



THE CENTER FOR
AQUACULTURE
TECHNOLOGIES
CANADA

IDENTIFYING UNKNOWN DISEASE AGENTS IN AQUACULTURE AND BUILDING DIAGNOSTICS TO SCREEN FOR THEM





FACILITIES

TWO FACILITIES: 67,000 SQUARE FEET OF AQUATIC ANIMAL RESEARCH SPACE AND INCLUDE EXPANSIVE, PURPOSE-BUILT, WET AND DRY LAB AREAS.

AQC1/2/3 (AQUATIC ANIMAL CONTAINMENT) WHICH PROVIDE SERVICES IN DRUG APPROVALS, VACCINE TESTING, BATCH RELEASE, AND EVALUATION OF FEED INGREDIENTS.

A PILOT-SCALE FEED EXTRUDER ADDRESSES THE INDUSTRY'S NEED FOR SMALL TO MEDIUM-SIZED BATCHES OF CUSTOM AND R&D AQUAFEDS.

PRINCE EDWARD ISLAND, CANADA



Souris



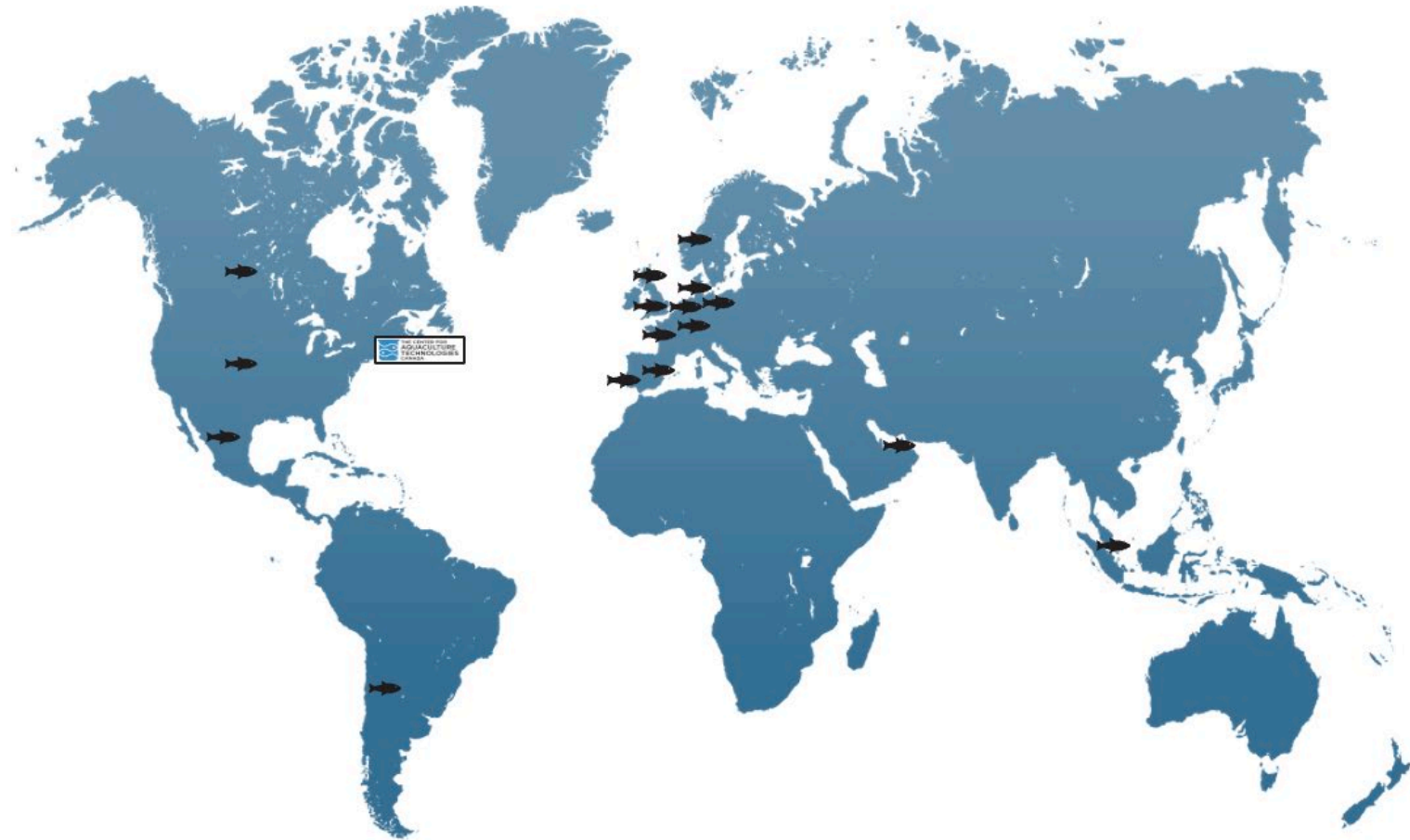
Victoria

ABOUT US

WE TEST NEW TECHNOLOGIES, PROCESSES, AND IDEAS THAT AIM TO IMPROVE PRODUCTIVITY, EFFICIENCY, AND SUSTAINABILITY IN THE AQUACULTURE INDUSTRY.

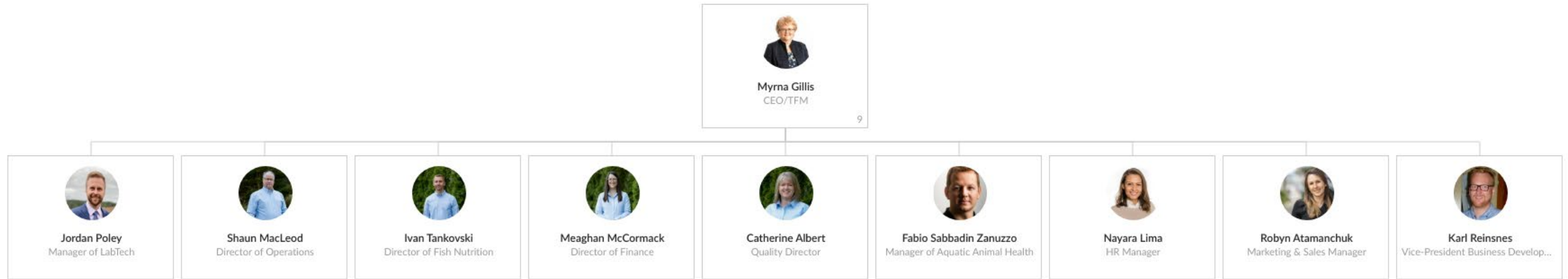
WE SERVE THE GLOBAL AQUACULTURE COMMUNITY AND ARE FOCUSED ON:

- FISH, OYSTERS, SHRIMP, AND OTHERS
- SALMONID HEALTH
- LAB AND FEED TECHNOLOGY
- PRODUCT TESTING
- OYSTER BREEDING PROGRAMS
- DIAGNOSTICS





OUR TEAM



COLLECTIVE BACKGROUND OF 600 YEARS OF SCIENTIFIC EXPERIENCE & OVER 375 YEARS OF AQUACULTURE EXPERIENCE THAT SPANS DIVERSE ASPECTS OF THIS FIELD, CATC BRINGS A COMPREHENSIVE UNDERSTANDING OF FISH & SHELLFISH RESEARCH & INNOVATION.

- OVER 150 YEARS EXPERIENCE IN VACCINE RESEARCH
- OVER 45 YEARS IN VIROLOGY
- OVER 100 YEARS IN BACTERIOLOGY
- OVER 50 YEARS IN PARASITOLOGY
- OVER 110 YEARS EXPERIENCE IN REGULATED STUDIES
- 181 PUBLICATIONS
- 10 PHDS
- 16 MASTER DEGREES
- OVER 30 YEARS EXPERIENCE IN QA & QC
- OVER 30 YEARS EXPERIENCE IN REGULATORY





FACILITY



GOOD LABORATORY PRACTICE



GOOD CLINICAL PRACTICE



GOOD MANUFACTURING PRACTICE



GOOD ANIMAL PRACTICE

CATC HAS ESTABLISHED AN EXTENSIVE INTERNAL QUALITY MANAGEMENT SYSTEM AND OPERATES TO GxP STANDARDS. WE ENSURE THE STUDY PROCESS IS COMPLIANT WITH ALL THE ABOVE STANDARDS BY IMPLEMENTING THE HIGHEST ONE, THEREFORE REMOVING THE RISK THAT A STUDY OR BATCH RELEASE WILL BE REJECTED ONCE IT IS REVIEWED BY THE REGULATORY AGENCIES.



OUR AQUATIC ANIMAL CONTAINMENT LEVEL 2, 3 CERTIFICATION ALLOWS US TO WORK WITH ANIMALS AND PATHOGENS FROM ALMOST ANYWHERE IN THE WORLD.





Pacific Oyster Thermal and OsHV-1 Challenge Model



LABORATORY TECHNOLOGIES: MOLECULAR



- CUSTOM GENE EXPRESSION PIPELINE
- BIOCHEMICAL ANALYSIS OF MUCUS, BLOOD, AND TISSUES
- CUSTOM MICROBIOME PIPELINE
- DIAGNOSTICS AND EXPLORATORY METHODS
- EQUIPMENT DISINFECTION PROTOCOL DEVELOPMENT
- EFFLUENT VALIDATIONS ON THE BENCH AND *IN SITU*
- BIOLOGICAL INVESTIGATIONS, CONSULTANCY, AND EDUCATION

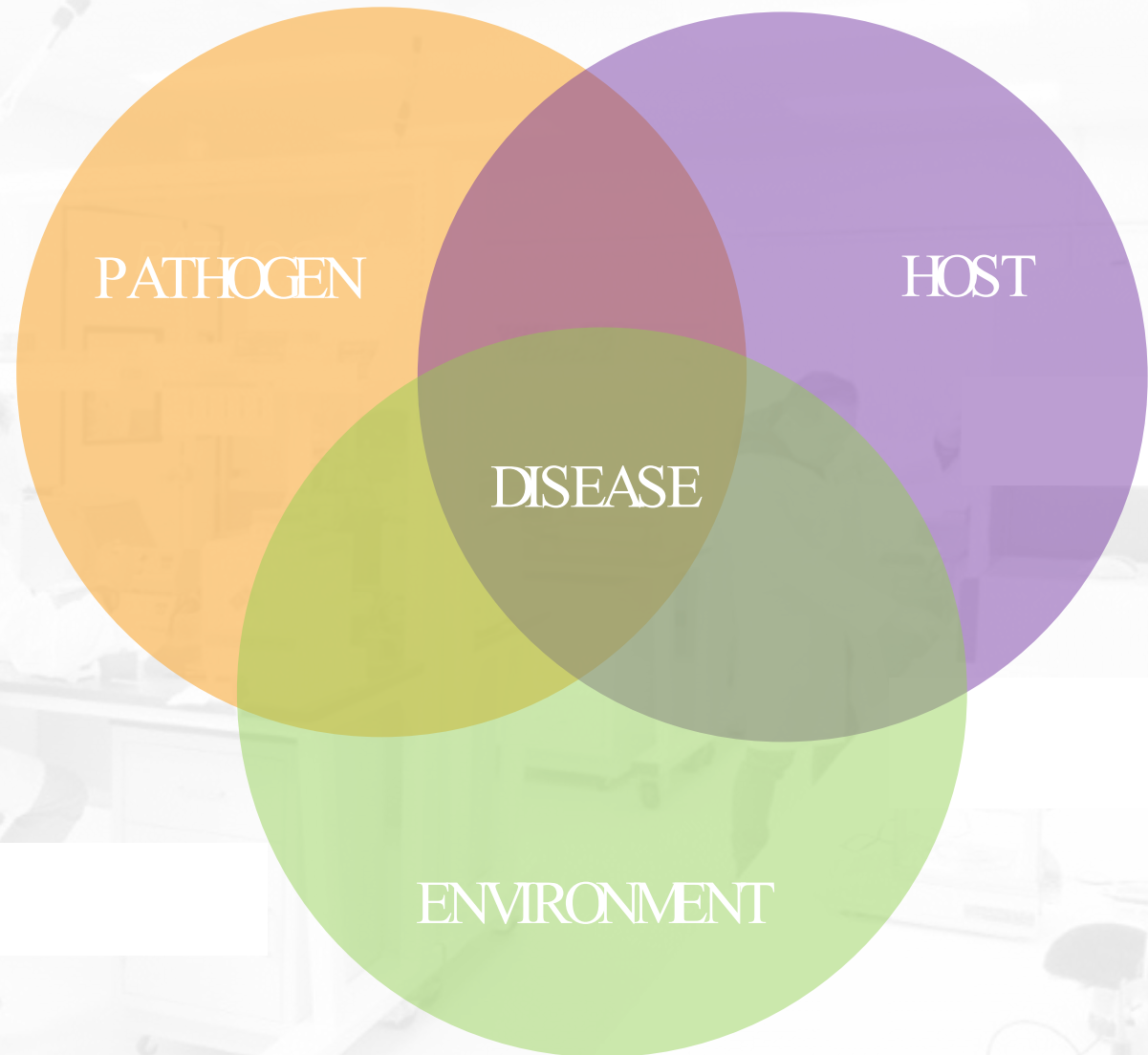
Center for Aquaculture Technologies Canada

Diagnostic Screening:

- Regulated Diagnostics
- Targeted Screening programs
- Exploratory Diagnostics

Diagnostic Considerations:

- Ideally rapid TAT
- Competitive pricing
- Flexible services (customization)
- What is the target?
- CFIA recognized



Diagnostics - Hosts



Salmonids



Bivalves



Tilapia



Cobia



Shrimps



Barramundi

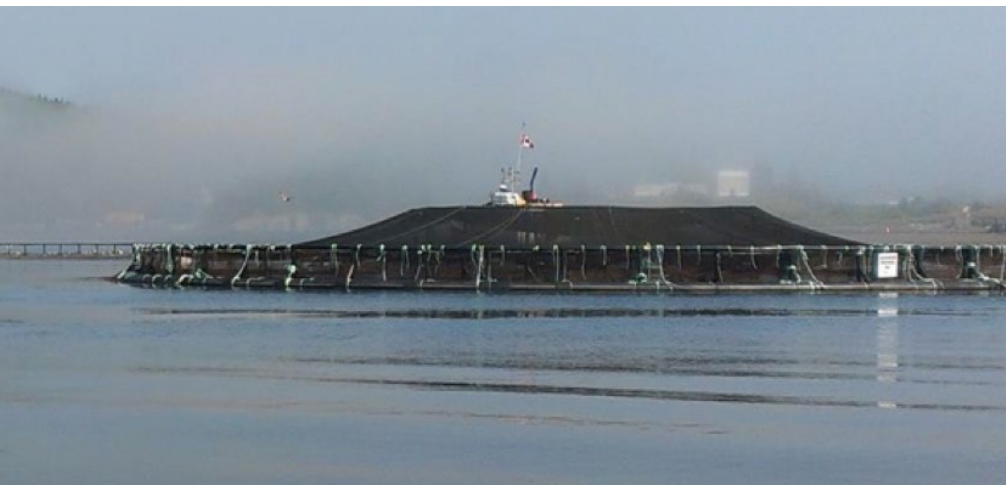
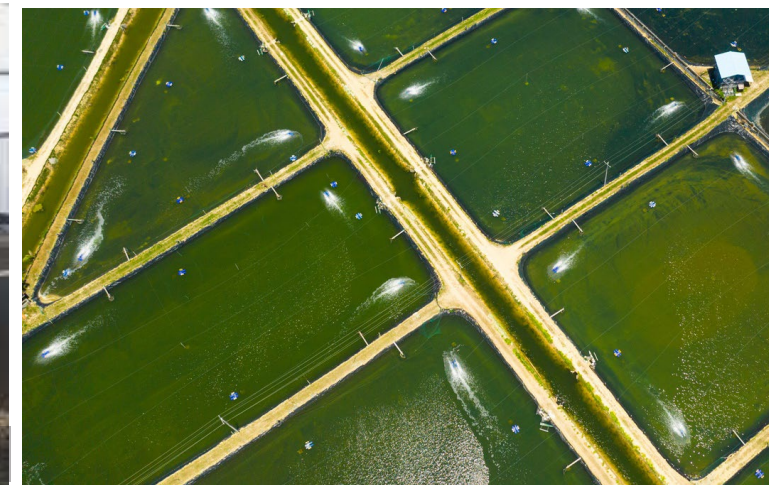


Catfish



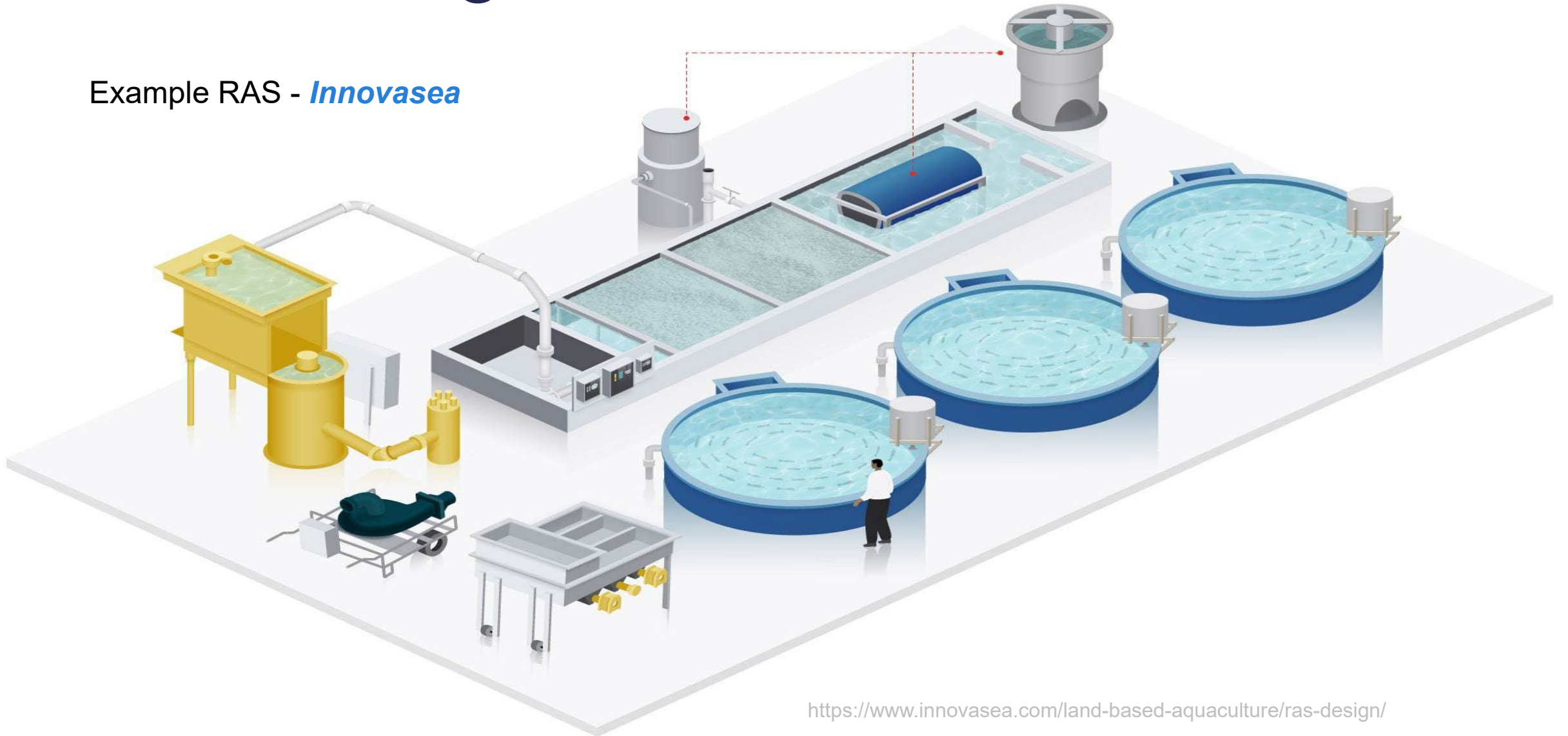
Flatfish

CAT Diagnostics - Environments



Diagnostics - Environments

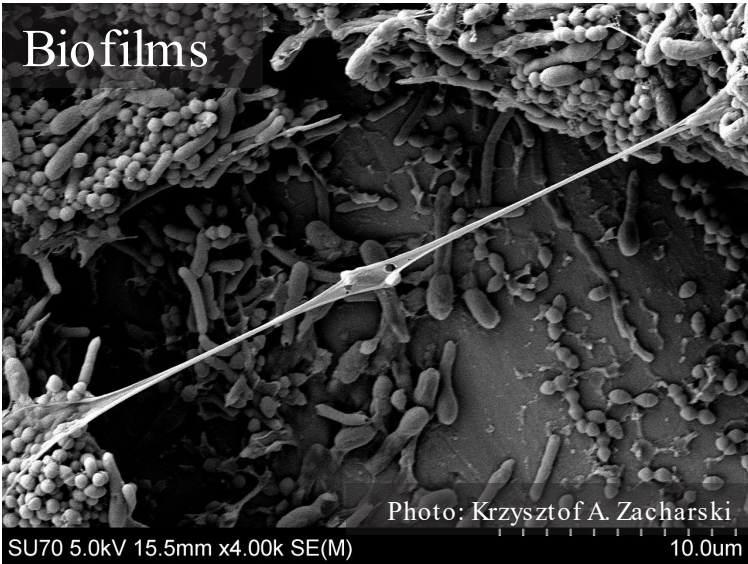
Example RAS - *Innovasea*



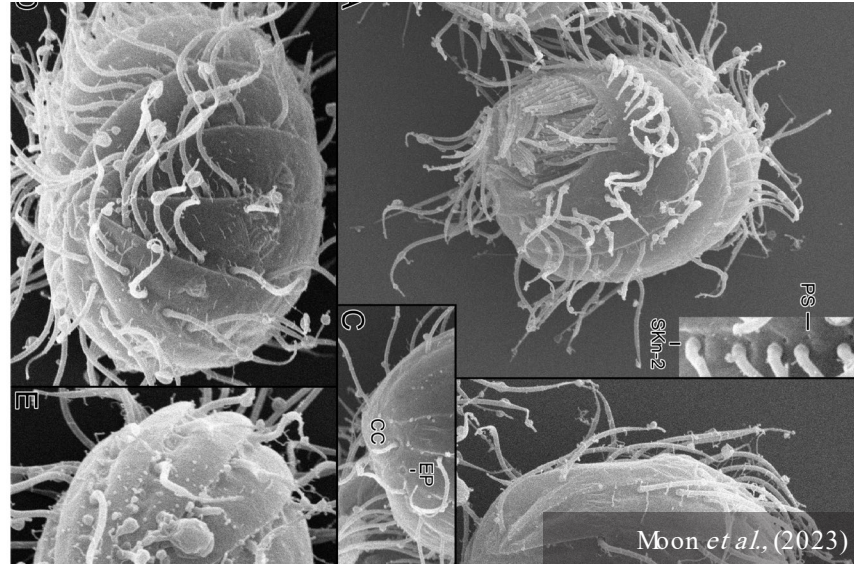
<https://www.innovasea.com/land-based-aquaculture/ras-design/>

Diagnostics - Pathogens

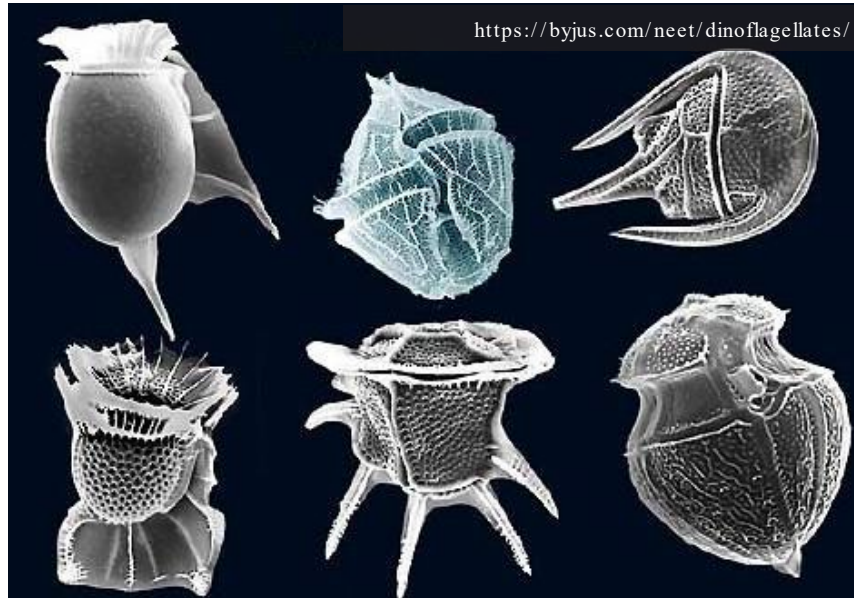
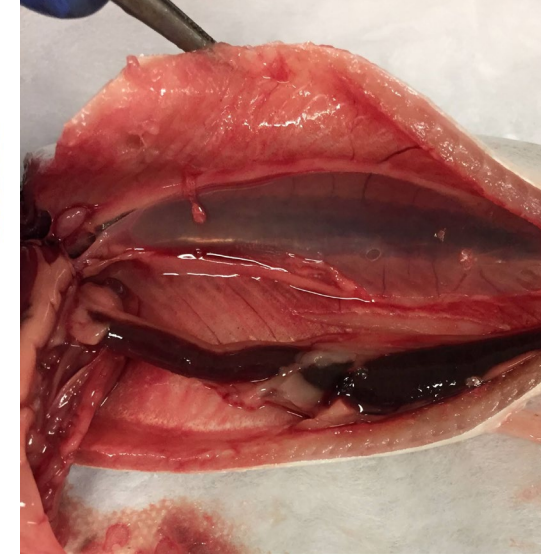
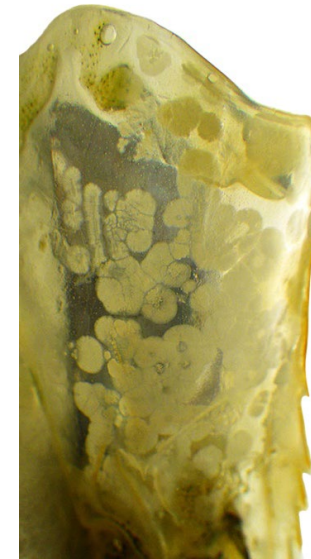
BACTERIA



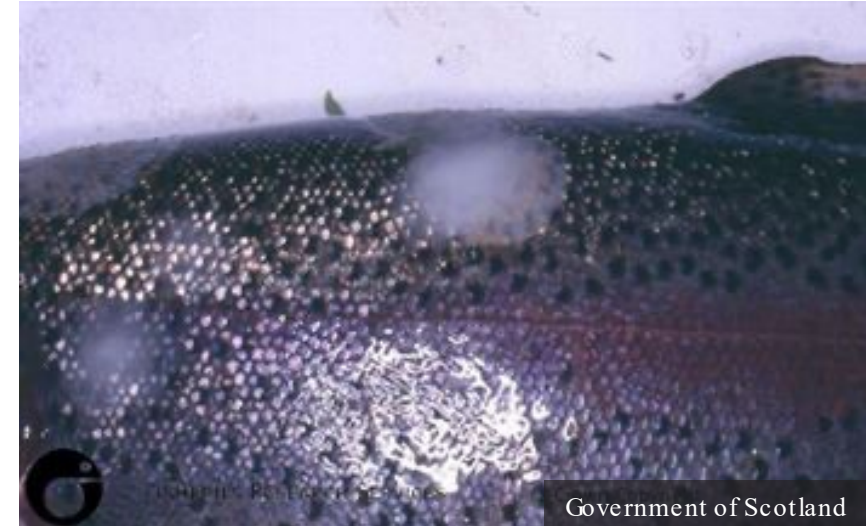
PROTOZOANS



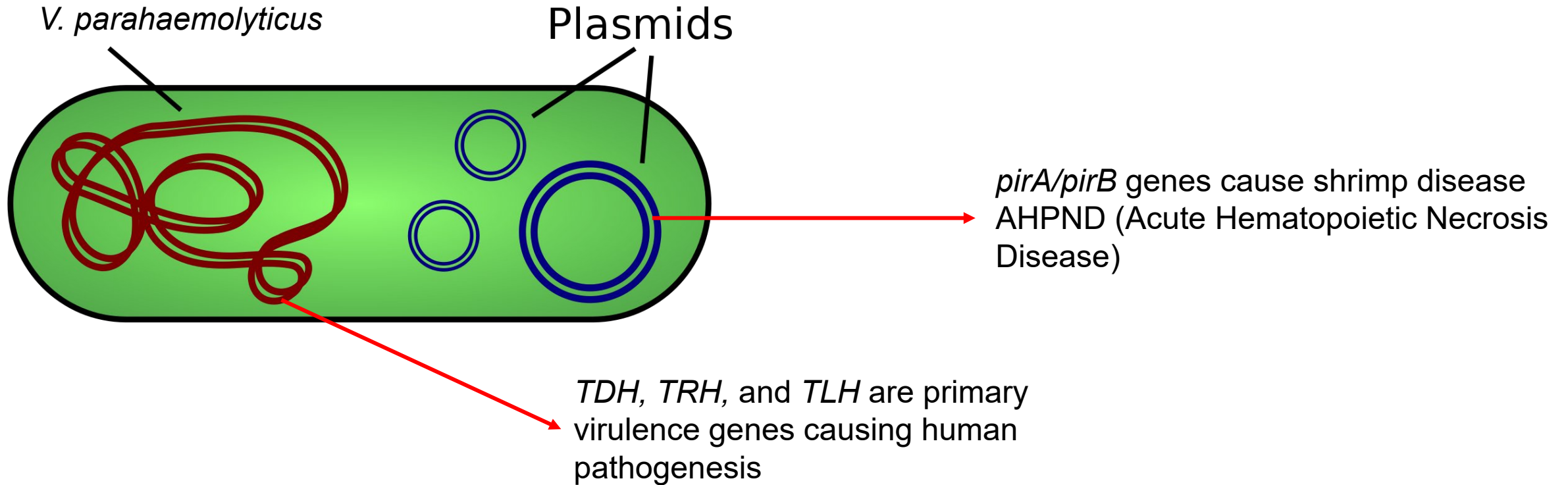
VIRUSES



FUNGI/ OOMYCETES



Vibrio parahaemolyticus



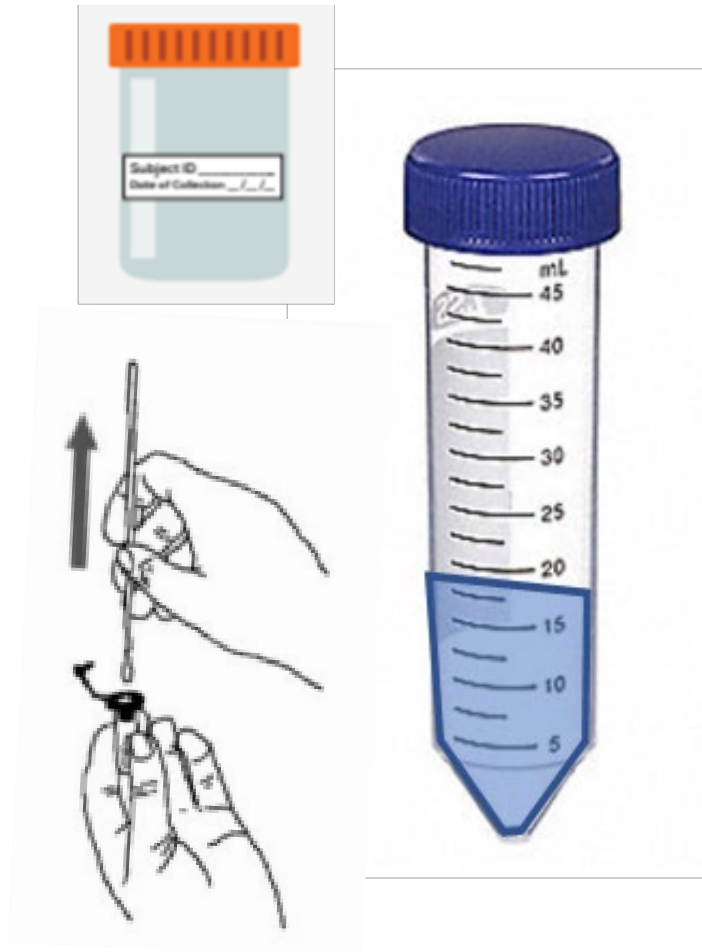


Diagnostics - Sampling

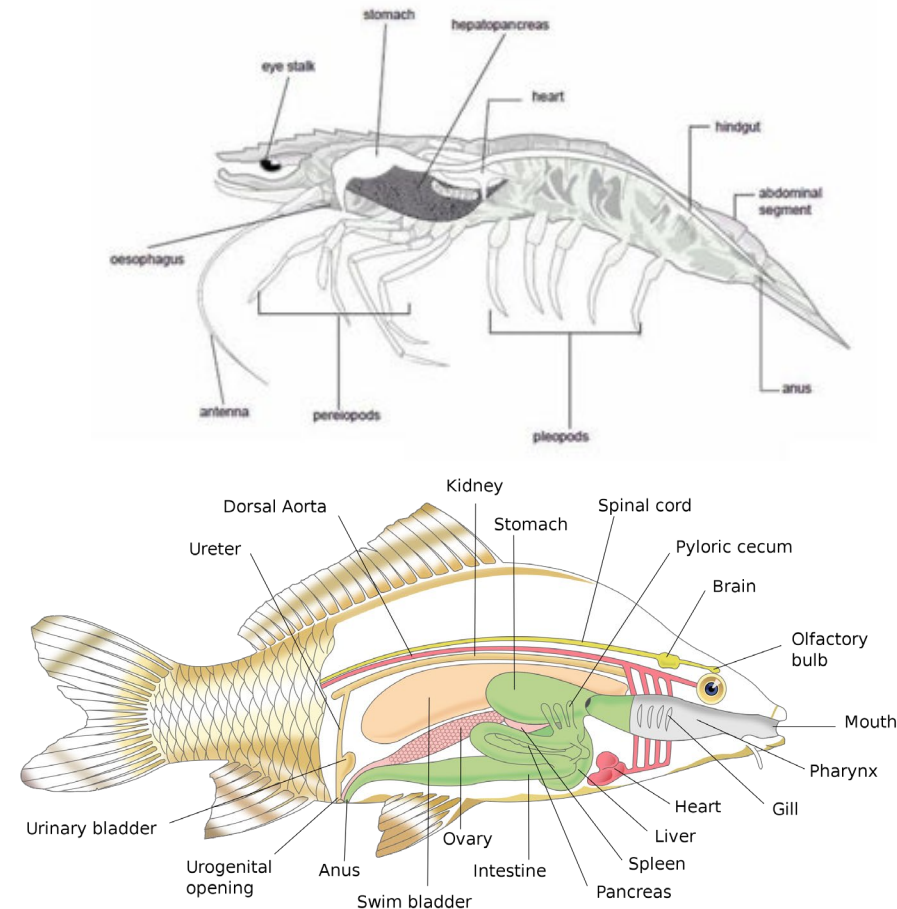
Exploratory Sampling

- Initial decisions on sample type will inform on study outcomes
- **Environmental samples** include water, sediment, and surface swabs
- **Host-specific samples** include tissues, mucosa, and digesta

Environmental Sampling

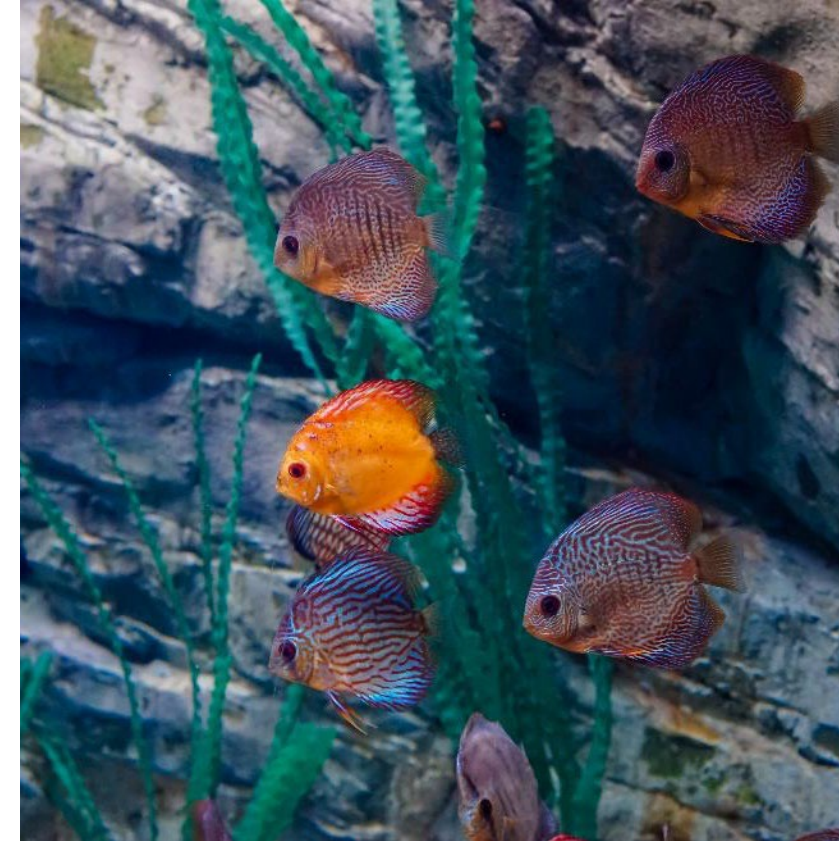


Host-specific Sampling





Diagnostics - Sampling



- **Sampling site selection** is key. For example, host-specific factors such as tissue selection is key. Likewise, broad sampling of aquaculture systems is often required
- Understanding **production cycle factors** (e.g. season, water quality) can aid in determining factors associated with microbial presence (or absence).



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AC
BIOHazard

SUITE
1

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Handwritten notes on a whiteboard, including a list of names and dates.

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Case Studies

1) Purple Eggs

Purple Salmon Eggs

Samples

Application

Water

- Microscopic observations
- Bacteria and Ciliate ID

Eggs

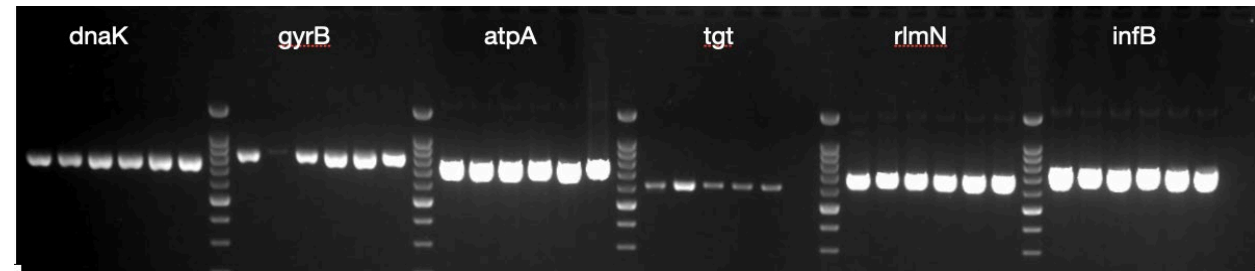
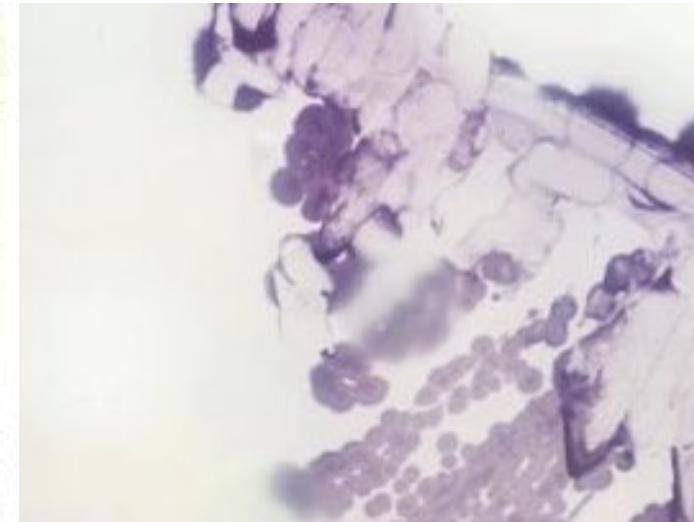
- Pigment extract
- Bacterial ID

Surface swabs

- Bacterial ID

Fish

- Disease monitoring



Ethanol dissolved pigment turns green when titrated with sulfuric acid, as expected for violacein

Purple Salmon Eggs



1. Oomycetes compromise salmon egg chorion via hyphal penetration
2. Pathogenic bacteria such as *Aeromonas* and *Flavobacterium* species invade egg
3. Pathogen growth is fueled by access to nutrients within the egg
4. Species of *Janthinobacterium* respond to the competitive pathogen pressure by producing an antimicrobial and antifungal compound, violacein.



Purple Egg



Orange Egg



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Case Studies

2) Oyster Microbiomes

Pacific Oyster Farm - Microbiome

Microbiome Monitoring

Analyze microbiome of sediment and water samples from four oyster farming sites.

Addressing Ongoing Mortalities

Examine pathogen and harmful cyanobacterial communities to understand their influence.

Functional Indicators

Explore predictive markers of disease and describe the effect of seasonality on the bacterial community



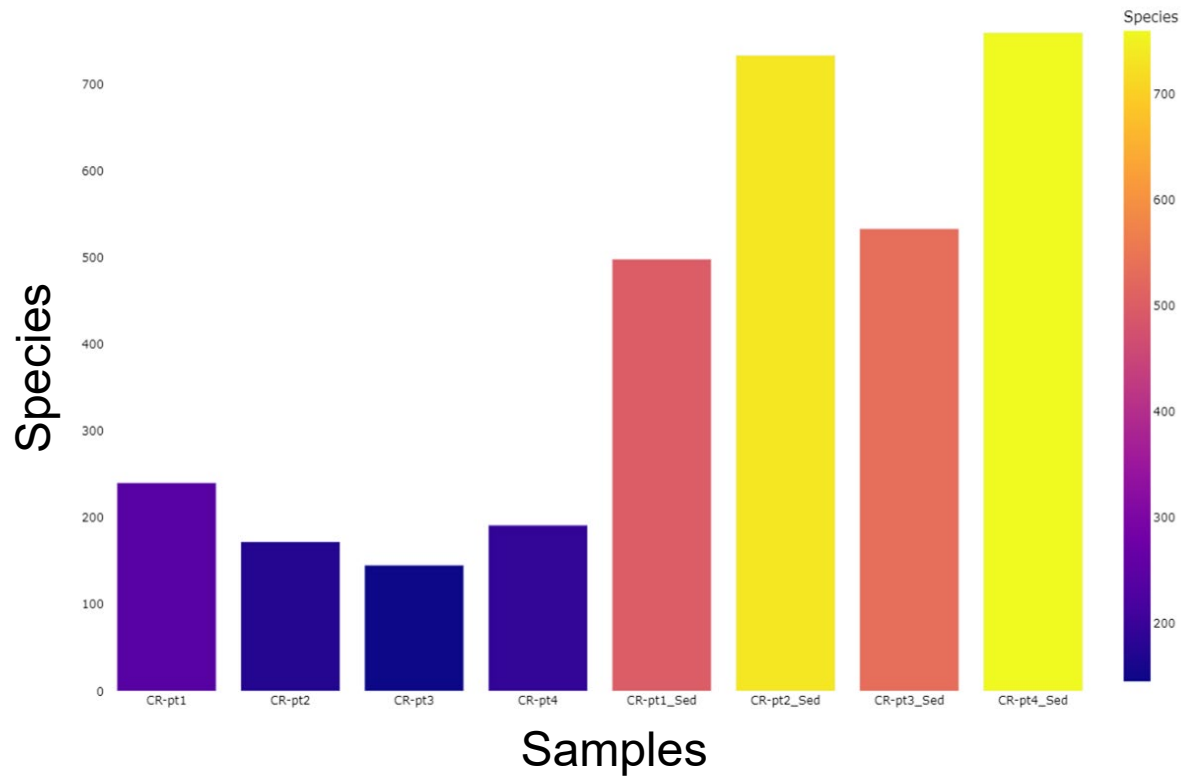
Pacific Oyster Farm - Microbiome

- **Bivalve Pathogens:** *V. tubiashi*, *V. bivalvicida*, *V. alginolyticus*, *V. mediterranei*, and *V. corallityicus*
- Disease outbreaks occur following detection of Vibrios in high abundance from upstream water samples.
- **Human Pathogens:** *Salmonella*, *E. coli*, *Shigella*, *V. cholerae*, and *V. vulnificus*
- Sediment samples are highly representative of cyanobacterial and functional bacterial abundance.
- Water samples better reflect seasonal variations overall compared to sediment

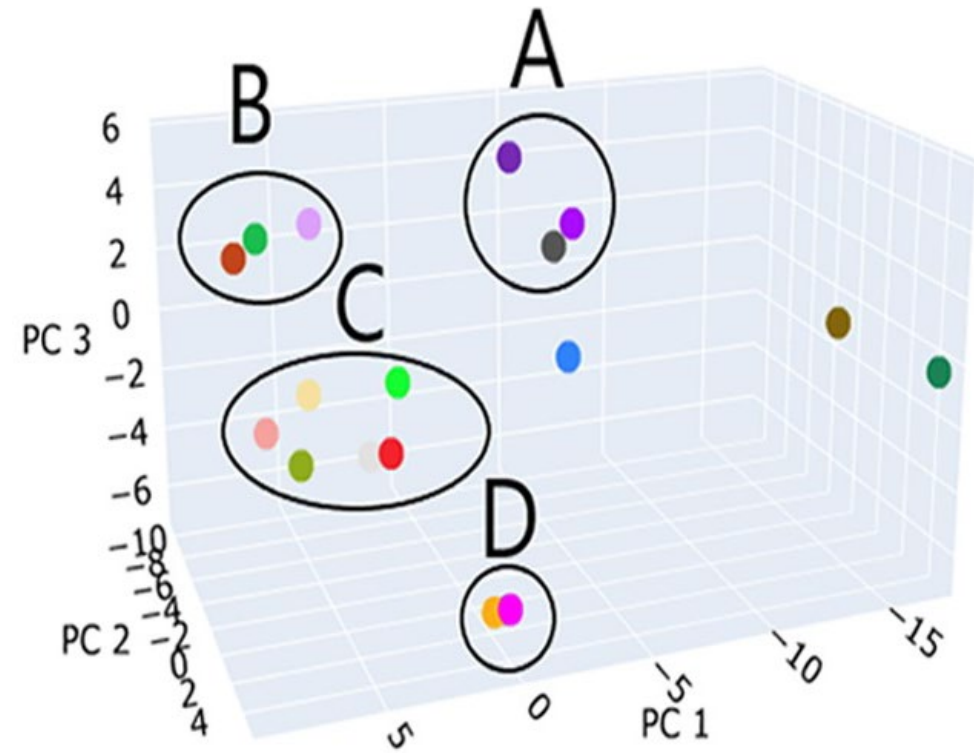


Microbiome Analysis - Diversity

Alpha-Diversity: Number of bacterial species per sample



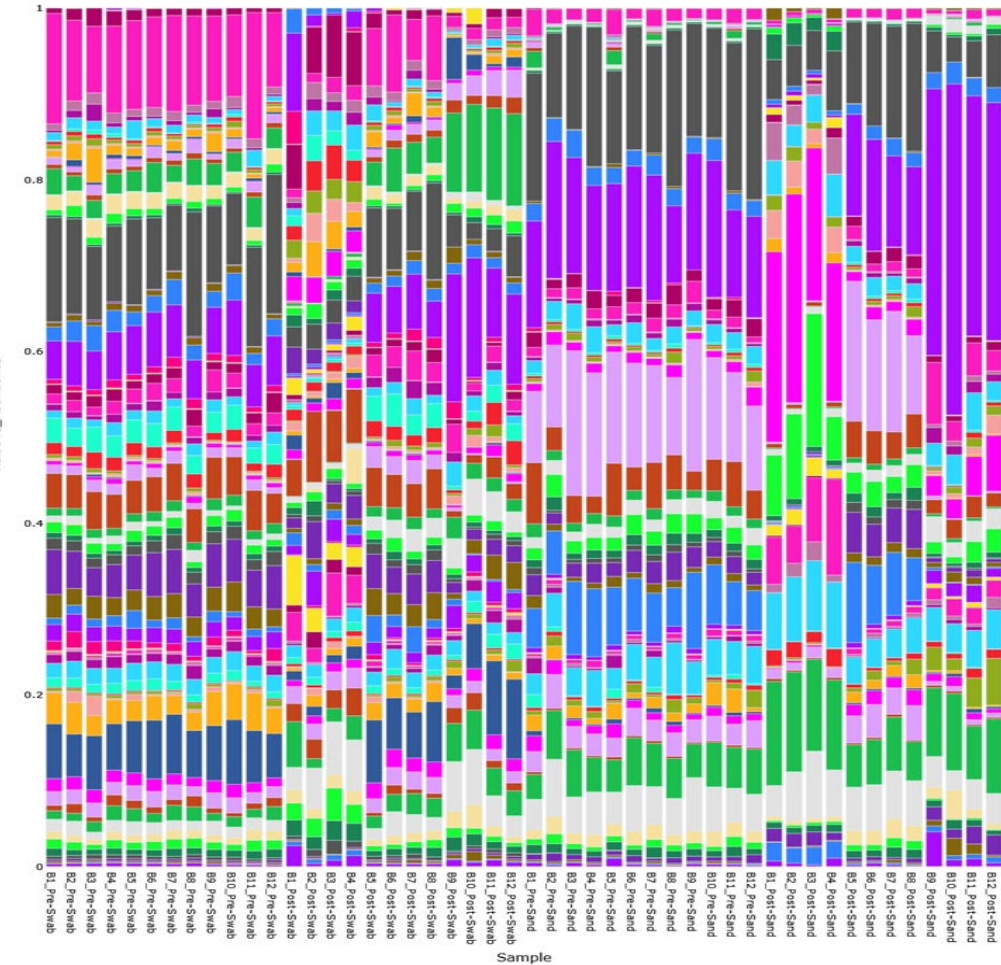
Beta-Diversity: Similarity of microbial communities between samples



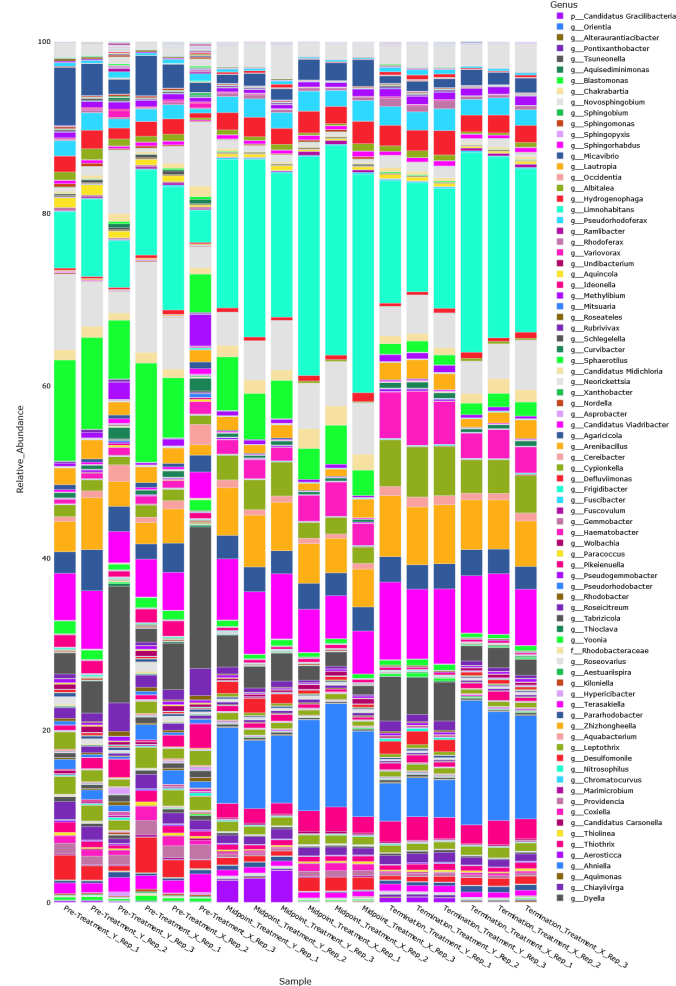


Microbiome Analysis – Relative Abundance

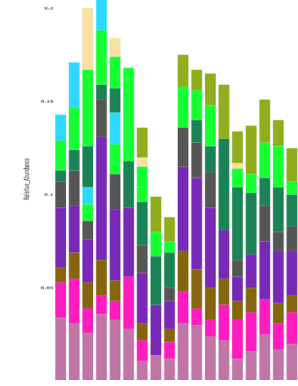
Full Study Results



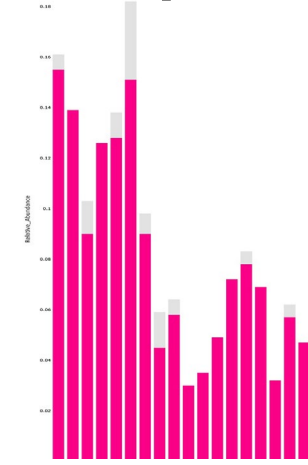
Health Indicators



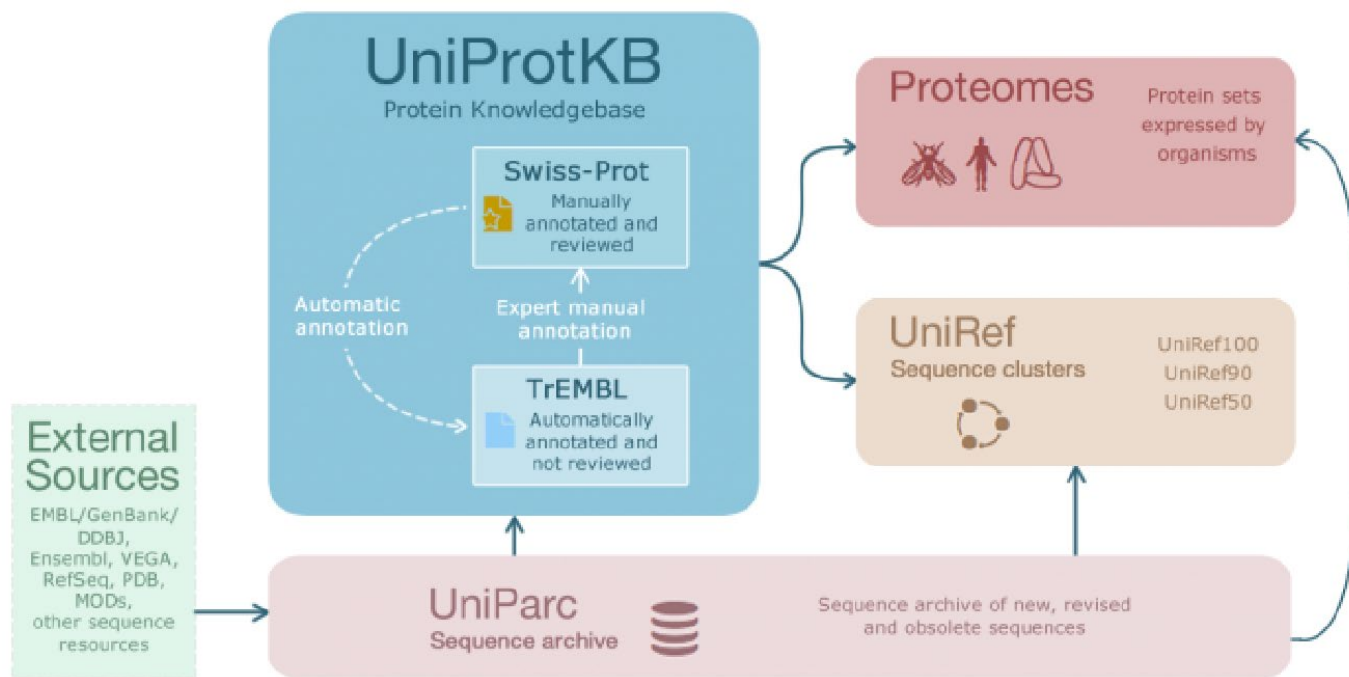
Sulfur-Cycling



Off-flavor producers



Functional Outputs



Off-flavor Producing Bacteria
Cyanobacteria
Pathogens
Toxin Producers
Nitrogen Cyclers
Oxidative Potential
Biofilms
“Healthy” Indicators
“Disease” Indicators

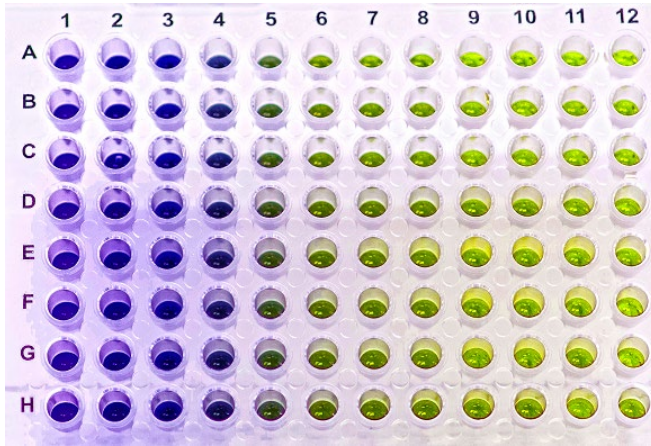


General Remarks

- **Exploratory diagnostics** goes beyond just identifying pathogens. It links phenotypic changes and environmental variation to the microbial community as a starting point for further exploration.
- Microbiome can be used as a **routine screening tool** or as a **relative comparison tool**. It's important to have samples of a “desirable situation”.
- Molecular techniques paired with observational data can offer powerful management insights.
- Deep characterization or targeted approaches are available for any sample type.

Point of Care Diagnostics

ELISA TESTING



Detect and Quantify:

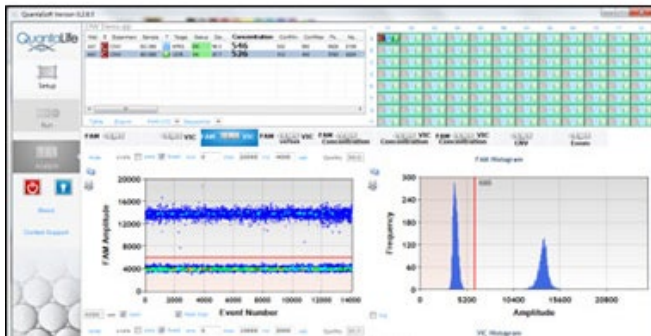
- Pathogens
- Toxins (and other proteins)
- Antibodies



LATERAL FLOW ASSAYS



PCR-BASED TESTING

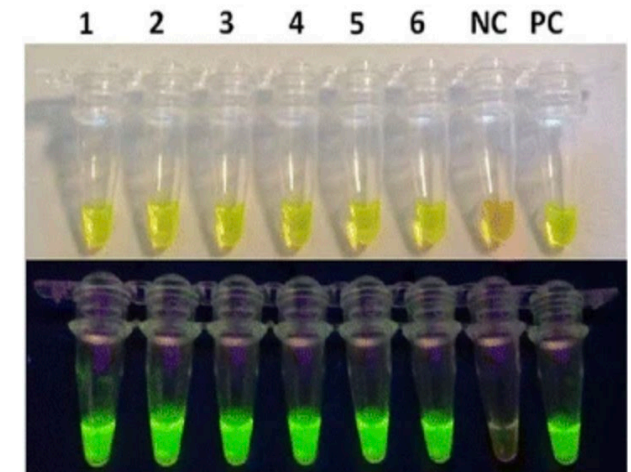


Detect and Quantify


- Pathogens
- Expression of genes
- eDNA
- Microbial communities
- Unknown disease causing agents




LAMP ASSAYS




Bentaleb *et al.*, 2016



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 [aquatechcenter](https://twitter.com/aquatechcenter)

 [The Center for Aquaculture Technologies Canada](https://www.linkedin.com/company/the-center-for-aquaculture-technologies-canada)

DELIVERING RESULTS YOU CAN USE.



Cristine Lepin: Biofilters and disinfection protocols in RAS



Abhinav Choudhury: Anaerobic Digestion from RAS waste



John Davidson: Off flavor bacteria in RAS systems



**Christopher Good, Director of Research
The Conservation Fund Freshwater
Institute, all projects**

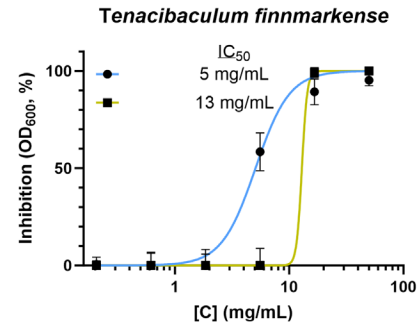
Thanks to our colleagues from the Conservation Fund Freshwater Institute for allowing use to use the tool and learn with them about specific application of the Microbiome studies on their projects



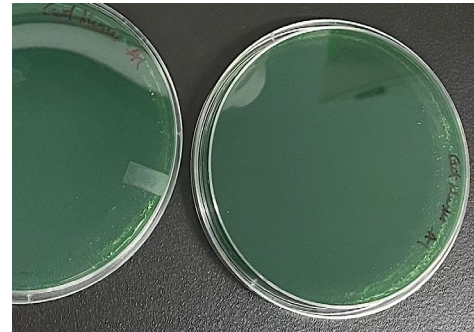
LABORATORY TECHNOLOGIES: PATHOGENS

- ANTIBIOTIC RESISTANCE TESTING
- VACCINE ANTIGEN TESTING
- PROBIOTIC GROWTH COMPETITION AND EXTRACELLULAR PRODUCT SECRETIONS AGAINST PATHOGENS OF INTEREST
- ECTOPARASITIC AND BARRIER HEALTH ASSAYS
- HOST-DIRECTED THERAPY TESTING AND CUSTOM ASSAY DEVELOPMENT

<https://labtech.aquatechcenter.com/>



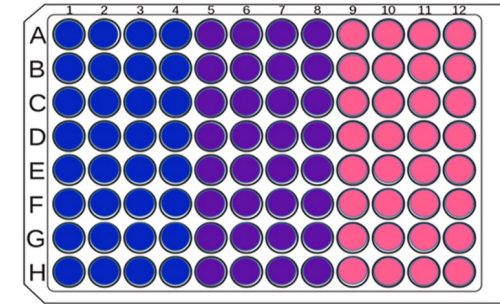
Bacterial Sensitivity



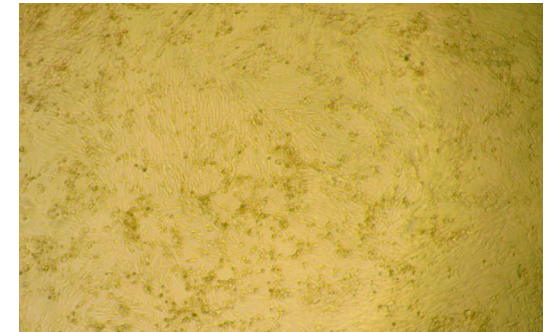
Probiotics vs Pathogens



Saprolegnia spp. Testing



High-Throughput Screening



Cell Infection Models



Sea Lice Bioassays