2) fish, but no SC; (3) no fish, but SC; and (4) no fish and no SC. Sea cucumbers were observed feeding on biofouling organisms on the nets in treatment 3 and preferentially consuming excess feed / salmon wastes in treatment 1. Gut-content analysis and biochemical profiles of the sea cucumbers were conducted for treatments 1 and 3. No negative interactions (e.g. health and/or behavioural) were detected between the salmon and the sea cucumbers suggesting that this is a good partnership to explore further.

Fig. 1 Sea cucumber feeding on biofouled nets.

NOWLAN, J

EXPERIMENTAL INDUCTION OF TENACIBACULOSIS IN ATLANTIC SALMON (*Salmo salar* L.) USING *Tenacibaculum maritimum*, *T. dicentrarchi*, AND *T. finnmarkense*

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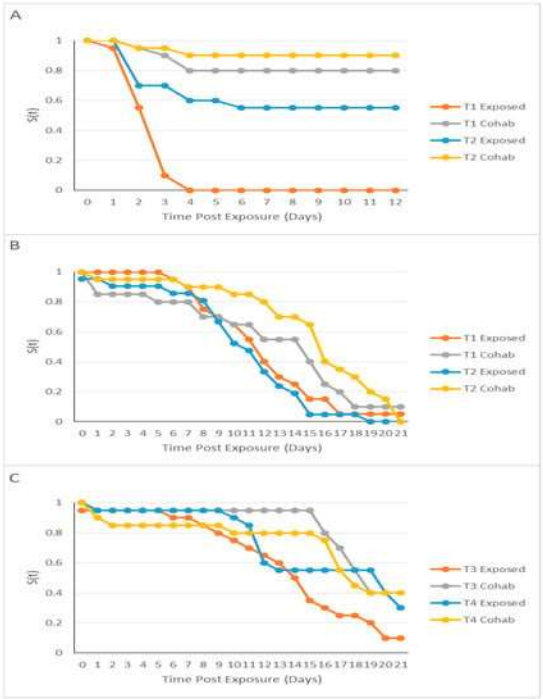
There is a limited understanding of the pathogenesis of tenacibaculosis in Atlantic salmon (*Salmo salar* L.) and there are few reproducible exposure models for comparison. Atlantic salmon were exposed via bath to *Tenacibaculum maritimum*, *T. dicentrarchi*, or *T. finnmarkense*, and were then grouped with naïve cohabitants.

Mortalities had exaggerated clinical signs of mouthrot, a presentation of tenacibaculosis characterized by epidermal ulceration and yellow plaques, on the mouth and less frequently on other tissues. Histopathology showed tissue spongiosis, erosion, ulceration, and necrosis ranging from mild to marked, locally to regionally extensive with mats of intralesional bacteria on the rostrum, vomer, gill rakers, gill filaments, and body surface.

Exposure to *T. maritimum* resulted in less than a 0.4 probability of survival for both exposed and cohabitants until Day 21. Exposures to *T. dicentrarchi* resulted in 0 and 0.55 (exposed), and 0.8 and 0.9 (cohabitant) probability of survival to Day 12 post-exposure, while *T. finnmarkense* had a 0.9 probability of survival to Day 12 for all groups. This experimental infection model will be useful to further investigate the pathogenesis of tenacibaculosis, its treatment, and immunity to *Tenacibaculum* species.



PARK, P

BRIDGING THE RAW MATERIAL GAP: UPDATE ON NOVEL INGREDIENTS IN AQUAFEED.

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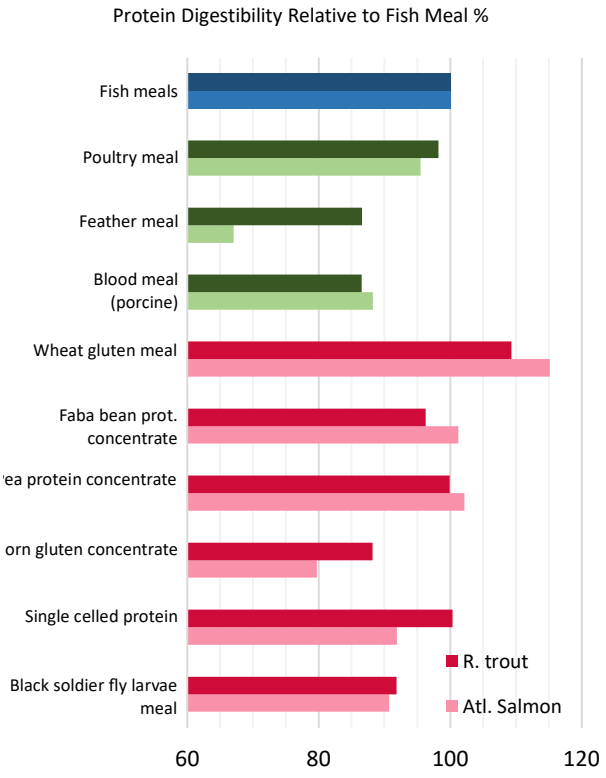
Challenges in the global supply chain seen in the last 3 years from government COVID-19 policies, role of global powers and shortage of labour among others have significantly impacted the aquaculture industry. In addition, continuous increase in consumer demand of protein has driven up the cost of raw materials important to fish farming, namely fish meals and oils, while wild fisheries output has stagnated and at times decreased. Consequently, there has been accelerated demand for more nutritional innovations that may be sustainably produced domestically while reducing the competition with the human food chain.

Novel ingredients are non-conventional feedstuffs of plant or animal origin, either through advanced processing of traditional ingredients or scaling products not suitable for human food. In salmonid feeds, alternative sources of protein and EPA & DHA are actively explored with many showing promise; however, all considerations must be considered before large-scale use. The complexity surrounding sustainability, nutrition, quality, regulatory, end user perception and financial perspectives must be fully understood.

This presentation will demonstrate current trends and developments in alternative proteins and oils relevant to the Canadian aquaculture industry. Nutritional assessments and sustainability initiatives of novel raw materials will be emphasized from a feed manufacturer's perspective.



PEET, C

WHAT DOES CERTIFICATION 2.0 LOOK LIKE?

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Aquaculture is widely recognized as one of the most efficient animal protein production systems on the planet, but it is not without its impacts. Perhaps especially because the industry covers such a diversity of species and systems, there have been decades of clashes with environmentalists over the development of the aquaculture industry. Certifications are a useful tool to promote seafood sustainability, but many of the current standards were developed through NGO collaborations and mainly focus only on managing local environmental risks. While these tools have brought about progress, they have not succeeded in building sufficient consumer trust to allow for the necessary social license for the aquaculture industry to expand. Although the goal of achieving more sustainable seafood is shared by all, further growth requires an evolved certification model. The private sector, encompassing both producers and end buyers, has the opportunity to spearhead the development of a certification model that is more inclusive of other key issues such as gender equality, climate, and animal welfare. This updated scheme must be more cost effective, adaptable to climate challenges, equally credible as existing options, and enable more accurate data collection on sustainability issues by incorporating technologies. Where Food Comes From is a new entrant to the seafood industry and is well-positioned to lead the next phase of the certification dialogue

PLETSCH, L

HOW MULTISITE / GROUP CERTIFACTIONS WITH INTERGRATED MANAGEMENT SYSTEMS (IMS) HELPS THE FARMER.

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Certifications have become an important part of many agriculture and aquaculture industries. Certifications are a vital part in creating a strong social licence within the industry and within your local community because of this it is important to set farmers up for success when pursuing certifications. A strong management system is the foundation of any multisite or group IMS certification. A strong management system sets clear and achievable expectations for everyone in their role of achieving the certification. A strong management system also makes it very easy to shift employees around to different farms or areas because everything is standardized. Another important part of an IMS is a strong internal audit and inspection team. With a strong internal audit and inspection team you can educate employees about the standards and correct deficiencies before external audits. A strong inspection team also helps with ongoing support to farms and strives for continues improvement of the IMS. Multisite and group certifications with IMS also reduce the number of annual external audits which makes auditing a large group of sites easier and more cost effective.

QUINN, B

WELLFISH DIAGNOSTICS CLINCAL CHEMISTRY BASED FISH HEATLH ASSESSMENT: SAV CASE STUDY

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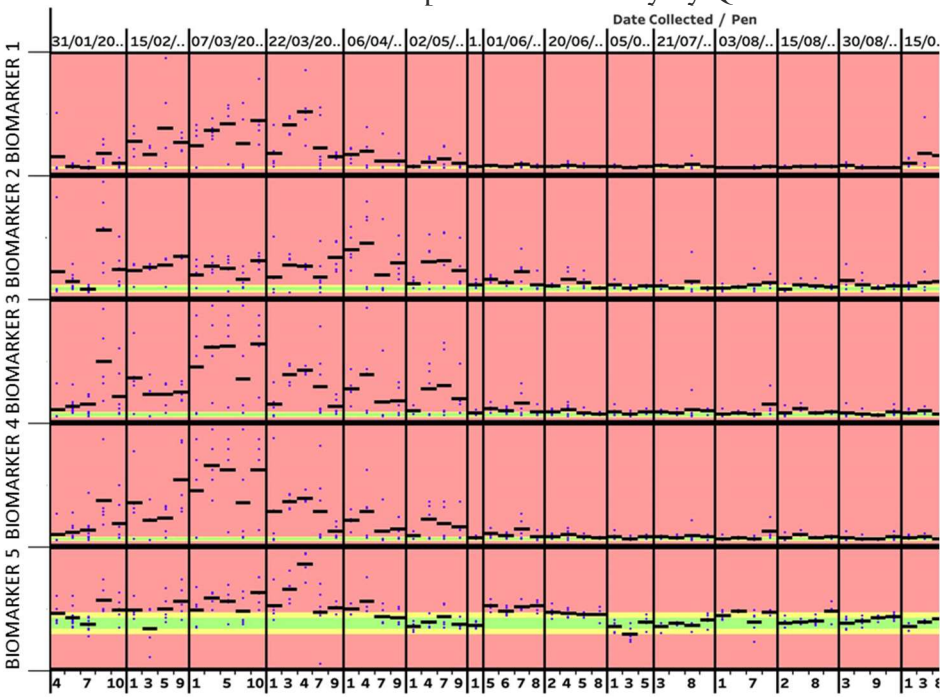
WellFish Diagnostics improves fish health and welfare management by providing rapid, non-lethal fish health assessment for the aquaculture sector using blood based clinical chemistry analysis. Using our unique database and AI models we provide clinically interpreted results within 24h, facilitating continuous health monitoring and early heath challenge detection, predicting health outcomes based upon their biomarker profiles. Biomarker results are presented using an intuitive "traffic light reference range system".

SAV infections are characterised by the presence of liver and heart/skeletal muscle tissue damage. This tissue damage results in the increased activity and leakage of enzymes and these changes can be traced at blood level using this health monitoring approach. This case study involves the health monitoring of a specific site infected by SAV, from healthy stage, through the early onset, peak and recovery from the tissue damage. This ability to monitor the progression of the infection using biomarker profiles to determine the condition/function of key organs leads to a better understanding of stock health status, improved decision making and faster interventions by health managers with a view to mitigating disease outcomes. Although developed in Scotland this approach shall be available to the Canadian aquaculture industry by Q3 2023.



REID, G

FARMING IN NATURAL SYSTEMS (FINS): AN AQUACULTURE CARRYING CAPACITY MODELLING PLATFORM FOR NOVA SCOTIA

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There are multiple published carrying capacity models which have practical application to temperate aquaculture. These include finfish and shellfish production, organic deposition, sulphide production, dissolved nutrients, disease transfer risk, and phytoplankton dynamics. Several of these models are currently being integrated into an overarching software application called FINS, which will enable carrying capacity assessment of aquaculture scenarios around Nova Scotia. The Finite Volume Community Ocean Model (FVCOM) defines the underlaying hydrodynamics of key aquaculture bays around the province. Carrying capacities are calculated as a function of aquaculture type, target production, location, site configuration, and proximity to other aquaculture operations. Model outcomes are overlaid with a maximum wind and wave layer to quantify exposure risk. Supporting field data collection is ongoing and FINS development is currently underway. This presentation reviews FINS objectives, current status and implications for decision support.

REID, G

MODERN LAND-BASED AQUACULTURE FACILITIES: HOW SHOULD WE MONITOR DISCHARGE IN MARINE ENVIRONMENTS?

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The number and scale of global land-based aquaculture facilities is increasing dramatically. Current trends of culturing large post-smolts for marine stocking and political decisions to transition net-pen culture to land, suggest this trend will also increase in Canada. Modern land-based culture technologies enable extensive removal of dissolved nutrients, organic solids and can facilitate therapeutant degradation prior to discharge. However, the discharge nutrient load, form and resultant concentration in the marine environment can vary extensively, due to multiple technological and environmental drivers. This presents challenges for regulatory discharge monitoring and determining what exactly should be monitored. Most discharge monitoring protocols assume the receiving water body has a limiting nutrient, it is known, measurable and there is an understanding of how nutrient addition could affect trophic status. This is not always well understood for coastal marine system, suggesting that default monitoring strategies such as point measurements of nitrogen concentrations at prescribed distances, may not always be appropriate. This presentation reviews the current state of knowledge of discharge from modern land-based facilities, monitoring knowledge gaps, the load vs concentration debate, potential applications of new technologies and how *ad hoc* monitoring approaches might be unavoidable.

REIMER, S

BACTERIAL MICROBIAL COMMUNITIES ASSOCIATED WITH JUVENILE SALMON *Oncorhynchus kisutch* IN ENHANCEMENT HATCHERIES.

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Pacific salmon reared in enhancement hatcheries have been shown to have a lower resistance to stress than their wild counterparts, which, paired with high rearing densities increases the risk of proliferation and transmission of opportunistic pathogens between fish. Understanding the factors that lead to microbial dysbiosis in hatchery-reared salmon is important to mitigate disease occurrence in juveniles in the enhancement hatchery environment.

The aim of this work was to use MinIon full length 16S bacterial sequencing (Nanopore technology) to characterize the microbial communities in fish mucosa, tank biofilm and water associated with juvenile Coho in Vancouver Island (British Columbia, Canada) enhancement hatcheries. We collected longitudinal samples from Coho rearing ponds and channels from two broodstock cohorts during their development, extracted and amplified DNA using 16S universal primers, and sequenced samples using the MinIon platform (Nanopore NGS technology).

Our results showed that salmon have unique mucosal microbial communities distinct from their biofilm and water environments, and the microbial diversity of samples differed depending on sample type and time of year, with water samples having the highest richness and fish mucus the lowest. Our analysis also identified several bacterial genera of note with high relative abundance in multiple samples, including *Aeromonas spp.* in mucus and biofilm samples predominantly in summer, and *Flavobacterium spp.* in water and biofilm samples. The presence of these bacteria in high amounts at specific times of the year and only in certain sample types may indicate that the combination of low species richness and specific environmental factors may result in favorable conditions for disease development.

ROTH, M

BRITISH COLUMBIA FISHERIES AND AQUACULTURE OCEAN ACIDIFICATION AND HYPOXIA ACTION PLAN

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To better understand and respond to climate change in BC's coastal waters, the Province of BC undertook the development of an Ocean Acidification and Hypoxia (OAH) Action Plan. While the Plan addresses these issues through a fisheries and aquaculture lens, its scope is intended to reach beyond these sectors by considering BC coastal marine ecosystems, communities, industries, and economy.

The Plan was informed by four virtual workshops between November 2021 and March 2022 to assess: OAH science; seafood sector and coastal community perspectives and, policy and governance considerations. Overall, 172 individuals representing 88 groups and institutions contributed to the workshops.

The Plan consists of two documents. The first, the BC OAH Action Plan, is a summary of the history, regional context, sectoral and First Nations relevance, and science related to OAH in BC and is intended for general audiences. The plan provides five goals, fifteen objectives and sixty-two actions. The second is a comprehensive Scientific Assessment that supports the Action Plan and is intended for subject matter experts.

Together, both documents support the *CleanBC Roadmap to 2030* (2021), the *Climate Preparedness and Adaptation Strategy: Actions for 2022-2025* (2022) as well as BC's Coastal Marine Strategy (in development). In addition, the Plan addresses BC's commitments to the Pacific Coast Collaborative, the Pacific Coast Climate Leadership Action Plan, and the International Alliance to Combat Ocean Acidification. Further, it addresses United Nations (UN) Sustainable Development Goal 14.3: "*Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels*" and has been endorsed by the United Nations as an Ocean Decade project.

ROTH, M

SOCIO-ECONOMIC ANALYSIS OF FARMING SALMON IN RECIRCULATING AQUACULTURE SYSTEMS (RAS) IN BRITISH COLUMBIA.

Myron Roth*, Edwin Blewett, Sam Chen, and Lillian Hallin

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We report on an economic analysis of farming salmon using recirculating aquaculture system (RAS) technology and strategic considerations to support the development of RAS salmon aquaculture in British Columbia (B.C.)

The analysis is based on a generic economic model developed by Blewett and Nelson (2019)[1] that was restructured for two species of salmon (Atlantic and steelhead trout), three farm sizes (1,000, 5,000 and 25,000 tonnes annually) and two locations (Lower Mainland and Interior). The model was refined using the latest available information gleaned from articles and published reports and, where no information was available, the expert judgements of industry participants. Gross domestic product (GDP), jobs & employment, household incomes, and tax revenues were estimated using an economic Input-Output Model for BC (Hallin, unpublished) calibrated using one-time capital expenditures and ongoing annual operating expenditures from our model.

The analysis suggests that Atlantic salmon yield slightly higher net economic returns than steelhead trout; Small farms are not economically viable, but scale economies allow medium farms to survive and large farms to earn reasonable margins; and RAS salmon farms will be more likely to locate in the Lower Mainland. While financial rates of return are low, investment would create significant jobs and economic contributions to the province.

[1]Blewett, E. & Nelson, S. (2019). RAS Atlantic Salmon Industry on Vancouver Island Financial Model & Economic Impact Analysis. Counterpoint Consulting. 31p.

SALVO, F

AT SEA SUGAR KELP CULTIVATION TRIALS IN CAPE BRETON AND FUTURE DEVELOPMENTS

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Shellfish aquaculture operations in Nova Scotia have been seriously impacted in recent years by climate change including raising of invasive tunicates and sea duck predation. Thus, sea farmers have aimed to diversify their activities on leases where traditional shellfish farming was no longer economically viable. They were looking for alternative species able to grow on current leases with little or no modifications to their current infrastructure. Various seaweed species of commercial interest that can be cultivated are growing naturally around the province including sugar kelp, winged kelp, dulse, etc. Seaweed has an important market worldwide and husbandry can easily be adapted to mariculture leases. Two years of trials were performed with 3 industry partners on shellfish leases where sugar kelp (Saccharina latissima) seeded lines were deployed at 2 and 4 m depth. Growth, quality and yield were monitored along with environmental parameters. Results showed that the cultivation of seaweed is productive in Cape Breton, especially in bays without ice covers.

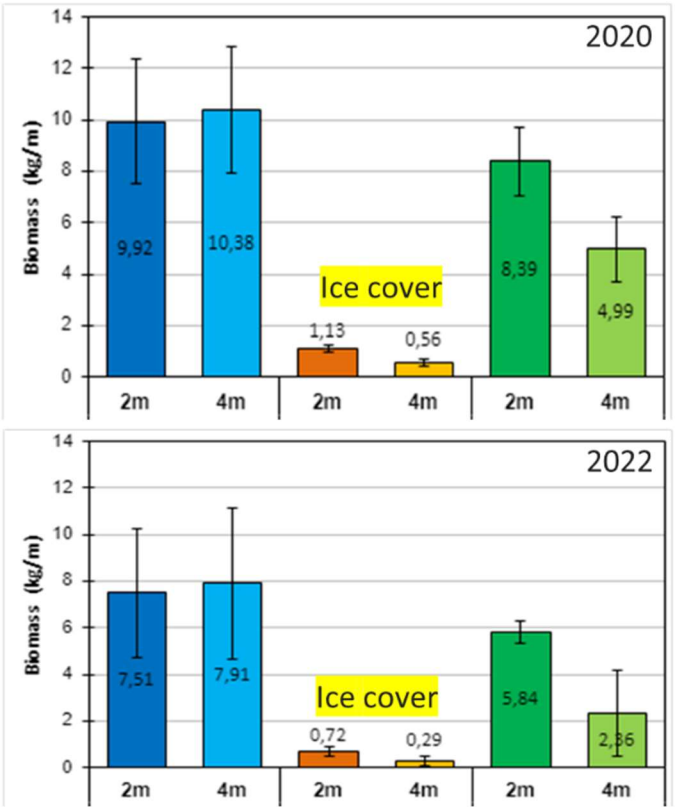

Figure: Yield biomass of sugar kelp after 8 months of growth (November – June) in 2020 and 2022. Each color represents a different site

To scale up seaweed farming in the province the industry must improve seeding, cultivation, harvest and hatchery technology. In that regard, Merinov is also leading a project with NRC on population genetics and banking of sugar kelp seeds in Atlantic Canada to support the industry towards climate change.

SANDER, C

AN IN-DEPTH LOOK INTO ORGANIC CERTIFICATION

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In this presentation we will look at the 5 easy steps to organic certification, review of transition requirements and go over commonly asked questions on organic certification such as:

- What aquaculture products can be certified organic?
- Does my feed need to be certified?
- Cost of certification?
- What are the COR 312 labelling requirements?
- Where can COR 312 products be marketed?

SAVILLE, B

CONTROL OF AQUACULTURE PATHOGENS USING SOLUBLE MANNO-OLIGOSACCHARIDES

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Infections caused by *Vibrio spp.*, *Tenacibaculum spp*. and *P. salmonis* have led to billions of dollars in losses in the shrimp and salmon, yet there are few options to prevent or manage these infections. Manno-oligosaccharides (MOS) are widely recognized for their ability to control pathogens such as *Salmonella spp*. and *E. coli* in the poultry and livestock industries, but are not widely used in aquaculture. GreenSage Prebiotics (GSP) has developed a high purity, soluble MOS targeted at key pathogens impacting aquaculture, animal, and human health. GSP has conducted *in vitro* and *in vivo* trials to evaluate its novel MOS product (GSP-MOS). *In vitro* trials to determine the minimum inhibitory concentration (MIC) and minimum lethal concentration (MLC) of GSP-MOS versus *Vibrio parahaemolyticus*, *Tenacibaculum maritimum* and *Aeromonas salmonicida* demonstrated the effectiveness of GSP-MOS and the superiority of GSP-MOS versus yeast-based MOS products (Table 1). GSP-MOS also exhibited significant inhibition of *P. salmonis* in Atlantic Salmon Kidney cells, reducing *P. salmonis* progression (and cytopathic effect) by >50% during a 19 day assay.

Additional *in vitro* studies have demonstrated enhanced growth of beneficial microbes such as *Lactobacillus spp* with GSP-MOS; both products support the digestive and immune systems.
An *in vivo Vibrio parahaemolyticus* challenge trial was completed in shrimp, following six weeks of consumption of feed containing GSP-MOS. Shrimp consuming 0.25 wt% GSP-MOS had 100% survival following a *Vibrio* challenge, compared to 42% survival in shrimp that did not receive MOS (Figure 1).

Pathogen	MIC, mg/mL		MLC, mg/mL	
	GSP-MOS	Yeast MOS	GSP-MOS	Yeast MOS
Vibrio parahaemolyticus	5.55	>50	50	>50
Tenacibaculum maritimum	16.67	50	50	50
Aeromonas salmonicida	16.67	>50	50	>50

Table 1: MIC and MLC of MOS Products

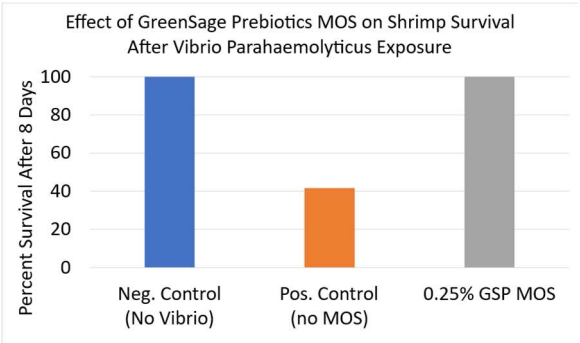

Figure 1: GSP-MOS Improved Shrimp Survival from 42% to 100% after Vibrio Challenge

This presentation will discuss the benefits of high purity, soluble MOS as a feed additive for control of pathogens, and the corresponding impacts for aquaculture and animal health.

SHAW, K

AN OVERVIEW OF THE AREA-BASED AQUACULTURE MANAGEMENT INITIATIVE IN BRITISH COLUMBIA

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Area-Based Aquaculture Management (ABAM) is a new initiative in British Columbia (BC) which aims to have governments, stakeholders, and industry working together to spatially plan, manage, monitor, and improve aquaculture activities. This will occur within distinct geographical areas so unique jurisdictional, ecological, social, cultural, and economic values can be considered. Enhancing coordination and collaboration between the Federal Government, the Province of BC, and Indigenous groups is a key focus of ABAM.

In spring 2022, two areas were selected to pilot an area-based approach to aquaculture management; one with a focus on shellfish aquaculture, and the other with a focus on marine finfish aquaculture. DFO has been working closely with partnering First Nations in the selected areas to learn about an area-based management approach, build tools and materials, identify challenges, and consider how ABAM may be expanded in the future.

Through collaboration, DFO hopes to advance reconciliation, strengthen the role of Indigenous groups in aquaculture planning and management, improve transparency and decision-making, adopt an ecosystem-based management approach, and improve social and economic benefits for communities in BC.

Lessons learned from this pilot will inform the Net-Pen Aquaculture Transition Plan being developed in parallel to this pilot.

SUTHERLAND, B

SHELLFISH POPULATION GENOMICS TOWARDS HIGH-THROUGHPUT TOOLS FOR ADVANCING BREEDING METHODS

Ben J. G. Sutherland*, Amy M. Chan, Curtis A. Suttle, Timothy J. Green

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Pacific oyster *Crassostrea gigas* and Yesso scallop *Patinopecten yessoensis* are commercially grown in British Columbia (BC) and provide a local, nutritious, and sustainable food source as well as an economic driver for the region. The Pacific oyster and Yesso scallop both originate from Asia, although the Pacific oyster now grows naturally in BC waters. Shellfish are sensitive to climate change due to both environmental perturbations as well as disease, providing an impetus to ensure that crops are cultivated for current optimal growth and production targets but also for maintenance of genetic diversity. Here we present ongoing work that uses next-generation sequencing to genotype thousands of single nucleotide polymorphism (SNP) variants within hundreds of Pacific oysters or Yesso scallops either from their native range (Japan, China), from coastal BC, or from hatchery or farm sources. We compare genomic diversity among these groups, as well as identify markers for high throughput commercial panel design. The objective of this work will be to have 500-marker commercial genotyping panels available to the research and production community, and database management systems for broodstock management to aid in the continued development of breeding lines for optimal growth and production in a changing environment.

TREMBLAY, R

BIVALVE LARVAE PHYSIOLOGY AND SPAT PRODUCTION

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The majority of marine bivalves have a benthopelagic cycle and their larval settlement and metamorphosis are a complex phenomenon integrating morphological and physiological changes essential for their success in a new benthic habitat. The metamorphosis success is critical for the spat production, as over 50 % of mortality are regularly observed during this critical stage in wild spat collection and in hatcheries. Research studies showed great plasticity of bivalve larvae during this period, with impressive capacity of larvae to delay their metamorphosis or their possibility to return in the water column following their metamorphosis for a second settlement process. The metamorphosis and this plasticity mechanism of selecting benthic habitat have important energetic impacts on individuals and needs chemical or environmental cues. Thus, knowledge on larval nutritional needs to support metamorphosis process is primordial. A better control of this process is essential to increase spat production with the use of artificial collectors in the field, but also in the hatchery. This is particularly important in the context of global changes involving new stressors, like heat waves, acidification, hypoxia and anthropogenic noise. This presentation will focus on knowledge obtained during the last 20 years in my laboratory on mussels, oysters, clams and scallops and their potential application in shellfish aquaculture.

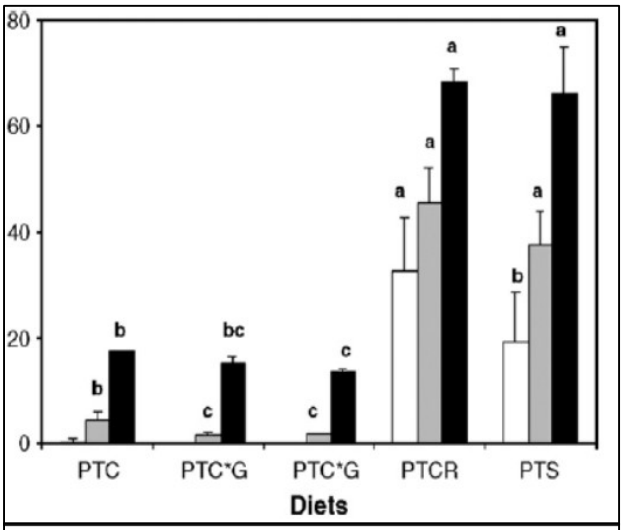

Fig. 1. Metamorphosis success in scallop larvae fed on different microalgae diets (mean±SD; n=3 replicate tanks per diet).

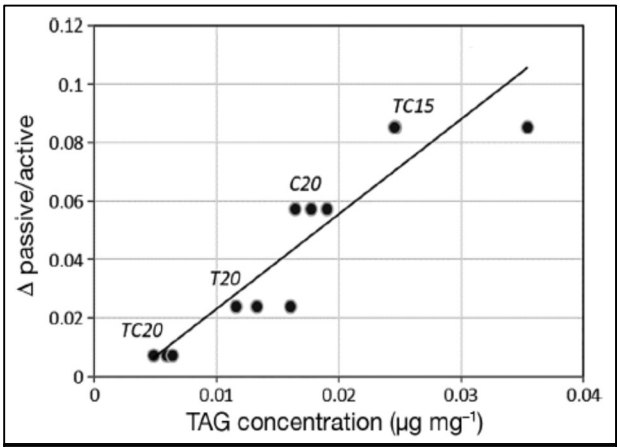

Fig. 2. Relationship between the Δ passive/active parameter reflecting secondary migration ability as a function of lipid energy content (TAG: triacylglycerol, $R^2 = 0.849$).

VANDERSTEEN, W

USE OF INSECT MEAL AND ALGAL OIL IN FEED FOR *Oncorhynchus tshawytscha*

Wendy Vandersteen*, Miki Shimomura, Gary Marty, Ian Forster

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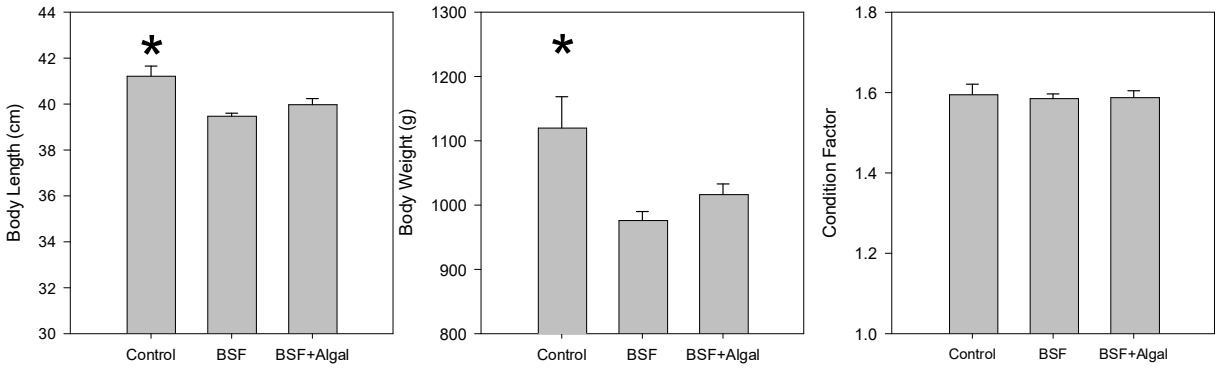
Black soldier fly larvae (*Hermetia illucens*) are a possible alternative protein source for fish but the lipid component can lack essential fatty acids needed for fish health and consumer expectations. Combining BSFL meal and algal oil could yield an effective diet supplement to reduce demand on marine resources and maintain organic status for this product while providing healthy food for consumers.

Three diets were tested: 1) control; 2) 10% inclusion of BSFL; 3) 10% inclusion of BSFL and 5% inclusion of algal oil. Chinook salmon smolts were transferred into 12 tanks at the Pacific Science Enterprise Centre and reared on the diets until they reached market size. At the end of the experiment, multiple organs from a subsample of fish were subjected to histopathology and fillet samples were collected for sensory analysis, quantification of pigmentation, proximate analysis, and fatty acid composition.

Inclusion of BSFL was associated with a decrease in size of the fish at the end of the trial. In the liver, mild inflammation affected 11 of 25 (44%) fish fed a diet that included BSFL compared with 0 of 11 (0%) fish fed the control diet. Results from the sensory analysis will also be presented.



VELTMAN, C

IDENTIFICATION OF GENE EXPRESSION PATTERNS IN COMPLEX GILL DISEASE: USING JELLYFISH TOXINS AND HYDROGEN PEROXIDE BATH TREATMENTS AS LABORATORY MODELS OF GILL DISEASE IN ATALNTIC SALMON (*Salmo salar*)

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In recent years, the prevalence of multifactorial gill pathologies has increased significantly, causing substantial losses in Atlantic salmon aquaculture. Complex Gill Disease (CGD) is a multifactorial gill disorder, resulting from a culmination of exposures such as pathogenic organisms, environmental insults, and farm management practices. Hydrogen peroxide treatments help mitigate diseases such as sea lice, however, has unintended effects on gill health. Increasing ocean temperatures due to climate change have influenced the frequency of jellyfish blooms. Nematocysts toxins can be dislodged into the water column via water currents or under net pressure washing causing direct damage to the gill. The purpose of this study is to examine genetic biomarkers associated with hydrogen peroxide exposures and jellyfish toxins, *in vitro* and *in vivo*. Preliminary results have shown healing in the gill after twenty-four hours for fish exposed to jellyfish toxins. Further analyses will use targeted transcriptomics correlated with histopathological changes associated with these trauma models to help analyze biological responses such as damage, repair, and oxygen transport mechanisms. By the end of this study, gene expression patterns will be identified, aiding the aquaculture industry in diagnosing and assessing preventative strategies in the field.

WOLTER, M

EFFICACY ASSESSMENT OF RENOGEN® EMPLOYING DIFFERENT I.P. VACCINATION STRATEGIES WITH FORTE MICRO™ AND FORTE VII AGAINST *Renibacterium salmoninarum* CHALLENGED THROUGH AN I.P. FRESHWATER CHALLENGE MODEL FOR ATLANTIC SALMON *(Salmo salar L.).*

Marilyn Wolter*, Astrid Dominguez, Stephanie Businger, Alicia Macdonald

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Bacterial Kidney Disease (BKD) is an important infectious disease affecting various fish species, including Atlantic salmon (*Salmo salar L.*). The disease typically results in chronic mortality and reduced feed conversion rates (FCR) and is thus of major economic importance. Renogen® is the only commercially licensed vaccine in Canada against BKD. The present work evaluates the efficacy of Renogen against an intraperitoneal infection challenge of *R. salmoninarum* in fresh water, following administration in one of eight vaccination strategies compared to a negative control group. Vaccines were administered intraperitoneally and vaccination regimens evaluated as Groups under the current studies are summarized in Tables 1 and 2. Following the complete vaccination regimen and a period of 400 dd (Table 1; Forte Micro study) or 600 dd (Table 2; Forte V II study), 35 fish per group were i.p infected with *R. salmoninarum* and followed for mortality, body weight and growth, bacterial load (IFAT), and gross pathology (renomegaly score) in a duplicated, common garden design. Study results will be presented and discussed.

Table 1. Vaccination regimens evaluated as study groups in Study 1 (including Renogen and Forte-Micro vaccines)

Group Code	1st vaccination 36g	2nd vaccination 58g (400dd)
C/C	Control	Control
R/FM	Renogen	Forte Micro
FM-R/R	Forte Micro+Renogen	Renogen
FM-R/C	Forte Micro+Renogen	Control
FM/R	Forte Micro	Renogen

Table 2. Vaccination regimens evaluated as study groups in Study 2 (including Renogen and Forte-VII vaccines)

Group Code	1st vaccination 36g	2nd vaccination 78g (600dd)
C/C	Control	Control
R/FVII	Renogen	Forte V II
FVII-R/R	Forte V II+Renogen	Renogen
FVII-R/C	Forte V II+Renogen	Control
FM/R	Forte Micro	Renogen

BRITNEY, S

A NEW HIGH-THROUGHPUT SEQUENCING ASSAY FOR THE CHARACTERIZATION OF Tenacibaculum COMMUNITIES.

Scott R. Britney*, Joseph P. Nowlan, John S. Lumsden and Spencer Russell.

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Nanaimo, British Columbia, Canada V9R 5S5
Scott.britney@viu.ca

Tenacibaculum are a ubiquitously distributed marine bacterial genus with several species known to induce tenacibaculosis in Atlantic salmon (Salmo salar L.). In British Columbia Canada, outbreaks of tenacibaculosis are responsible for significant annual mortality necessitating antimicrobial intervention at significant financial expense. The detection and characterization of Tenacibaculum isolates using 16s rRNA sequencing for isolate screening reveals a significant limitation in the resolving power of the 16s gene within the genus. Moreover, these methods do not capture the dynamic and changing nature of bacterial communities. Here, a new high- throughput sequencing approach targeting the conserved bacterial Adenosine triphosphate synthase gene (atpA) was used as a phylogenetic marker to more precisely identify members of the Tenacibaculum genus. This assay was tested using a series of mock communities, constructed from known dilutions of seven Tenacibaculum species and outgroups, and directly compared to analogous 16s rRNA amplicons.

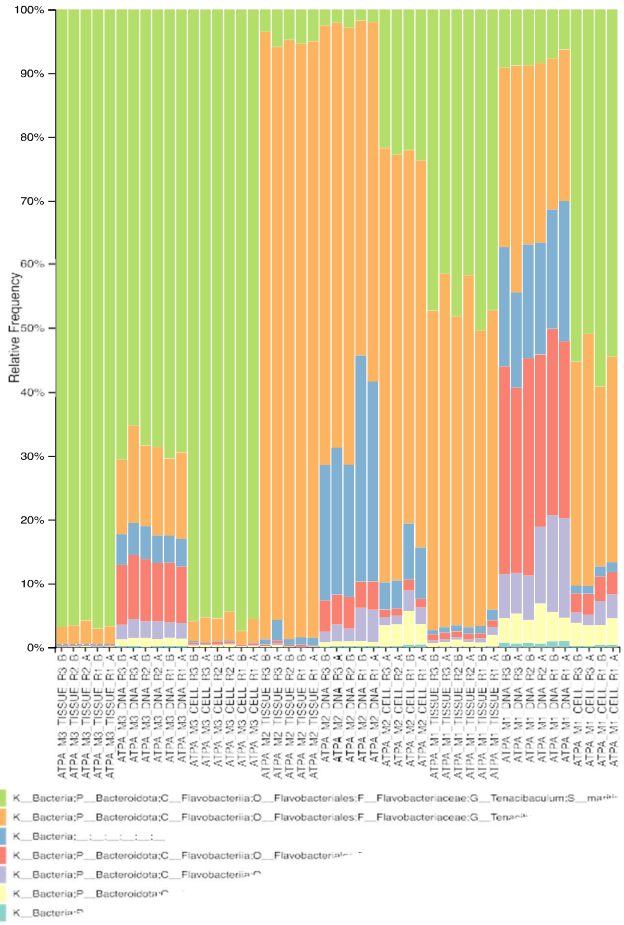

Figure 1.

The atpA gene identifies 86% of represented Tencibaculum species (Figure 1), within 4 clades, while the 16s gene identifies only 42% of represented species in 3 clades. Mock community analysis reveals this atpA assay offers the potential for more precise characterization of Tenacibaculum diversity, providing an enhanced visualization of the dynamics of Tenacibaculum communities in the environment.

GHANEI-MOTLAGH, R

ISOLATION AND CHARACTERIZATION OF *Bacillus* PROBIOTICS WITH ANTI-QUORUM SENSING AND ANTI-PATHOGENIC ACTIVITIES: A PROMISINIG STRATEGY TO DISARM GRAM-NEGATIVE BACTERIAL FISH PATHOGENS

Reza Ghanei-Motlagh*, Mark D. Fast

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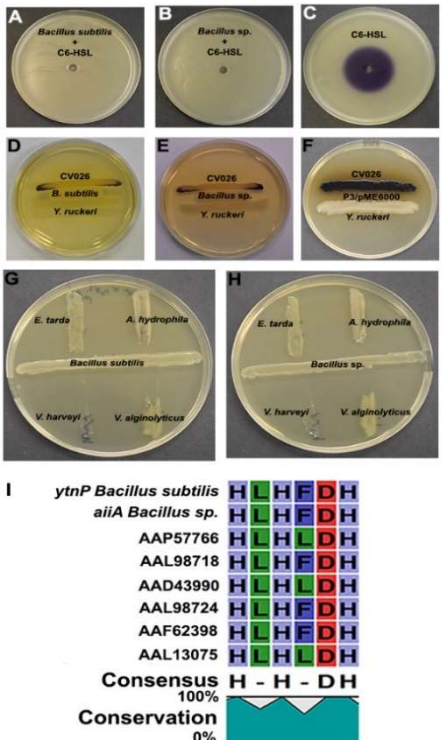
Quorum sensing (QS) is a process that allows bacteria to monitor their population in a cell-density dependent manner through the secretion, exchange and detection of small signaling molecules. *N*-Acyl homoserine lactones (AHLs) are an important group of QS signals which are involved in production of virulence factors in Gram-negative bacteria.

In this study, two bacterial strains able to degrade synthetic AHL were isolated from the intestine of rainbow trout and identified by 16S rDNA ribotyping as *Bacillus* sp. and *Bacillus subtilis*. The quorum quenching (QQ) activity of the isolates was initially confirmed by both the agar well diffusion test and the degradation assay using *Chromobacterium violaceum* CV026 as QS biosensor. The AHL-lactonase genes (*aiiA* and *ytnP*) were amplified and sequenced from the isolates, and multiple alignment of the translated amino acid sequences revealed the presence of the conserved motif HxHxDH. The anti-pathogenic potential of both isolates was tested against *Aeromonas hydrophila*, *Edwardsiella tarda*, *Vibrio harveyi* and *Vibrio alginolyticus*. The isolates were further screened by several probiotic tests including hemolysis assay, antibiotic resistance test and resistance to low pH and bile salts.

Our results suggest that QQ *Bacillus* strains isolated could be used for biocontrol of bacterial infections in aquaculture.



A-C. AHL-degrading activity of *Bacillus* sp. and *Bacillus subtilis*. **D-F.** Quorum quenching potential of both isolates against natural AHL produced by *Yersinia ruckeri*. **G-H.** Positive anti-bacterial activities of the QQ isolates against *A. hydrophila*, *V. harveyi* and *V. alginolyticus*. **I.** Comparison of the amino acid sequences of AHL lactonase from *Bacillus subtilis* (YtnP) and *Bacillus* sp. (AiiA) with other AHL lactonases from the superfamily MBL fold metallohydrolase, representing the common conserved motif "HxHxDH".

GILCHRIST, K

INVESTIGATING THE MICROBIOME OF *Patinopecten yessoensis* DURING LARVAL REARING

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High and unexplained hatchery mortality is a major impediment to the successful cultivation of the Yesso scallop (*Patinopecten yessoensis*) in British Columbia, and many other parts of the World. Adverse or unhygienic conditions might cause the microflora of scallop larvae to become pathogenic to their host. Probiotic bacteria are environmentally safe and promising for controlling pathogens in hatcheries. Using culture-dependent and -independent methods, this project will report changes in the bacteria community of scallop larval tanks over time. The project will also determine whether the addition of a probiotic strain of *Roseobacter* sp. improves the survival and growth rate of scallop larvae. Knowledge generated from this project should improve hatchery husbandry of *P. yessoensis* in British Columbia.

HEESE, B

USING QUANTITATIVE-PCR TO IDENTIFY *Tenacibaculum Ovolyticum* (*T. ovo*) AT A B.C. ATLANTIC SALMON (*Salmo Salar* L.) NET-PEN SITE.

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Tenacibaculum ovolyticum (*T. ovo*) is one of eight bacterial species in the genus associated with outbreaks of tenacibaculosis. Working off research conducted by Nowlan (2020), a variety of samples were subjected to a newly-developed, *T. ovo* specific quantitative PCR (qPCR) assay (Figure 1) in order to describe the presence of *T. ovo* at an Atlantic salmon (*Salmo salar* L.) net-pen site.

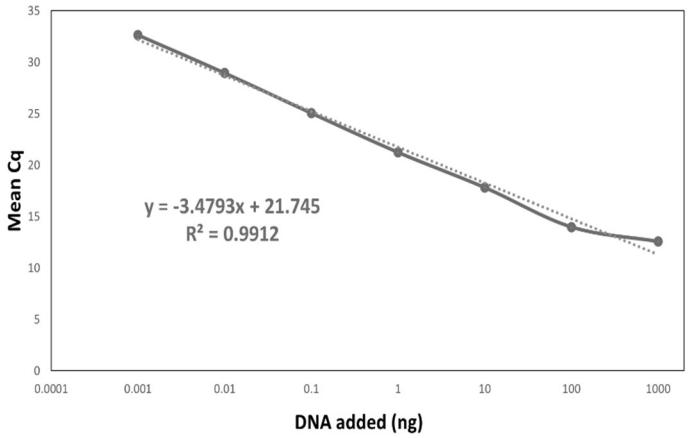

Figure 1. Standard curve using genomic DNA from *Tenacibaculum ovolyticum.*

A variety of abiotic and biotic samples were selected before and after introduction of smolts, and during and after antibiotic treatment of mouth rot (Table 1). Of the 100 samples tested, two were positive for *T. ovo* before an outbreak and before treatment.

SAMPLE TYPE:	BEFORE FISH 09-APR-2019	1 WEEK AFTER FISH INTRODUCTION/BEFORE TREATMENT 24-APR-2019	DURING TREATMENT 24-APR TO 29-MAY-2019	AFTER TREATMENT 12-JUN-2019
WATER	0m (2)	0m (3)	0m (3)	0m (3)
	5m (2)	5m (3)	5m (3)	5m (3)
	10m (2)	10m (3)	10m (3)	10m (3)
FISH TISSUE (LIVE)	N/A	Skin (3)	Skin (3)	Skin (3)
		Gill (3)	Gill (3)	Gill (3)
		Upper Jaw (3)	Upper Jaw (3)	Upper Jaw (3)
		Kidney (3)	Kidney (3)	Kidney (3)
FISH TISSUE (MORT)	N/A	Skin (mort) (3)	Skin (mort) (3)	Skin (mort) (3)
		Kidney (mort) (3)	Kidney (mort) (3)	Kidney (mort) (3)
INVERTEBRATE	*Mytilus sp.* (1)	*Mytilus sp.* (1)	*Mytilus sp.* (2)	*Mytilus sp.* (1)

Table 1. Summary of samples from the Midsummer net-pen site (Nowlan, 2020) with number of biological replicates in brackets.

Further work is needed to establish a comprehensive understanding of the complex relationships between *Tenacibaculum* species found in the environment, the microbiome of host(s), and clinical outbreaks at Atlantic salmon net-pen sites in B.C. waters.

NOWLAN, J

GENOMICS OF *Tenacibaculum* SPECIES IN BRITISH COLUMBIA, CANADA

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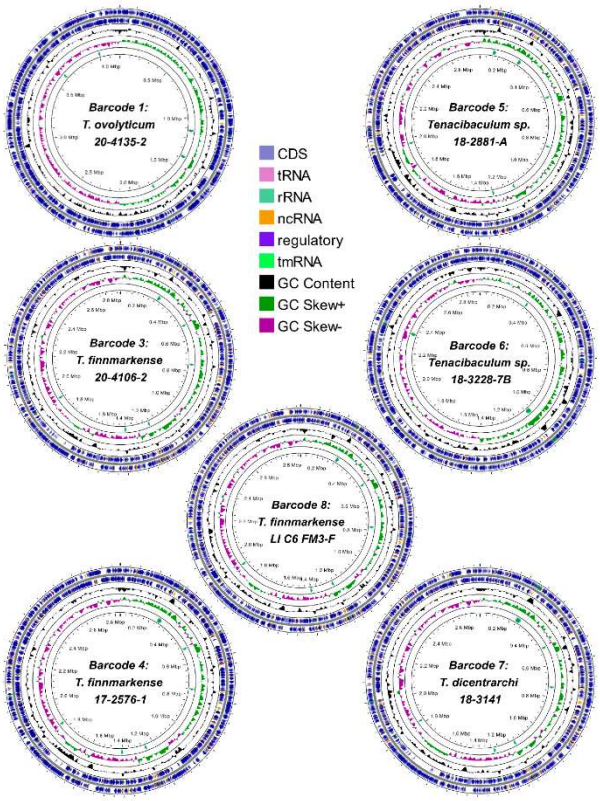

Tenacibaculum is a genus of Gram-negative filamentous bacteria with a cosmopolitan distribution. The research describing *Tenacibaculum* genomes stems primarily from Norway and Chile due to their impacts on salmon aquaculture. Canadian salmon aquaculture also experiences mortality events related to the presence of *Tenacibaculum* spp., yet no Canadian *Tenacibaculum* genomes are publicly available. Ten isolates representing four known and two unknown species of *Tenacibaculum* were selected for shotgun whole genome sequencing using the Oxford Nanopore's MinION platform.

Average nucleotide identity analysis identified *T. ovolyticum*, *T. maritimum*, *T. dicentrarchi*, two genomovars of *T. finnmarkense*, and two proposed novel species *T. pacificus* sp. nov. type strain 18-2881-A^T and *T. retecalamus* sp. nov. type strain 18-3228-7B^T. Annotation in most of the isolates predicted putative virulence and antimicrobial resistance genes, most-notably toxins (i.e., hemolysins), type-IX secretion systems, and oxytetracycline resistance. Comparative analysis with the *T. maritimum* type-strain predicted additional toxins and numerous C-terminal secretion proteins, including an M12B family metalloprotease in the *T. maritimum* isolates from BC. The genomic prediction of virulence-associated genes provides important targets for studies of mouthrot, and the annotation of the antimicrobial resistance genes provides targets for surveillance and diagnosis in veterinary medicine.

STENHOUSE, S

INNOVATIONS AND FINDINGS OF DFO AQUACULTURE MANAGEMENT FRESHWATER SALMON HATCHERY INSPECTIONS: 2020- PRESENT

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As the lead regulatory authority for aquaculture in British Columbia, Fisheries and Oceans Canada conducts a robust field audit program for marine finfish facilities. The Fish Health Audit and Intelligence Program (FHAIP), has been in operation since 2010, when the program was adopted in its entirety from the BC Ministry of Agriculture.

In 2020, new functions were added to the FHAIP to perform regular inspections of freshwater land-based hatcheries for the marine finfish sector. Inspections included the collection of fish samples for diagnostic testing including bacteriology and molecular screening using polymerase chain reaction (PCR). New requirements were also put in place for industry to conduct their own pre-transfer testing of fish to be transferred. A discussion of the development of these features and implementation will occur.

Detections of pathogens and disease have been low, however when detections have occurred appropriate mitigations have been put in place by the respective facilities to minimize impact to the population. A review of the findings will be made available during the presentation.

With growing interest in land-based aquaculture in BC, these inspections are a stepping stone to future refining the FHAIP program. A brief discussion on future needs, challenges and opportunities for the FHAIP with regards to the land-based sector.