Ontario Aquaculture Research Priorities Roundtable
2019

LRIC LIVESTOCK RESEARCH INNOVATION CORPORATION

Ontario Aquaculture Association
EAT ONTARIO FARMED SEAFOOD

April 2019

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Executive Summary

On Feb 1, 2019, the Livestock Research Innovation Corporation (LRIC) conducted a facilitated session to consider research priorities and areas of industry focus for the aquaculture sector in Ontario in partnership with the Ontario Aquaculture Association (OAA).

As suggested by UofG, OAA and OMAFRA, each group discussed technical opportunities and barriers, specific to: Open Water Net Pens, Recirculating Aquaculture System (RAS) & Land-based Farming, Alternative Technologies (ie – Aquaponics) and Alternative Species. Further discussions considered:

A. Genetics
B. Nutrition
C. Health and Welfare
D. Environmental Impacts
E. Economics and Market Development
F. Social License

The Ontario farmed seafood sector is 94% production by volume and 91% of farm gate sales rainbow trout (Aquastats 2017), primarily produced in open water net systems, which was reflected in the overarching priorities. However, there is significant investment opportunity in other systems and species with indications of growth potential in all areas should advancements be made that reduce the costs of the technology, and some regulatory issues are addressed.

Overall, the following outcomes were gleaned from the all the discussions.

Outcomes

1. To grow the net pen industry in Lake Huron and Lake Superior to between 30,000 and 50,000 MT in the next ten years.

2. Develop a formal breeding program for Ontario rainbow trout through a partnership between industry and government. A first step would be assessing the amount of genetic diversity in existing lines of rainbow trout and then initiating a family-based breeding program. This approach would combine new and existing tools and techniques.

3. Development of engineering and multidisciplinary technology for:
    - recirculating aquaculture systems, multi-trophic aqua and aquaponics that can be developed into commercially scalable and economical systems, creating opportunities for expansion in Ontario.
    - phosphorus binding and effluent control and/or divergence of waste products to usable resources for any/all types of aquaculture systems
    - Alternative usages for systems waste components

- Systems for offshore operations to handle severe weather and mitigate climate change impacts by moving to cooler water environments.

4. Development and implementation of a science-based benthos and sediment monitoring protocol for freshwater net pen systems.

5. Development of best practices and protocols for the humane culture, euthanasia, slaughter and shipping of fish livestock

6. Development of nutritional diets across any of the technology systems employed in aquaculture that are cost effective, sustainable, and could use local (Ontario or Canadian sourced) and/or novel (not displacing anything used in/for human diets ie. insect larve, black soldier flies etc.) components, that have nutraceutical properties, and improve immunity.

7. Development of a model for assimilative capacity and mass balance for off-property (stream) discharge of land-based farms that regulators will recognize for licensing and monitoring.

8. Updated discharge standards for RAS that distinguish between mass loading and concentration with the ability to incorporate alternative waste usages.

9. Area of social license and education for OAA to facilitate were identified as follows:

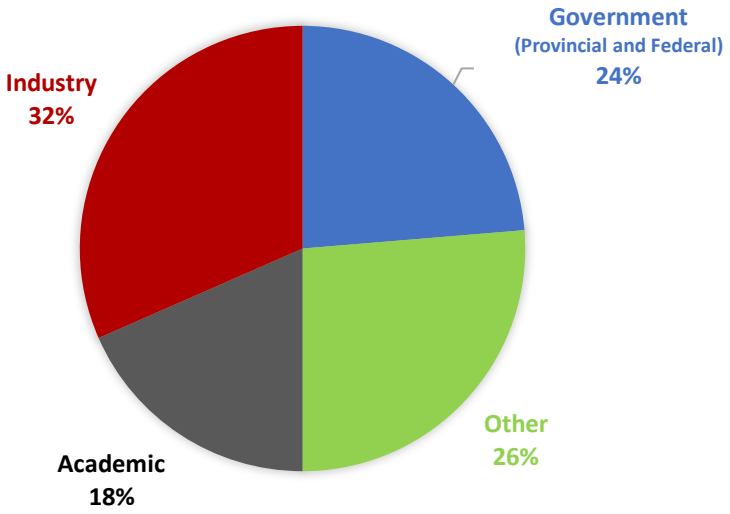
Communication
- Environmental Impact – Science
- Industry Transparency
- Industry Successes
- Positive impact on local ecosystem/wild fish
- Knowledge Translation and Transfer (KTT) - Research results shared
- Media friendly/open
- How people perceive aqua story
- Government to message the benefits of aquaculture

Education
- Next generation – benefits of fish farming
- Strategy
- Positive messaging to farmed fish opposition

Background

In September, 2014, key stakeholders in Ontario aquaculture met at a facilitated workshop. The key goals of the workshop were to: I. to establish research themes, and identify the desired outcomes within each of those themes, and II. identify areas of focus around those desired outcomes to mobilize research action. Significant change and expansion has occurred in the industry since that time.

On Feb 1, 2019 a second facilitated session was held to again consider research priorities and areas of industry focus. The meeting had 39 attendees depict in the representation below:



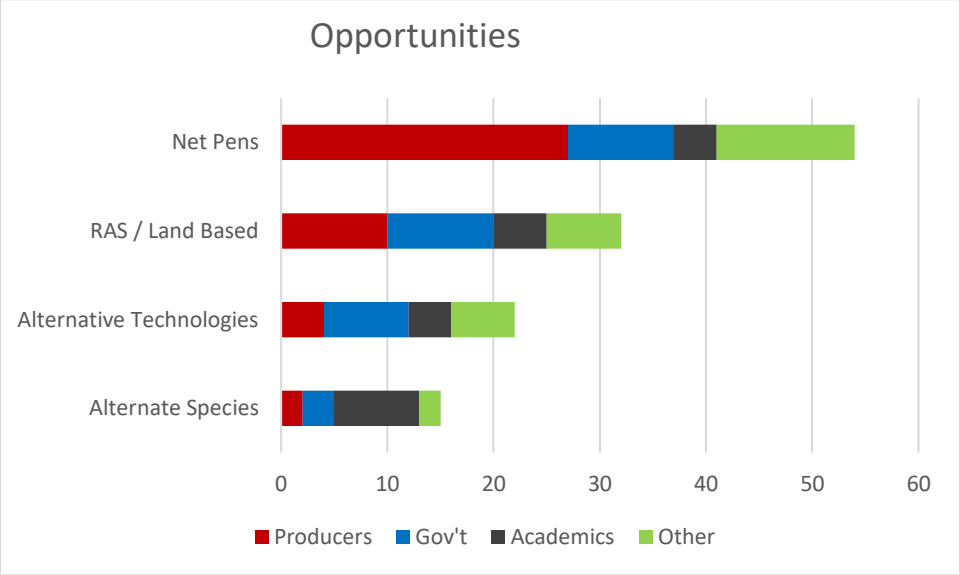
RJ Taylor, Managing Director of the Ontario Aquaculture Association, provided an overview of the industry, with Rich Moccia of the University of Guelph presenting an overview of aquaculture research and capacity in Ontario. Neil Rooney also from the University of Guelph provided an overview of a collaborative research model, and Gavin Christie for the Federal Department of Fisheries and Oceans presenting on federal research projects and capacity. The remainder of the day was spent in facilitated discussions, with the group divided into 6 clusters all with a mix of a least one person from each participant group represented.

Discussion Areas

Opportunities and Barriers

A. Net-pen farming
B. Recirculating Aquaculture System (RAS) & land-based farming
C. Alternative technologies (ie – Aquaponics)
D. Alternative species

Following discussion, the participants were invited to score the opportunities which they believed will have the greatest potential to effectively take the industry forward.



Below is the summary of the results for those areas that scored above 20 points.

Net Pens

Opportunity
To grow the net pen industry in Lake Huron and Lake Superior to 30,000 to 50,000 MT in the next ten years.
Barriers/Gaps:

Genetics

- Egg/fingerling Supply
- All-female Populations
- Triploid Induction Techniques

Regulatory

- License more farms
- Being Recognized as Agriculture

Environmental

- Sediment Requirements for Fresh Water Systems

Social License

- Public Perception

RAS/Land Based

Opportunity

1. Development of a model for assimilative capacity and mass balance for off-property (stream) discharge of land-based farms that regulators will recognize for licensing and monitoring.

Barriers/Gaps

Regulatory

- Model acceptance and recognition by regulators

2. RAS in Ontario are expanded, with continually improvement for fish health and divergence of waste products that are developed into marketable or usable resources.

Barriers/Gaps:

Economics

- Costs
- Energy efficiencies

Regulatory

- Resistance to adoption
- Difficult to bring fish health products to Canada
- Registration of new products

Social License

- Public perception
- Marketing

Education

- Training on proven models
- Farm diversification promotion
- Knowledge capacity

Alternative Technologies and Species

Opportunity

A multidisciplinary approach for opportunities for an economic multi-trophic aquaculture, aquaponics and/or hybrid model for any/all types of systems provides phosphorus binding and effluent control and would be economically viable are probed. Consideration to both new and native species, through genetic and new consumer products.

Barriers/Gaps

Animal and Plant, Health and Biology

- Unclear if there are coexisting species for freshwater culture
- Capital costs
- Genomic tools and technologies including biotechnology

Engineering

- Technology - demonstrated
- Plant and fish species alternatives

Regulatory

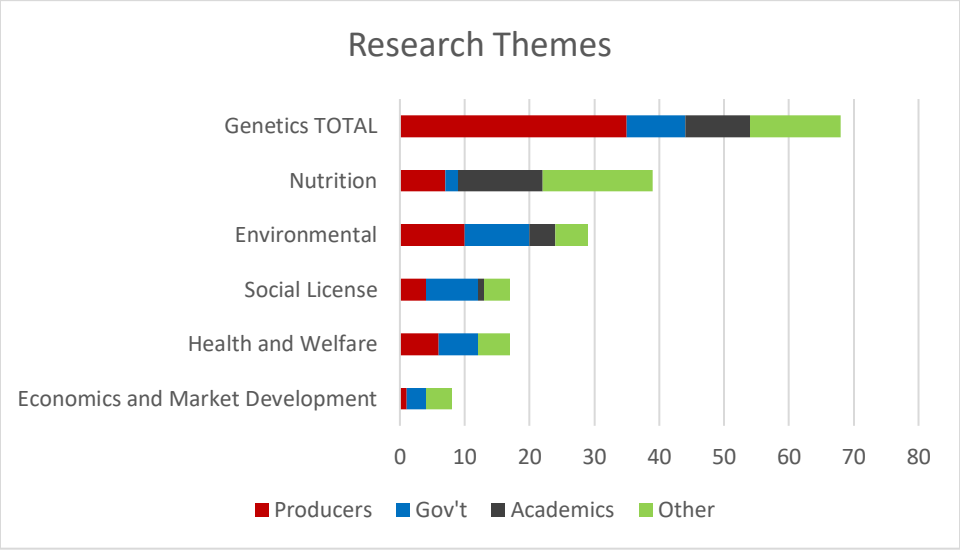
- Barriers from existing regulations

Research Themes

Further discussions were held on research opportunities within the following areas

A. Genetics
B. Nutrition
C. Health and Welfare
D. Environmental Impacts
E. Economics and Market Development
F. Social License

Following discussion, the participants scored the research which they believed to have the greatest potential to effectively take the industry forward.



The below summary focuses on the results for areas that scored above 20 points.

Genetics

Opportunities

- Production of all-female populations

- Production of sterile populations (e.g. triploid induction)
- Pedigree
- Quantitative genetic/genomic mapping
- Formal ON breeding program
    - Assess existing genetic diversity
    - Specific traits to be determined - eg
        - Growth
        - Maturation
        - Thermal tolerance
        - Resilience
        - Feed Efficiency
        - Health – disease tolerance
        - etc.
- Global collaboration for strain development
    - Long term – importing genetics

NOTE: Establishment of an overarching program is important prior to deciding on program details

Nutrition

Opportunities

- Functional Feeds
    - Nutraceuticals
    - Improve immunity
- Ingredient Opportunities
    - Lentils
    - Black Soldier Flies
    - ON/CAN sourced
- Cost Effective Diets
    - Use of inexpensive local ingredients
    - Use of Novel Feed ingredients – ones that are not used in/for human diets
- Precision Diets
- Diet impacts on thermal tolerance/growth in high temps – seasonal diets/ starve periods/fish size

Environment

Opportunities

- Sediment/Benthos/Discharge
    - Licensing and monitoring system needs to be science-based
        - Monitoring protocol development is needed
        - Development of an assessment guide for provincial staff receiving monitoring reports
    - Quantifying extent of cage footprints and land-based discharge plumes, developing protocols to undertake this work

    - Existing provincial monitoring protocols and thresholds need to be reconciled with up-coming federal Aquaculture Activity Regulation requirements
    - Research to understand assimilation of waste in the environment
        - rates of degradation and assimilation and environmental controlling factors
        - fallowing – for how long
    - Improve technical merit /transparency of use of data requirements for licensing of new sites and changes to existing
- Incorporate ecosystem assimilation capacity into nutrient management
- Development and testing of a large-scale assimilative capacity model to predict cumulative effects of nutrient additions from multiple farms
- Develop evidence based discharge standards for RAS facilities
    - Mass loading vs concentration-based discharge limits
    - Incorporate alternative waste use
        - Nutrient recapture/reuse

Conclusion

The outcomes are summarized in the executive summary, with details provided in Appendix 3. After discussions, each participant was provided with 5 coloured stickers to use to indicate the areas that held the highest priorities to them. The color of the sticker indicated the participants affiliation within the industry. The information from all discussions as prioritized are distilled and found in Appendix 1 and 2.

The industry currently operates in an environment where it cannot supply the demand for farm raised trout. Changes to licensing requirements and developing science-based regulations, for Ontario lake and land-based production systems would send a positive signal for increased investment in the sector. Development of value added and new products are not a focus in the short term.

Alternate species were identified, and there is some investment in other species with indications of potential growth potential if economic viability can be achieved. This is not identified as area for industry funding to be applied at the current time. It does however provide an opportunity for “blue sky” research that has the potential to drastically change the industry by increasing the ‘local’ farmed seafood offerings.

It is important to review these outcomes in the next 3 – 5 years and **not later than February 2024**. This will insure accurate priorities that are focussed for continual advancement and growth of the industry to its full potential.

TECHNOLOGIES PRIORITIZATION

Appendix 1 Technologies Prioritization

Opportunities	Barriers/Technical Gaps	Prod	Gov't	Acad	Other	Total
Net Pens - TOTAL		27	10	4	13	54
Optimizes seed stock for lake conditions • Availability • Genetics	Gaps in Supply Chain International Trade Genetic Deficiencies				1	1
Diversification of Species - Whitefish: Other Species	Market Development Brood stock Licensing Framework for Success Enviro conditions Public Perception		3		2	5
Increasing 30,000 to 50,000 MT L Superior/L Huron	Regulatory Egg Supply – Alma All female sex reversed to hatcheries - Genetics program - Triploidy protocol DFO – Cheryl Podemski - Fixing sediment requirements	19	3	2	4	28
Expansion (Rainbow Trout)	- Tech - Climate Change - Public trust/perceived public trust issues - International impacts - hatcheries	1	1	1	4	7
Supply (food, eggs (etc.) genetics	- location, finance, regulations, industry size (critical mass), traceability, transparency	1				1
Facilities, brain trust and good genetic base for furthering genetic improvement	Conflict of Interest and funds to move ahead	5		1		6
Multidisciplinary modelling for impacts of net pens	Do not have recognized tools that we can all use now		1		1	2
Collaborative base is stronger than before but needs to continue forward	Public perception and credibility to maintain integrity i e BC					

TECHNOLOGIES PRIORITIZATION

Opportunities	Barriers/Technical Gaps	Prod	Gov't	Acad	Other	Total
Social Licence and Public Perception	- understanding - education - competing interests - trust - transparency		1			1
Regulation (& siting)	- complicated process - expensive - "excessive" precaution - Timelines/renewal/length - Financing					
Being recognized as agriculture	- Public perception - Government doesn't view/fund fish as ag - Enviro concerns	1	2			3
Automated Smart Monitoring Water and Benthos	- Cost - Availability of technology - Resistance to adoption				1	1
RAS / Land Based - TOTAL		10	10	5	7	32
Opportunities	Barriers/Technical Gaps	Prod	Gov't	Acad	Other	Total
Technology	- Financing - Access - Feasibility/Payback/return (ROI) - Optimization - Reliability - Qualified people - People capacity					
Alternative Energy	- Prohibitive Cost	1				1
Improved filtration, aeration, and pumping technologies	- Cost (minimizing op cost) - Regulatory (resistance to adoption	1		1	2	4
Assimilative Capacity and Mass Balance of Different Types of Land Based Systems	- Finding a model that can measure full downstream effects.	5	1			6
Evidence Based regulations (ie discharge research that supports RAS)	- Not enough government focus - Species list				1	1

TECHNOLOGIES PRIORITIZATION

Opportunities	Barriers/Technical Gaps	Prod	Gov't	Acad	Other	Total
Waste Products (development, marketing)	- Regulation - Cost - R & D - Knowledge capacity - Marketing - Public perception - Capacity			3	2	5
More RAS / Growth through RAS	- Economic viabiliy - Training on proven models / tech - Energy efficiencies /costs - Farm diversification promotion	1	3		1	5
RAS Expansion to Support Net Cage	- Net Cage Expansion	1				1
Alternative Species	- Risk - Density - Market - Regulation - Disease - Capacity - Anti-microbial resistance - Vet assess - Research and Development		1			1
Diversification of Species (even non-native, shrimp, barramundi)	- Never zero effluent - Lack of local expertise - Registration to aqua list					
Aquaponics	- Niche Market - Scale of Production - Economics					
Demonstrated profitable model	- Cost of developing model - Information and Success sharing					
Standardizing of cookie cutter a model that can work for specific markets and species	- Collaborative decision making - Still and art form not a model				1	1

TECHNOLOGIES PRIORITIZATION

Opportunities	Barriers/Technical Gaps	Prod	Gov't	Acad	Other	Total
Improve fish health/reduce antibiotic use	- Slow uptake in fish health initiatives - Difficult to bring fish health products to Canada - Registration of new products	1	2	1		4
Local Food Production Food Soventry	- Capital cost - Never zero effluent - Lower distant to market		3			3
Alternative Technologies - TOTAL		4	8	4	6	22
Alternative Energy	- Cost prohibitive now		1		2	3
GMO, CRSPR	- Social Licence - Regulatory Environment - Cost		2			2
Breeding Technologies/Techniques (Genomics)	- Cost - Availability of Markets - Expertise		2			2
Optimization through software in industry not accustom to software	- Cost to pilot - Decision paralysis on so many options - Training					
Borrowed tech	- Retrofitting - Contracts - Discovery - Cost - Regulations					
Offshore operations that handle modern weather	- Human Safety Issue - Cost Prohibitive - Just not there yet		2	1	3	6
Multi-Trophic Aqua and Aquaponics for any/all types of systems – Phosphorus binding and effluent control	- Not sure of good coexisting species for freshwater fish - Capital costs - Tech	1	1	2	1	5
Aquaponics and Hybrid systems	- Regulation - Technology - demonstrated - "think outside the box" need multidisciplinary - Plant and fish species alternatives	3		1		4

TECHNOLOGIES PRIORITIZATION

Opportunities	Barriers/Technical Gaps	Prod	Gov't	Acad	Other	Total
Aquaponics – Niche opportunity ONLY	- Not commercially viable - Don't waste research dollars					
New Cage Technology offshore, sinking, better mooring, high energy loads	- Research and development - Costs - Lack of adopters					
Enhancing Food Security populous areas remote areas	- Market developments - Specialized nutrition - Economic models that work – getting past the theory - Scalability					
Freezing Packaging	- Economics - Demonstrated success					
Humane Euthanasia/Harvest/Shipping	- Costs - Uptake - Tech - Sizable scale					
Biproducts and Alternate ingredients processing	- Consumer acceptance - Regulator approvals					
Alternate Species - TOTAL		2	3	8	2	15
Export Opportunities and Penetration Quality Product	- Trade - Production capacity					
import replacement	- Can we compete $$					
"Live" Market	- Transportation/location - Regulation - Risk					
Tropical/Warm water fish (tiliapia, barranmdi, etc)	- Market differentiation - Competition with imports - Brood/juvenile	1		2		3
Bring high Value Species to Ontario	- Getting new species added to culture list - Getting species accross border				1	1
Value added processing	- Public education - Restaurant/chef education - Marketing - Change adversion					

TECHNOLOGIES PRIORITIZATION

Opportunities	Barriers/Technical Gaps	Prod	Gov't	Acad	Other	Total
new species	- Culture technology - Breeding and genetics - Health management - Domestication					
Collaboration with commercial fisheries for consistent supply	- Social barriers between groups and public					
Polyculture (including plants)	- Expertise - Technology - Species added to culture list			1	1	2
Whitefish or other native ie walleye	- Brood/juveniles - Market development, not pre existing - Differentiation	1	2	2		5
"Country Foods" (local species – reduce pressure on stocks)	- Risk to natural species - Smaller margins - Research and Development					
New Consumer Products Drive consumption (increase per capita consumption)	- Competition with meat (chicken/beef/lamb) - Marketing - Development of new products /"fast food" – make it easy					
increased growth with GMO variants of existing species	- Public perception - Regulatory approval - Capital costs - Marketing pr			1		1
Shrimp	- RAS associated Barriers (viability, energy, production model) - Differentiation - Market - Brood/juveniles - Nutrition/feed ingredients		1	2		3
Low opportunity	- Many - Impossible to make money					
Genetic alteration for betterment of culture	- Public trust - Communication (how to?)					

Appendix 2 - Research Themes

GENETICS	GROUP				
	Prod	Gov't	Acad	Other	Total
Genetics TOTAL	**35**	**9**	**10**	**14**	**67**
Triploidy Control Solve import restrictions/regulatory issues regarding Canadian use of Methyl T					
Produce sex reversed females and distribute to farmers	12			1	13
Breeding Program to select for traits (farmers involved in trait selection discussions)	2	3		4	9
Self-sufficient egg production in Ontario BARRIERS – - Expansion of Hatcheries - Licensing - Economics - Scale	2				2
Assess Genetic Variation in Ontario Stocks	2	1	3		6
Ability to effect change for: - Maturation - Thermal tolerance yield - Feed efficency - Fish health		2		3	5
Later of not maturing fish that can handle extended times in net pens BARRIERS - Understanding of triploidy resilience and tech - Let's figure out how to do in Ontario					
More Shrimp/Rainbow trout/other species egg suppliers to assure supply and development BARRIER - $ - Regulation (Sanitary) - Long Time Horizon	3			1	5
Centralized Facility for Breed Nucleus BARRIER - Willpower & $					

RESEARCH THEMES

GENETICS	GROUP				
	Prod	Gov't	Acad	Other	Total
Quantitative genetic/genomic mapping Formal ON Breeding Program Global Collaboration for Strain Development BARRIER - $$ - Location - Ownership - Big Players buy up all stock - Long term investment - CFIA	11	3	3	3	20
More resilient fish in erratic/high summer temperatures with net pens Low DO/increase temp tolerant R. Trout strains Disease Tolerance BARRIERS - Improved Breeding Program in genetic selection - Breeding Program implementation - Field variation	2		4	2	8

HEALTH AND WELFARE	GROUP				
	Prod	Gov't	Acad	Other	Total
Health and Welfare TOTAL	**6**	**6**		**5**	**17**
Humane Culture, Euthanasia, Slaughter, Shipping Practices - Best practice - Stress measurement - protocols	1	4		3	8
Fish Health - Management Protocol - Diagnostics – Quick - Vet availability	3			2	5
Biosecurity Measures and Hazard Response - Vet Network	2	2			4
Availability of Health Products for fish - Vaccines etc.					

RESEARCH THEMES

NUTRITION	GROUP				
	Prod	Gov't	Acad	Other	Total
Nutrition TOTAL	**7**	**2**	**13**	**17**	**39**
Cost Effective Diets Use of inexpensive local ingredients Use of Novel Feed ingredients – would not be used in human diets	2		2	3	7
Understanding how feed or feed additives impact thermal tolerance/growth in high temps – seasonal diets/ starve periods/fish size			2	6	8
Environmentally sustainable feed				1	1
Synchronize with genetics AA and protein mapped in genome		1		1	2
Functional Feeds - Nutraceuticals - Improve immunity Ingredient Opportunities - Lentils - Black Soldier Flies - ON/CAN sourced Barriers - Regulations - Costs	4		6	4	14
Precision Feeding - 100% digestibility - Micro diets	1	1	3	2	7

RESEARCH THEMES

ENVIRONMENTAL	GROUP				
	Prod	Gov't	Acad	Other	Total
Environmental TOTAL	**10**	**10**	**4**	**5**	**29**
SUMMARY (9 pts below) Sediment/Benthos/Discharge - Monitoring - Quantifying	10	10	3	5	28
Improve efficacy of Sediment Licence requirement - Improve technical merit	3	4	1		8
Resolve benthos sediment issues					
Incorporate ecosystem assimilation capacity into nutrient management		3	1	1	5
Nutrient recapture/re-use -phosphorus binding, recapture and sell as fertilizer, multitrophic		2	1		3
Realtime monitoring and tracking				1	1
Sediment Monitoring for Net Pens Simplified					
Develop Evidence based discharge standards for RAS facilities - Mass loading vs Concentration - Incorporate alternative waste use	5	1		2	8
Quantify nutrients into environment					
Modern Methods and Proper Monitoring				1	1
Multidiscipinary Modelling Accepted - Points system	2				2
Regulatory approach – Differentiate between Cage and Land based (RAS) Cultures					
Ensure 100% stock sterile					
Impacts of Net Pens on wild fish populations Escapes - Nets aren't 100% - Costs - Mother nature - Transparency			1		1

RESEARCH THEMES

SOCIAL LICENSE	GROUP				
	Prod	Gov't	Acad	Other	Total
Social License TOTAL	**4**	**8**	**1**	**4**	**17**
Communication - Environmental Impact – Science - Transparency - Industry Successes - Positive impact on local ecosystem/wild fish - KTT/research results shared - Media friendly, open - How people perceive aqua story - Government to message the benefits of aqua Education - Next gen – benefits of fish farming - Strategy - Positive message out to opposition	4	7	1	4	16
Ability to control quality and safety of farmed product					
Best Management Practices		1			1

ECONOMICS AND MARKET DEVELOPMENT	GROUP				
	Prod	Gov't	Acad	Other	Total
Economics and Market Development TOTAL	**1**	**3**		**4**	**8**
Expand Production to meet Demand					
New Products - Value add - Development of new	1	2		3	6
Increase Shelf Life					

Tell the story –
- Human Health Benefits of Fish
- Educate the public, chef, school, younger generation
- Reach consumer with good story
  ○ Local
  ○ Informed
  ○ Ethical
				1	1

Access to Government funding - Risk mitigation - Recognized as Ag		1			1
Alternate Species Market					

OUTCOMES BACKGROUND

Appendix 3 – Outcomes Background

1. To grow the net pen industry in Lake Huron and Lake Superior to 30,000 to 50,000 MT in the next ten years.

   Research Requirements

   - Need for research and development of a rainbow trout pedigree and genetic selection tools
   - Development of triploid induction technique
   - Production of all-female populations

   NOTE: Work in this area could take place at the Alma Aquaculture Research Station.

2. Develop a formal Ontario breeding program for Ontario rainbow trout in conjunction with industry participants. A first step would be assessing the amount of genetic diversity in existing lines of rainbow trout and then initiating a pedigree-based breeding program. This approach would combine existing breeding methods (mass selection) with utilizing quantitative genetic/genomic mapping through new and existing tools and techniques.
   - Specifics to be determined - eg
     - Growth
     - Maturation
     - Thermal tolerance
     - Resilience
     - Feed Efficiency
     - Health – disease tolerance
     - etc.

   NOTE: Establishment of an overarching program is important prior to deciding on program details

3. Development and implementation of a science-based benthos and sediment monitoring protocol for freshwater net pen systems

   Research Requirements

   - Development of protocols for quantifying the extent of farm footprints and for science-based monitoring of effects on sediment and benthos.
   - Research to understand assimilation of waste in the environment
     - rates of degradation and assimilation and influencing factors
     - fallowing – is this an effective mitigation strategy and if so when should a site fallow and for how long
   - Research to develop understanding of assimilative capacity of sediment for aquaculture waste and of the ecosystem for aquaculture nutrient and BOD loading.

- Incorporation of Department of Fisheries and Oceans Canada research in the development of monitoring methods and thresholds.

  NOTE: Dr. Cheryl Podemski has been conducting research into the potential freshwater monitoring parameters and thresholds for use in the AAR. This work is to be published in 2019 and the results need to be reflected in regulation and monitoring.

4. Development of engineering and multidisciplinary technology for:
   - recirculating aquaculture systems, multi-trophic aqua and aquaponics that can be developed into commercially scalable and economical systems, creating opportunities for expansion in Ontario.
   - phosphorus binding and effluent control and/or divergence of waste products to usable resources for any/all types of aquaculture systems
   - Alternative usages for systems waste components
   - Systems for offshore operations to handle modern weather

5. Development of best practices and protocols for the humane culture, euthanasia, slaughter and shipping practices.

   Research requirements
   - Stress measurement tools

6. Development of nutritional diets across any of the technology systems employed in aquaculture that are cost effective, and could use local (Ontario or Canadian sourced) and/or novel (not displacing anything used in/for human diets ie. insect larve, black soldier flies etc.) components, that could have nutraceutical properties, improve immunity etc.

   NOTE: There is progress on alternative ingredients, however there are regulation barriers and CFIA and Health Canada need to be included in projects and discussions. It was noted that the multinational Feed Companies are doing research in this area and not an area for the industry to focus funding.

Social license and regulatory issues were noted and are topics for OAA to address that didn't appear to have any identified research outcomes

Areas that required updating of the existing regulatory monitoring and licensing requirements.

7. Development of a downstream model for assimilative capacity and mass balance for different types of land-based systems that regulators will recognize for licensing and monitoring.

8. Updated discharge standards for RAS that distinguish between mass loading and concentration with the ability to incorporate alternative waste usages.

OUTCOMES BACKGROUND

Social License and Education areas for OAA to facilitate

- Communication
  - Environmental Impact – Science
  - Industry Transparency
  - Industry Successes
  - Positive impact on local ecosystem/wild fish
  - KTT/research results shared
  - Media friendly, open
  - How people perceive aqua story
  - Government to message the benefits of aquaculture
- Education
  - Next generation – benefits of fish farming
  - Strategy
  - Positive messaging to farmed fish opposition

Note: LRIC is involved in a funding application “Improving the Effectiveness of Advisory Services for Facilitating Information Sharing, Accessibility and Adoption of Sustainable Farm Management Practices in Ontario” that if funded can potential provide assistance in research adoption.

PARTICIPANTS

Appendix 4 - Participants

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