Development Award Deed

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Aquatic Animal Health Training Scheme Application

FINAL REPORT

AWARD RECIPIENT: Dr. Peter Mohr

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HOST ORGANISATION: EU Reference Laboratory (EURL) for Fish and Crustacean Diseases
Technical University of Denmark, National Institute for Aquatic Resources
2800 Kgs. Lyngby, Denmark

DATE: 5th November 2019

ACTIVITY UNDERTAKEN

Visit to the EU Reference Laboratory for Fish and Crustacean Diseases for observation and discussion of diagnostic testing procedures for aquatic disease agents, maintenance of quality systems, aquatic experimental facilities and proficiency test programs.

OUTCOMES ACHIEVED TO DATE

By visiting the EURL for Fish and Crustacean Diseases the following outcomes were achieved;
- Knowledge of the laboratory's roles, responsibilities and capabilities as Denmark's aquatic animal disease diagnostic and research laboratory, an EU National Reference Laboratory (NRL) and EURL.
- Gained an understanding of the similarities and differences in laboratory approaches to diagnostic fish disease investigations and surveillance activities for a range of pathogens that are exotic to Australia.
- Insights provided into current research involving PRV-3, red mark syndrome, eDNA and phage treatment.
- Similarities in accreditation and reporting with possible improvements identified that could be implemented to enhance quality assurance systems and proficiency test programs.
- Observed a functioning world class aquatic animal experimental challenge facility in use for fish and crustacean experiments.
- Opportunities identified for possible sharing of materials, information and collaborative projects between the two laboratories.

Acknowledgments

I would like to acknowledge the hospitality, facilities and knowledge that Professor Niels Olesen and his group at the EU Reference Laboratory for Fish and Crustacean Diseases were willing to share during my one week visit.

Background

The CSIRO-AAHL Fish Diseases Laboratory provides diagnostic testing and research programs to support and expand Australia's ability to detect exotic and emerging pathogens of farmed and wild aquatic animals (in particular; fish, molluscs and crustaceans).

Dr. Mohr has responsibility for oversight of diagnostic testing and research programs with the AAHL Fish Diseases Laboratory for aquatic animal pathogens. This includes maintenance of quality assurance under ISO17025, experiments within limited aquatic experimental facilities and the provision of reagents and tests to national and international laboratories to assist in capability maintenance and expansion.

The EU reference laboratory for fish and crustacean diseases is funded by the European Commission and its functions are concerned with harmonizing diagnostic procedures for notifiable fish and crustacean diseases of Europe. Professor Olesen's group conduct diagnostic testing, provide annual workshops, training courses, proficiency tests and maintain an active aquatic disease research program that includes experimental challenge trials.

Need

Knowledge sharing between Dr. Mohr and Professor Olesen's group will lead to continued improvement in how the AAHL Fish Diseases Laboratory meets Australia's needs and obligations for detecting and responding to incursions of exotic and emerging aquatic pathogens as well as assist in Dr. Mohr's professional development.

Objectives

For one week Dr. Mohr would discuss, observe and obtain knowledge of how the Olesen Laboratory conduct;
1) Diagnostic testing for aquatic disease agents that are exotic and enzootic to Australia
2) Research of aquatic disease agents and recent discoveries
3) Maintenance of quality assurance systems
4) Aquatic experimental facilities and processes
5) Proficiency testing programs
All five of these objectives were achieved during the September visit.

Methods

The program and activities for the week;

Day 1 – Monday 16/09/2019

Welcome, introductions and program planning for the week (Niels Olesen)

- Niels – Head of DTU Unit for Fish and Shellfish Diseases.
- EURL Fish Diseases holds two training courses each year; 1) Virology and diagnostics and 2) Biomolecular, bioinformatics, pathology and serology.
- Provided with a hard copy of 2018 Training Course Material for Virology and diagnostics to read during the visit. The 2019 courses were to be held in October.

Tour of laboratories including cell culture, sample processing, virus isolation and PCR rooms (Niels Olesen and Argelia Cuenca)

- GMO work (i.e. recombinant viruses) conducted in separate dedicated rooms with access restricted.
- Cell culture and virus isolation conducted in separate access restricted laboratories. Virus isolation generally 14 d with a passage at 7 d. Largest collection of fish cell lines in one laboratory in the world.
- Samples generally received for virus isolation for diagnostic and surveillance investigations with confirmation by ELISA and some require PCR.
- Samples homogenised by mortar and pestle due to virus isolation and use of all organs. Investigation of homogenisation by bead-beating has been limited to date.
- PCR workflow observed and use of genomic or synthetic controls in both laboratories discussed.
- Nucleic acid (NA) extractions performed with Qiagen kits and platforms.
- Accredited tests for VHSV and IHNV PCR but very few samples tested.
- Illumina MiSeq and HiSeq used for next generation sequencing but MinION to be evaluated in upcoming project.

EURL Crustacean Diseases (Argelia Cuenca)

- CEFAS provided infected materials and detailed protocols during transfer of EURL Crustacean Diseases responsibilities.
- WSSV material generated in *L. vannamei* for PT with distribution of pleopods to occur as per previous CEFAS program.
- Discussion of PT materials distributed for crustacean diseases by AAHL.
- Discussion of YHV1 PCR testing and potential to obtain AFDL YHV1 RT-qPCR with MTA.
- New staff member starting in October to be responsible for EURL Crustacean Diseases

EURL Fish Diseases (Niels Olesen)

- Niccolo Vendramin EURL co-ordinator for fish diseases for last 6 years.
- EU National Reference Laboratories to have capability for VHSV, ISAV, IHNV and KHV no longer SVCV and ISAV HPR0 (not exotic), EHNV and no longer EUS (exotic). EU Law and Acts – provide sampling and testing directions.
- Laboratory 17025 and 17043 (PT) accredited (DANAK – Denmark's equivalent to NATA) and recently obtained flexible scope for PCR.
- OIE VHSV reference laboratory responsibilities now split with two other laboratories (Kyle Garver – Canada and Hyoung Jun Kim – South Korea).
- Update to VHSV chapter to soon be included in OIE Manual, will incorporate a new RT-PCR from Kim et al. 2018 that has been demonstrated to detect all VHSV genotypes worldwide.
- As part of being EURL for fish diseases, EU RING test generated and also participated in (separate staff for both).
- All Denmark's aquatic diagnostic samples received at the laboratory, referred by farms but mostly through 3 vets.
- Majority of Denmark's aquaculture rainbow trout
- Recent research: PRV-3 causes similar HSMI in rainbow trout as PRV-1 in Atlantic salmon, detected in most farmed rainbow and brown trout in Denmark back to

1990's (in similarity with PRV-1 and PRV-2 is not culturable on cells), disease is strongly associated with recirculating aquaculture systems (RAS) in Denmark.
- Recent research: RMS (red mark syndrome) in farmed rainbow trout, bacterial disease most likely caused by a Midichloria-like organism (MLO) – not culturable, red marks are due to inflammatory response in fish from which they recover and seems to have a protective effect with lower mortalities from VHSV or IHNV.
- IPNV is widespread in Denmark trout.
- VHSV genotype IV of big concern to Europe as the fish are naïve and highly susceptible.
- EHNV exotic – Request if any further isolates can be shared with the laboratory – recently whole genome sequenced only isolate held at the laboratory. Genome sequences have been produced at AAHL and possibility of sharing for a comparison or publication.

Day 2 – Tuesday 17/09/2019

Diagnostic/Research technician team meeting (Tine Iburg)
- Daily co-ordination of technical staff performing diagnostic testing and research activities.
- Desks shared through-out DTU but technicians have a desk each due to QA paperwork demands.
- Progression to iPads for digital QA paperwork a longer term objective.

Cell culture (Betina Lynnerup Warming)
- Clean cell-culture laboratory requires change of shoes or overshoes to enter.
- Diagnostic cells routinely cultured; CHSE, BF-2 and EPC, when split into plates an overnight boost at elevated temperature is provided dependent on cell line.
- Cell lines passaged 30-35 times over two years and the re-started. Undertaken earlier if sensitivity decrease seen in 6 monthly check.
- Diagnostic plates (24 well) – routinely ½ BF-2 and ½ EPC. Due to high prevalence of IPNV – overnight incubation with anti-IPNV required.
- Benches in laboratories height adjustable (mandatory in new labs), at least 40% of light to be from natural source for work environment.

Tour of Aquarium facilities (Niels Olesen)
- DTU building housing the laboratories and aquarium completed only 2 years earlier. Third location that Niels has had an aquarium facility designed and set-up. Aquarium rooms and plumbing housed on level 2, laboratories housed on level 4.
- Waste water treated by steam and special heat exchanger used to remove heat before discard to sewer system. Heat exchanger of special metal to handle high heat without salt water corrosion. Waste water tank with 40,000 L capacity, 50 kg Virkon in reserve to treat water in case problem with heat treatment.
- SPF rainbow trout room (has its own recirculation system) – eggs from farm chemically treated on arrival. Various stages of rainbow trout in differing tank systems at very high density (no mortalities or disease). SPF rainbow trout critical to having reproducible experiments.
- Quarantine fish room – fish from farms etc, brought in and held until ready for experiments.

- 4 Challenge trial rooms – 3 differing sizes of tank depending on the size of fish (1. large and square, 2. Round with conical bottom on metal stands, 3. Bowls with lids.
- Change to boots and Virkon foot bath to enter each room. No gas decontamination of experimental rooms after trials, instead spray or treat tanks, benches, floors etc, and areas with Virkon.
- One experimental trial room had a tank where red mark syndrome had been in constant culture for several years. The red marks on the rainbow trout were distinctive and take 6 weeks to appear. The flesh is fine to cook and eat but decreases the value for sale.
- A small examination and processing laboratory located close to the 4 experimental trial rooms. Samples from all of these rooms can be processed in the one room.

Quality Systems, LIMS and Diagnostic Reports (Tine Iburg)

- Demonstration of LIMS in use – Ester software
    - In Denmark all livestock have identifiers, at the fish level identifiers are recorded for farms – with species, number, etc. publicly available on CHR database. Each farm has a unique CHR identifier and most have a previous aquatic system identifier.
- Diagnostic submissions
    - Checks of results and entering done by technicians etc., authorization of results and sending reports limited to laboratory heads.
    - Final report/submission/bacteriology/virus isolation paperwork, with a note relating to the batch testing by ELISA or PCR are recorded on submission page. Complete record of ELISA and PCRs kept in laboratories. Completed records are in locked storage.
- Quality Systems
    - Software originally developed for veterinary institute. Has been migrated to DTU with last move and used by many groups on-site.
    - Captures much greater documentation than currently on SharePoint at AAHL. Validation related documents, reagent comparisons, SOPs and most interesting the variation from protocol records that are reviewed and approved by Tine.
    - Internal and external audits are performed annually. The level of scrutiny within the Quality System by DANAK during external audits appeared to be far more rigorous than by NATA.
    - DANAK technical assessors contracted for 5 year periods.
- Provided a demonstration of AAHL Quality System, LIMS, Diagnostic Reports to Tine
    - LIMS - Sample Manager
    - SharePoint – Quality Manual
    - Example of Diagnostic submission, testing, job summary report, completed paperwork scan, etc.
- Tine asked for the same demonstration for Argelia and a general discussion of quality systems etc. to be provided in Thursday presentation when all the technicians were present.
- Discussed hardcopy record retention, electronic copies, paperless office, etc.

Day 3 – Wednesday 18/09/2019

Sample Receipt and Preparation for Virus Isolation (Christina Flink Desler)

- Samples from 4 rainbow trout farms arrived that day for virus isolation (collected and submitted by a vet)
    - Check if any farms IPNV free (if so, processed first)
    - Entry of jobs into Ester (very simple with standard templates for testing)
    - Surveillance to represent the range of fish for each farm and if fish above a certain size, vet is to process and submit pooled organs in VTM in one tube. Smaller fish are submitted whole in bags. 10 fish per sample – dependent on what being tested for.
- Demonstration of heart, spleen and head kidney excision from smaller fish.
    - Tissues ground in mortar and pestle with sterile sand in original VTM then topped up to 1/10 solution before centrifugation 15 min, 4000 rpm. When using mortar and pestle a special wrist supporting brace worn to prevent injury – technicians like wearing as holds hand in the right position to minimize damage.
    - Supernatant added to cryotube for storage at -80°C for at least 3 months after reporting (all positives kept). Remaining S/N added to gentamicin for overnight incubation at 4°C prior to inoculation of cells. Cells in plates ordered for the next day. If samples from IPNV farm then incubation is with anti-IPNV – essential for VHSV and IHNV to distinguish development of CPE.
    - If samples arrive on Friday can be incubated for 4 hours with cells seeded on same day – more technically demanding for reading the plates.
- Government pays for the on-going surveillance programs in fish farms for notifiable agents in Denmark.

PCR flexible scope of accreditation and EU requirements for accreditation (Argelia Cuenca)

- Flexible scope – enables documented changes to be made to accredited protocols during the year with assessment at the next DANAK audit. The previous process meant all changes were sent to DANAK and assessed before being implemented at considerable extra cost.
- EU Regulations – recently changed to insist that methods being used in the laboratories for testing of notifiable agents to be accredited.
- As requested by Tine, discussed Quality Systems, LIMS and Diagnostic Testing at AAHL.
- Discussed the Tapia IPNV RT-qPCR assay already under evaluation at AAHL.

Journal Club (all aquatic staff and students)

- Fontes et al. 2017 – '*Tetracapsuloides bryosalmonae* abundance in river water'. A myxozoan parasite of freshwater bryozoans and salmonids, causing proliferative kidney disease in salmonids. Particularly relevant to Denmark rainbow trout farms, with spores not cleared and causing kidney swelling (dead-end host) but not in brown trout. Thought to be related to rainbow trout being introduced from North America and brown trout being native.
- Publication described concentrating water samples on filters and testing with a SYBR real-time qPCR. The student presenting the Journal Club was repeating the work in Denmark with issues identified with filtering water and extracting nucleic acid. A TaqMan qPCR was present in the EURL for detection within fish tissues but not being used on water samples yet.

PRV-3 and rainbow trout (Niccolo Vendramin and research assistant)

- Subject of his PhD and on-going research summarised and presented
- Recent publication Vendramin et al. 2019 - Piscine orthoreovirus subtype 3 (PRV-3) causes heart inflammation in rainbow trout (*Oncorhynchus mykiss*)
- Recent sequencing of PRV-3 from rainbow trout to identify if same segments in PRV-1 responsible for virulence in Denmark RAS disease causing isolates. Not the same pattern of pathogenesis that is so clear in PRV-1 and Atlantic salmon.
- Experimental infections of rainbow trout possible with PRV-3 but no disease observed. Interesting correlation between experimental infections and farmed infections with virus amplification and clearance by fish with qPCR C_T values.
- New PhD project – investigation of developing Fluidigm system to monitor pathogens (i.e. PRV-3) and immune response genes in rainbow trout farms.

Red Mark Syndrome in rainbow trout (Jacob Schmidt)

- Recent publication Jorgensen et al. 2019 'Skin immune response of rainbow trout (*Oncorhynchus mykiss*) experimentally exposed to the disease Red Mark Syndrome'.
- Recent findings from experimental trials summarised.
  1) Re-infection of rainbow trout that had resolved red marks 6, 12 or 18 months earlier resulted in no red marks but naïve fish did every time.
  2) Time-course of RMS development in rainbow trout, 6 weeks to develop red marks and a further 8 to resolve. MLO bacteria detected in skin but not at a high level – NGS demonstrated continued presence of MLO with syndrome and not pathogens such as IPNV or *Flavobacterium psychrophilum*.
  3) Time course of brown trout and rainbow trout exposed to MLO. Brown trout developed RMS earlier but to a lesser extent and cleared sooner.

Day 4 – Thursday 19/09/2019

EURL reference materials provided on-line for reference and reading

- Commission Implementing EU decision 2015/1554 – application of directive 2006/88/EC as regards requirements for surveillance diagnostic methods. Relating to VHS, IHN, KHV, ISA, *Martelia refringens*, *Bonamia ostreae* and WSSV.
- EURL Fish and Crustacean Disease web-pages (DTU); Proficiency Testing, Annual Workshops, Training Courses, Diagnostic Manuals, Scientific Activities and Reports.
- EURL Mollusc Diseases webpage (ifremer); Proficiency Testing, Reference Material, Tutorials, Workshops and Annual Meetings.

EURL annual workshops– Surveillance and Disease (Niccolo Vendramin)

- Annual workshop held at DTU with representatives from all EU NRLs.
- Updates provided based on survey sent-out and collated before the workshop (fish farms, species, virus incursions, outbreaks, etc).
- Updates on recent research activities at EURL and NRLs.
- Presentations and reports (those not commercially sensitive) made freely available on the EURL web-page.
- Interesting information from recent survey and workshop, lumpfish production dramatically increased to reduce sea lice in Atlantic salmon farming but has introduced new viruses and are susceptible to many existing problems and can be potentially carriers.

AAHL presentation (all aquatic staff and technicians)

- Introduction to AAHL
- Introduction to AFDL; structure, history, roles and responsibilities, capabilities, current projects
- Aquaculture species in Australia
- Australia's National List of Reportable Diseases of Aquatic Animals
- Emerging issues in the last ten years
- Example of emerging issue – POMV
- Emergency disease response – WSSV
- Diagnostic Testing and Reporting (for technicians)

PT programs and reporting (Niccolo Vendramin)

- Discussed SE Asia PT program and reporting in comparison to EU Ring test
    - The laboratory indicated interest in receiving both the crustacean and fish PT panels. Discussed possibility of sending panels (not as a participant) with results assessed vs stability or homogeneity C_T values. Would also be interested in what qPCR assays could be used with the panels for each agent. Happy to enter into an MTA for any of the in-house assays.

Day 5 – Friday 20/09/2019

Aquatic Bacteriology (Lone Madsen)

- Saw live cultures of *Aeromonas salmonicida* subsp. *salmonicida* and *Flavobacterium psychrophilum*
- Small numbers of samples have bacteriology performed, confirm bacteria ID by ELISA, agglutination and MALDI-TOF. The Lab have developed some references for MALDI-TOF and now use instead of AP biochemical tests.
- Discussed research of PhD student Valentina Laura Donati focussed on phages for control of *Flavobacterium psychrophilum* in rainbow trout.

Mollusc diseases and surveillance (Lone Madsen)

- Previous annual surveillance of flat oysters (*Ostrea edulis*) for *Marteilia refringens* (not present) and *Bonamia ostreae*. *B. ostreae* detections variable in prevalence from year to year.

Tour of Aquarium facilities - Engineering (Hans)

- Monitored every day of the year, manually once in am and pm. Remote alarm messages (SMS) sent to those monitoring and the company. Oxyguard fitted the entire system to the building, they will also often come to maintain the systems. An Oxyguard monitor and iPAD in each room to check and control temperature, oxygen, etc.
- Fresh, salt water (freshly made) and seawater available. Water is UV treated. Artificial salt water made to keep bacteria out of experiments. Waste water treatment with steam for a minimum of 2 minutes at 129°C. Recirculating systems in use in many parts of the aquarium to reduce the water consumed.

Inoculation of cell cultures for virus isolation (Betina Lynnerup Warming)

- Overnight incubated inoculums added to cell plates. When anti-IPNV included, one well for each cell line on plate has sera added as negative control. No removal of growth media prior to inoculation.
- Observed diagnostic virus isolations at 1 week and then their sub-culture to new plates. A combination of the three wells (Neat and dilutions) from original plate used as inoculum.

Animal ethics (Niels Olesen)

- At the national level 5 year applications covering many fish species and pathogens submitted. Including provision for emergency preparedness to set-up a fish trial within 2 weeks of an outbreak developing in Europe, if required.
- Each individual experiment also needs animal ethics approval internally (DTU) before commencing.

EU responsibilities and closing discussions (Niels Olesen)

- All EURL responsibilities, expectations and policies, etc. accessible on the laboratory web-page. EURL for fish diseases since 1994. Receive annual financial support for EU related activities, staff, training, workshops, etc.
- Fish Pathogens Database – available on laboratory web-page (maintained by Argelia). Platform for sharing available information on isolates of fish pathogens and their sequences to facilitate research and information sharing for fish pathogens. Free to use and encouraged for laboratories from across the world to access. Databases are currently for NNV, IHNV, SAV and VHSV.
- Two emailing lists for updates from the EURL available (one possibly limited to EU only) the other is a Newsletter subscription.

Results/Discussion

Regarding the five objectives of the training undertaken at the EURL for Fish and Crustacean Diseases the following has been learned;

1) Diagnostic testing for aquatic disease agents that are exotic and enzootic to Australia

- Commitment of the EU and their designated reference laboratories to engage and improve diagnostic procedures worldwide by openly sharing knowledge and information by workshops, training and documents available on-line.
- Current capabilities required by the EU of national reference laboratories for fish and crustacean pathogens and the associated acts and directives that provide guidance for sampling, testing and accreditation requirements.
- Gained an understanding of the laboratory's approach to fish disease investigations and surveillance for a range of notifiable endemic pathogens by virus isolation in fish cell lines. In depth demonstrations of how samples received, processed, cell culture and virus isolation procedures.
- Expanding capability within the laboratory for PCR and NGS with similar workflows and platforms.
- Greater responsibilities and capabilities required by the EU for the establishment of the Crustacean Disease reference laboratory roles.
- Additional to EURL responsibilities the need for the laboratory to fulfil Denmark's requirements for diagnostic and surveillance investigations particularly for rainbow trout farming.
- Concern for EHNV or VHSV genotype IV incursion in Europe and the continual presence of IPNV in Denmark and its impact on virus isolation procedures.
- Despite limited submissions or surveillance activities for aquatic bacteriology or mollusc diseases gained an understanding of the pathogens of interest and the procedures undertaken

- Co-ordination of technical staff to deliver on daily changes in demand for diagnostic or research activities being undertaken in parallel.

2) Research of aquatic disease agents and recent discoveries

- Insights gained into PRV-3 that is not culturable but demonstrated to cause HSMI in rainbow trout and its strong association with disease in RAS.
- The likely causative agent of RMS in farmed rainbow trout traced to a MLO that is not culturable. The observable red marks are due to the inflammatory response in fish from which they will recover.
- eDNA monitoring difficulties *Tetracapsuloides bryosalmonae* abundance in river water.

3) Maintenance of quality assurance systems

- Similar laboratory 17025 and 17043 accreditation but newly obtained flexible scope for PCR.
- External and internally auditing both occurring annually and the information assessed to a much greater level of rigor.
- Similar LIMS software, QA paperwork, sample traceability and diagnostic result authorization and reporting.
- Quality system software more sophisticated than Sharepoint and retaining a greater range of laboratory generated data than at AAHL.
- The requirement for diagnostic tests to be accredited for testing of notifiable pathogens in NRL.

4) Aquatic experimental facilities and processes

- Gained an understanding of the scale, operation and challenges of modern aquarium facilities capable of fish and crustacean experiments.
- A greater level of control and over-sight for the engineering responsible for maintaining and monitoring the aquaria facilities.
- One of the greatest expenses is the access to water and treating the water before release from the facility.
- The benefits of generating and maintaining SPF stock fish for consistency of experiments and the need for quarantine facilities for wild or farmed fish.
- Differing approaches to animal ethics applications, experimental set-up, staff movement and decontamination of experiments.
- The improvement to workflow of a separate laboratory near aquaria to examine and process specimens.

5) Proficiency testing programs

- Requirement for the laboratory to provide PT programs for the notifiable pathogens related to their EURL role.
- The differing approach being developed for the administration of crustacean PT.
- Shared how samples prepared and distributed for AAHL based PT programs differ from EURL approach.

Benefits and Adoption

The increase in knowledge and understanding of how the EURL for Fish and Crustacean Diseases conducts diagnostic testing, research, maintenance of quality systems, aquatic experimental facilities and proficiency test programs will strengthen the AAHL Fish

Diseases Laboratory capabilities and ability to meet Australia's needs and obligations for detecting and responding to incursions of exotic and emerging aquatic pathogens. Industries and communities with a focus or reliance on aquatic animals could all potentially benefit from this expansion of knowledge and understanding via earlier detections and diagnosis that could limit or prevent the spread of certain diseases in aquatic animals.

Examples of knowledge and understanding gained that will strengthen the AAHL Fish Diseases Laboratory capabilities:

1) Adoption of select diagnostic tests in use at the EURL for Fish and Crustacean Diseases; i.e. Kim et al. (2018) VHSV RT-PCR that detects all VHSV genotypes worldwide and will soon be incorporated in an update of the OIE VHSV chapter in the Aquatic Manual.

2) Implementation of best practice format and procedures for aquarium facilities capable of fish, crustacean and mollusc experiments; i.e. During the planned modification of the aquarium facilities at AAHL, consider different tank and room configurations as well as water quality monitoring options.

3) Improvement in the breadth of documentation currently captured by the quality assurance system at AAHL; i.e. Reports that detail comparability assessments of analytical sensitivity and limits of detection for pathogen-specific PCR assay as new nucleic acid extraction methods or PCR master mixes are evaluated.

Further Development

The training opportunity provided during this one week visit was unique, however after consolidation and evaluation of possible improvements at the AAHL Fish Diseases Laboratory, it is likely that future dissemination of this information would occur within the Australian laboratory network.

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