A Practical Tool: One Health Considerations for Land-Based Aquaculture

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I, Cathrine Liegey, hereby declare that:

1) The thesis has been composed by myself, the candidate.

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Signature: C. Liegey Date: March 5, 2024

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Abstract

The One Health concept attempts to provide infrastructure upon which promotion of secure and equitable food systems can be built. Amongst the agricultural methodologies, aquaculture is proving to be a field with exponential growth and potential. In order to capitalize on the benefits of increased seafood production, while reducing the likelihood of potential harm caused by the industry, support during planning stages is prudent. Currently, there is a lack of available tools to support methodical ways of assessing impacts during the planning stage. Hence, a rubric that can be used as an aid in planning is presented in this paper. The rubric is intended to guide the assiduous land-based aquaculture planner(s) in using a collaborative, One Health centered process by posing questions and providing prompts regarding impacts to consider.

Overview

As the spread of zoonotic diseases, health care inequalities, impacts of climate change and degradation and gender-related biases in agricultural systems are now discussed on the daily news, the concept, One Health, has taken center stage. Global food insecurity is potentially the most pressing issue being addressed through a One Health perspective; robust research is dedicated to promoting sustainable food production systems and limiting vulnerabilities within existing systems. The utilization of this approach ranges in depth from adaptations in fruit processing, improvements of silo storage facilities, and furtherment of aquaponic facilities, to eliminating forms of discrimination and advocating for equitable health and wellness systems. Endeavors that can be categorized under the One Health umbrella are weaved into environmental, human and animal health preservation. However, the accessibility, understanding, and therefore the value of a One Health prerogative leaves much to be desired.

Momentum behind addressing resource sustainability is growing across many sectors. “A sustainable food system is one that ensures food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition of future generations are not compromised” (FAO 2014). Locally and globally, stakeholders are collaborating to repair neglected food production systems and champion food equity. One example of this is the ‘Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems’ report launched in Stockholm in June 2016 (https://eatforum.org/eat-lancet-commission/eat-lancet-commission-summary-report/). The EAT-Lancet Commission recommendations are to seek commitment from a wide range of stakeholders to: make significant dietary change; produce better food not just more food;

sustainably intensify food production; safeguard land and oceans by stopping land clearing and overfishing; and to reduce waste by at least half.

Although One Health directives and achievements are identifiable, often buttressed by government buy-in, and demonstrate success, they may lack awareness and collaboration within the impacted community(s). Similarly, the importance of systems approaches, and multi-disciplinary integration stands to be expanded upon. Efforts to boost coaction, inclusivity and accessibility can aid in strengthening practices, policies, and systems that function across the human-animal-environment interface. As described within Institutionalizing One Health: From Assessment to Action "Multiple initiatives and tools are currently being deployed to assess, prioritize, and document One Health needs, gaps, and lessons learned through implementation and practice, supporting the vast knowledge network." (Machalaba et al. 2018). Based on this described need, the aim of this project is to introduce a practical tool to be called upon during the early planning stages of land-based aquaculture businesses and facilities. The developed rubric is an adaptable conglomeration of considerations that are recommended for fostering a One Health approach when analyzing proposals, nourishing existing methods, promoting resiliency, and mitigating unfavorable outcomes of land-based aquaculture practices.

Introduction

Over the past forty years, an upsurge in seafood consumption has driven the global demand for the expansion of aquaculture and evolution of new production processes. As part of the strategy to decrease non-communicable diseases, improving access to nutritious foods of animal origin, including aquatic animals, is crucial. Aquatic animals represent a vital and plentiful source of essential nutrients, such as iodine and omega-3 long-chain polyunsaturated fatty acids (LCPUFAs) (Gormaz et. al 2014). Aquaculture species have been recognized as an important source of healthy fats by the United Nations and the World Health Organization, which are attempting to strengthen national efforts to reduce the burdens of terrestrial livestock farming as well as processed and non-nutritious food consumption (Food and Agriculture Organization of the United Nations Rome, 2017). Some countries have put forth seafood dietary guidelines and publicized potential health benefits. The coinciding rise in demand on aquaculture production to support consumption requires expanded aquaculture production and wild-caught fish harvests. According to Gormaz (et al. 2014) “It may not be possible for wealthier nations to make progress on this recommendation without depleting global fisheries and further harming aquatic ecosystems, which could impact the food supplies of other nations.” Thus, mitigation through a One Health perspective steered at improving equity and protection of natural resources, must be considered.

Humans have historically consumed seafood as part of their diet; however, overfishing, population growth, pollution, ocean acidification, climate degradation and other factors have decimated wild fish stocks and damaged marine resources (Issifu et.al 2021). Given the unfortunate realities of current production and capacity trends, and the decline in fisheries, this aquatic food void will likely be occupied by marine and land-based aquaculture. Significant challenge lies in effecting methods capable of “increasing seafood production to the levels needed to positively impact diets at a population level without degrading aquatic ecosystems.” (Gomaz et al. 2014). Facilities must structure the intended production chain from growth to processing to product marketing and all sales processes in a conscientious manner.

While aquaculture in near- and off-shore waters is having remarkable international growth, the limited suitable oceanic environment is a short-term concern and long-term constraint. This knowledge paired with new technologies, such as land-based recirculating aquaculture systems (RAS), has brought with it new production solutions. Some of the described benefits to RAS systems include stable production, location and geographic versatility, lower dependency on medication due to reduced exposure to disease and environmental threats and several others (Ahmed et al. 2021). On the contrary, the introduction of RAS and other land-based aquaculture systems bring with it unique challenges, such as waste management, appropriate land-usage, greenhouse gas emissions, energy consumption, complicated system design, and production capacity limitations, to name a few (Corsi & Franchi 2005).

Recirculating or land-based aquaculture production systems, that are further separated from marine environmental interfaces, may have reduced negative impacts on their surroundings, compared to mariculture systems. Mitigation of unintentional introduction of hatchery-raised species to natural environments, interactions between wild and farmed animals, and other biosecurity concerns are more easily controlled in a land-based setting (Belton et al. 2021). Impacts on the local environment exist at all aquaculture sites, such as effluent discharges, water quality concerns, disease transmission between farmed and wild species, disposal of fish waste, fish escapes, and the role of aquaculture in emerging infectious diseases (Drumm et al. 2015). Specific risk factors exist for every production system based on the species, location, production practices, and disease threats both known and unknown. Contamination from facilities threatens soil and water contamination, especially if fish tanks are excavated and not lined properly. A deeper understanding of the impacts of various aquaculture production techniques, such as offshore and recirculating systems, is necessary.

Both corporate and individual producers of aquaculture species can learn much from researching the trials and tribulations of current and inoperative land-based facilities. Reasons for ceased and thwarted production range from issues with supply of juvenile fish stock, water contamination, to delays in production, high initial cost and investment funds, necessity of a specialized labor force, and the inability of product to compete with price of its ocean-net farmed equivalents (Belton et al. 2021). Species-specific diet requirements, feed conversion rates and feed availability all impact the likelihood of success for a new RAS enterprise in the early stages, and is largely dependent on the site location (Nesar et al. 2021).

Dramatic incidents in both oceanic and land-based aquaculture facilities are also well documented; care must be taken to avoid such occurrences. In August 2017, more than 160,000 Atlantic salmon escaped from a net-pen aquaculture facility in Washington into the Salish Sea (Drumm et al. 2015). The farm (which was legally permitted to operate), did not properly maintain the equipment and resulted in the release of thousands of non-native fish into state waters. In general, many of the most popular species cultivated in aquaculture farms are non-native species. As part of a European Union funded project, *Prevent Escape*, a research program was undertaken to document the extent, size and knowledge of the causes of escapes from marine fin fish farms in Europe over a three year period. Escape incidents described in six countries (Ireland, UK, Norway, Spain, Greece, and Malta), and other data was supplied by the Norwegian Fisheries Directorate and the Scottish Aquaculture Research Forum. "A total of 8,922,863 fish were reported to have escaped from 242 incidents. Of these over 5 million occurred in two catastrophic escape incidents." (Jackson et al. 2015). As exemplified by the Washington event and data from *Prevent Escap*e, aquaculture can easily become a pathway for the introduction of non-native species to new environments; thus, resulting in invasive species potentially devastating local ecosystems.

Concerns for materialized and potential damage affiliated with unsustainable growth of aquaculture are anchored in many realms. While land-based aquaculture systems may pose a decreased threat at the oceanic intersection, compared to open-water, also known as net-farming, some authors have documented that aquaculture has been responsible for the deforestation of millions of hectares of mangrove forests in Thailand, Indonesia, Ecuador, Madagascar, and other countries (Martinez-Porchas and Martinez-Cordova, 2012). Mangrove forests are a natural source of organic matter in coastal zones as well as habitat for a diverse array of flora and fauna.

Aquaculture farms are sometimes abandoned due to operative, managerial, and other problems encountered during design or operational stages. When the farms close, the site's remaining soil is unfit for agricultural use and often contaminated with applied chemicals. Although there are few published studies, it is postulated that inland aquaculture has been entirely or partially responsible for the deterioration of water bodies used for human consumption by means of increased wastewater generation (Martinez-Porchas and Martinez-Cordova, 2012). In addition to wastewater, effluent ecosystems may be subject to eutrophied and nitrified runoff from farms, especially if fish overfeeding is occurring and thus heightened the risk of ammonia toxicity to exposed organisms (Martinez-Porchas and Martinez-Cordova, 2012). Subjection to additional environmental contaminants including hormones, steroids, antibiotics, and parasiticides also exists. Displacement of native species and attraction of nonnative species by the implementation of aquaculture facilities should also be considered. Moreover, oceanic, and inland farming threaten to disrupt normalcy in ecosystem balance by injecting or promoting the spread of pathogens (Páez-Osuna, 2021).

Changes in weather patterns and landscapes also have been associated with the expansion of aquaculture, "The construction of shrimp farms in the riverbeds has modified the hydrological patterns in many regions of the world with the consequent impacts on the regional ecosystems and the local weather." (Martinez-Porchas and Martinez-Cordova, 2012). Social and economic impacts of aquaculture growth are highlighted by fishermen that attribute the collapse of fisheries to the alternative and less traditional farming and marketing techniques (Issifu et al. 2022).

Another purported problem is the dependency of aquaculture farms on fishmeal, fish oil, and other fish feed products. "The proportion of fishmeal supplies used for fish production have increased from 10% in 1988 to more than 30% in the last years, which classifies aquaculture as a potential promoter of the collapse of fisheries stocks worldwide." (Avnimelech, 2009). Furthermore, the role of developing and undernourished nations may be at risk of becoming or acting as the exploited supplier of seafood to economically superior countries, while potentially permanent damage occurs within them (Krause et al. 2020).

As aquaculture continues to advance as a major food-producing sector, the necessity for sustainable, ecologically, and socially sound practices, and responsible resource management becomes all too apparent. The promotion of simple tools, especially those adapted to the One Health approach, are vital. Such tools and techniques are needed in the earliest planning stages and should range from simple to advanced levels of planning. According to the Department of

Environmental Sciences at the University of Siena, "development of practical and validated tools is sorely needed in aquaculture."

Operationalization of One Health using Simple Tools

Operationalization of the One Health concept to facilitate collaboration among stakeholders focused on promoting consumption of seafood, while expanding aquaculture, can aid in minimizing risks to public, animal, and ecological health. Proactively considering and assessing concerns pertinent to aquaculture facilities, prior to their inauguration could decrease negative impacts. Reviews of existing facilities and retrospective analysis of failed enterprises from a One Health perspective can provide valid information to consider in planning new facilities. Interdisciplinary collaborations across fields of human, animal and environmental health are currently insufficient to meet the needs of the rapidly growing aquaculture industry. Additionally, assessing all pertinent One Health aspects is challenging due to the vast scope and depth of related matters.

An option to aid in assessing these multi factors prior to implementation of a new land-based aquaculture system, is the development of a rubric that prompts consideration of the many potential issues. A rubric is a common form of a rating scale utilized as an instrument of performance assessment. Both analytical and holistic rubrics exist and can be used in conjunction with other tools, such as checklists. Relevant concerns exist for employing any singular form of performance assessment, and strong evidence supports a multi-faceted approach (Rahman 2020). A rubric provides support for the user in assessing and articulating specific concerns for a proposal. The practicality and scalability of a rubric, in addition to the provocation of qualitative and real-world considerations, provide the basis that such a rubric can be valuable to the fabrication of a land-based aquaculture facility. Rubrics help directors construct consistent assessment parameters that can be used across operations, save time by serving as reference documents, provide opportunities for feedback, encourage blueprint component clarification, and establish stakeholder expectations (Machalaba 2018).

An example of a successfully employed rubric is the IASC Gender Marker, a tool that assesses, on a 0-2 scale, whether a humanitarian project is designed well enough to ensure that women/girls and men/boys will benefit equally from it or that it will advance gender equality in another way. (IASC. Gender Marker, 2011.) If the project has the potential to contribute to gender equality, the marker predicts whether the results are likely to be limited or significant. A similar effect can be obtained by the use of our rubric, especially when employed in a retrospective manner. Application of the rubric can contribute to improving the success and consistency in analyzing how well an aquaculture facility is encompassing One Health concerns.

Rubrics have been used previously in other agricultural systems such as beef and dairy cattle, goats, sheep, horses, swine, llamas, alpacas, with some publications as the Sustainable Agriculture and Food Systems Rubrics available through University of California Agriculture & Natural Resources (Doval 2020).

Building a One Health Tool for the Aquaculture Industry

With the goals of addressing issues linked to wellness, meeting societal needs, challenges in combating disease, conserving the ecosystem and public health, and promoting equity in aquaculture, efforts to enact a One Health centered tool were undertaken. Efforts to encourage strong and frequent collaborations between all stakeholders are dispersed throughout the drafting of the tool.

Experts and laypersons with substantial experience in aquaculture extension were implored to provide practical insight, often relying on real-life lessons learned, to improve upon the specificity for the industry. Trends evident in agricultural literature were analyzed and used to structure categories and organizational techniques. The formation of the tool to aid in assessment and articulation of elements of the expected venture was based on a variety of research papers, publications, presentations and valuable human insight.

Formulation and implementation of a rubric envisaged to be used by individual farmers, and corporate employees, brought together faculty from different fields of study, professionals from various One Health sectors, as well as private citizens. The tool was designed using resources from collaborative agricultural planning processes, and an emphasis placed on preemptive consideration rather than mitigation efforts, although they were not left out. It was determined that a simple rubric presented certain advantages over other types of tools such as checklists, guides, white papers, etc., due to its adaptability to blueprint size and phase (REF). Although it takes time to conscientiously review and complete a rubric, time will ultimately be saved in the long run as expensive complications can be avoided and a more streamlined pursuit embarked upon. Alternative and conjunctive tools that may aid in highlighting relevant considerations include checklists, guides, white papers, etc.

The Aquaculture Rubric: A Simple Tool

Considering the uses of rubrics in other areas and the need for simple tools to enable inclusion of One Health into planning, the rubric “One Health Considerations for Land-Based Aquaculture” was developed. It is arranged in three key One Health categories: 1) Cultural Competency, 2) Current or Projected Impacts, and 3) Mitigation or Development Strategies. Each category is aligned with human, animal and environmental concerns and prompts related to each are appended.

The development of the rubric was based on an extensive review of literature on successful land-based aquaculture systems as well as literature on ones that have failed or had negative impacts on the people or land in a region. Published rubrics that considered One Health in other types of projects were also used. Initially the rubric was designed with a generic agricultural system in mind, it was then tailored to incorporate specific and important nuances of aquaculture, and then more specifically land-based aquaculture. The rubric’s criteria were evaluated for necessity, relevance, and scope. User-friendliness was assessed through distribution of the tool to individuals without aquaculture knowledge for commenting.

The rubric was tailored to allow for a range of general to specific prompting of the user, e.g. a broader topic is presented such as *Impact on Various Demographics*, as well as *Role of Women* as a subcategory. Space was allotted for the description of actual and potential effects, in order to suggest a preemptive approach, and for strategy design. Focused questions were attached to the rubric to encourage consideration of pertinent topics that may fall outside of the rubric criteria that may facilitate initiatives.

Several experts in land-based aquaculture were also asked to review the rubric and provide feedback. The rubric was distributed to individuals for review via email, as well as discussed in-person at aquaculture themed conferences, namely the 2023 Northeast Aquaculture Conference & Exposition and the 42nd Milford Aquaculture Seminar. Aquaculture producers, habitat and ecosystem specialists, tribal society representatives, female aquaculture business owners and other stakeholders provided valuable feedback. Additionally, relevant coursework from Ross University School of Veterinary Medicine's Masters in One Health program, such as that included in VETPG140 One Health & Systems Approach, VETPG142 Research Project Design, VETPG146A Safety of Foods of Animal Origin and VETPG146C Animal Health Program Management, served as a guide for defining human, animal, and environmental considerations. The drafted product will be made publicly available.

The intended rubric user should be able to access the rubric by performing a simple internet search or being provided with a printed copy by a local agricultural or similar association during early project planning stages. The rubric could be translated into any language and would be most appropriately received in conjunction with information regarding local laws and regulations related to aquaculture.

The rubric user(s) should envisage the start-up or facility of interest in all stages from design to seafood production to marketing and complete as much information in the rubric prompts as possible. Some rubric segments may be fitting based on the setting and location, size, type (methodology and farmed species), etc., and should be modified according to the specific needs. The user(s) can modify the rubric to fit their specific needs.

The rubric is designed to aid in the communication of expectations and fundamentals of a project, raise awareness of potential setbacks, improve the initiation phases of land based designs, support working through complications in a timely and detailed fashion and as a mechanism to clarify intentions through organized communication. The essence of the rubric is intended to elucidate obstacles and can be modified by the user(s). It is intended to serve as a baseline and initiator of progress in planning using a One Health approach and be available to users of varying educational levels.

A Practical Tool: One Health Considerations for Land-Based Aquaculture Facilities

Facility Name: ____.

Location:____.

Planned/current fish species:____.

One Health Point Person(s):____.

One Health Areas	Current or Projected	Mitigation or Development Strategy
Cultural Competency		
Impact on Various Demographics (Role of Women)		
Impact on Religions and Traditions (Local Fishing Practices and Protected Areas)		
Continuing Education and Training (Professional Advancement Training)		
Geographic Region (Product Disbursement)		
Current Role/Dependency		

One Health Considerations for Land-Based Aquaculture Facilities pg___of___,

One Health Areas	Current or Projected	Mitigation or Development Strategy
Labor Availability		
Employment Creation (Diversity, Equity, Inclusion)		
Health & Wellness		
Potential for Zoonotic Disease (Collaboration with Local Physicians)		
Potential for Acute and Chronic Illness (Promotion and Prevention, including Physical and Mental Health)		
Impact on Occupational Health (Aquaculture-specific Safety Training, Handling/Exposure Zoonosis)		
Impact on Animals and Environment		
Impact on Land (Spatial Footprint)		
Impact on Air (Carbon		

One Health Considerations for Land-Based Aquaculture Facilities pg___of___,

One Health Areas	Current or Projected	Mitigation or Development Strategy
Footprint/Greenhouse Gas Emissions/Energy Consumption)		
Impact on Sea/Water (Disease and Farmed Stock Exposure)		
Waste Management Systems (Contained vs. Uncontained System)		
Potential for Antimicrobial Resistance (Litigious Use and Strict Containment/Prevention of Spillover)		
Potential for Vector Borne Disease (Flying Animal/Insect/Rodent/Pet Protection)		
Impact on Food Safety and Security (Contaminant and Pollutant Screening e.g. Bacteria and Heavy Metals)		
Impact on Animal		

One Health Considerations for Land-Based Aquaculture Facilities pg___of___,

One Health Areas	Current or Projected	Mitigation or Development Strategy
Welfare (Timely Disease Prevention and Treatment)		
Supplemental Food (Source/Supply)		
Integrative Farming (Additional Crops, Mono or Polyculture, Salt or Freshwater)		
Financial Sourcing and Management Practices		
Before (Planning/Construction Stages)		
During (Operational)		
After (Exit Strategy)		

Additional One Health Considerations:

- Who are the stakeholders (are they represented in facility plans)?

____

- Which experts (locals, naturalists, scientists, financial advisors, policy makers, etc.) should be contacted? Who will contact them and when?_______________

____

- What is the local political structure and how will this impact the facility?

____

- Are any government restrictions or promotions in place for the growth of specific species?

____

- Will a feasibility study be performed, if no-why not, if yes-how?

____

- How can a community input forum be fashioned? Who will initiate this, and when?

____

- How will this facility be regularly monitored from within the country/locally?

____

- What role can the media/news (local, regional, global) play?

____

- What will be an effective evaluation strategy (frequency, rigor, validity, sustainability)? How will it be determined if the venture has become a sustainable community-led social enterprise?

____

- What programs are in place to encourage empowerment, capacity building, democratic organizing, human rights education?

- What is the exit strategy for this production facility?
- What are the projected market trends?
- What facility security measures will be in place?
- What natural disaster or seasonal planning is advisable (flood, droughts, over-wintering, etc.)? Who can be consulted for an emergency contingency plan?
- What type of aquaculture system is utilized (extensive, improved extensive, semi-intensive, intensive)?

Discussion

User feedback and rubric evaluations are potential forms of data that can be used to determine support for the use of this multidisciplinary One Health rubric. Important factors of assessment should include ease of use, feasibility of dissemination, perceived level of confidence in the value of the rubric, and proof of the ability to apply One Health principles in aquaculture settings. Avoidance of aquaculture induced destruction, associated with industry demands, operational and managerial struggles, inequalities within the sector, damage to habitats, etc., can be studied through evaluation and comparison of ventures that are provided the rubric during planning stages in economically robust and newly industrialized countries. With a unique and strong interdisciplinary focus, this rubric provides an opportunity for forwarding sustainability and enhancing production in the aquaculture sector.

Concepts addressed in the rubric include a range of topics from natural resource management to zoonotic disease prevention. Operations that make use of our vital freshwater resources must consider the adverse impact on natural aquatic systems and the necessity of freshwater for other human needs. The quality of discharged water should reduce excessive chemicals and pathogens that adversely impact the environment. Biodiversity should be protected by preserving natural genetic resources and take place at every level from farm to continent borders. Production should aspire to be energy efficient and have a small spatial footprint compared to other food production systems. Protected areas and areas of traditional importance to humans should not be negatively impacted by the location of aquaculture systems. Incorporation of traditional cultural practices should be sought out.

The health and welfare of stock should be prioritized. This can be achieved through excellent biosecurity practices, efficient stocking and feeding strategies, decreased stressors, timely disease diagnosis, and treatment and other best practices. Chemical hazards should be reduced by ensuring that treatments are applied to cause a minimal adverse effect on the environment and surrounding biodiversity. Antimicrobial use should be minimized and the potential for spilling over to the surrounding environment, including wildlife and humans reduced. Prescription drugs should be regulated by the government and only used under the supervision of a veterinarian. More research is needed to better understand the mechanisms of disease in aquaculture species to ultimately reduce the need for intervention. The risk of zoonotic and environmental pathogen transfer to humans should be regularly assessed and reduced to preserve farmers' and public health. "Mixed species and multi-trophic systems should be used where possible which may be more ecologically stable. The population genetics of farmed animals should consider the potential impact of spillover to the natural environment, and disease resilience." (Saugh 2020)

Sustenance from aquaculture should be nutritious, free of contaminants, and affordable. Income and employment opportunities generated from aquaculture should aid in alleviating poverty in an equitable capacity while supporting the large businesses that back many operations. Aquaculture is poised in a unique position to create opportunities for women to work in and advance aquaculture. Arrangements that provide continued professional advancement and skill training to advocate sustainable aquaculture should be available.

Testing of the rubric in real-time will likely reveal shortcomings in its organization and content. Criticisms and accolades can be useful in its refinement. While the tool is intended to serve as an aid in laying foundational groundwork, it is likely that some parts of the rubric may not be applicable to all undertakings and its incorporation could prove difficult or unfulfilling. Future directions for this tool could incorporate components from other One Health sectors, tailoring of new tools for specific industry needs, and expansion into other field applications. Overall, the intent of the tool, and its endeavored use to endorse a One Health modus operandi contributes to the protection of human, animal, and environmental health.

Conclusion

Worldwide demand is driving rampant growth in the aquaculture industry as it provides half of the consumed seafood products. Advantages society reaps through aquaculture include a reduction in poverty due to expanding job opportunities, a decreased spatial and sometimes carbon footprint compared to wild capture fisheries, and the benefits purported to accompany bounteous seafood consumption. Still, there are sustainability challenges, apparent and hidden social justice issues, and animal welfare concerns below the watery surface.

In an array of diverse settings, the One Health concept strives to engage individual producers, government officials from various sectors, and extend an olive branch to larger corporations to collaborate in promoting the health and well-being of people, animals, and their shared environment. However ambitious the formal incorporation of One Health perspectives may be amongst all parties, accessibility and practicality remain hurdles to success. The implementation of One Health concepts in aquaculture requires international collaboration and cooperation by international agencies like the Food and Agriculture Organization (FAO), the World Organization for Animal Health (OIE), and the World Health Organization (WHO) as well as civilians. Appropriate tools and policies need to be in place, together with mechanisms for disease surveillance, reporting, capacity assessment, and emergency response. Societal demands for seafood must be balanced with the known risks of aquaculture practices to animal, environmental and human public health.

Reflection

Reflecting on the process of creating this One Health tool has identified successful portions of the project and areas for improvement. The formulation of a hypothesis appropriate for a mini dissertation was challenging. I was interested in several research topics and needed to investigate them further before concluding which would be most appropriate and manageable for this paper. I also wanted to avoid creating a redundant result, or the re-creation of work already widely available. Once a coherent idea was tweezed out from the brainstorming process, I had to define my project goals.

Based on the feedback from my advisor, Dr. Jennifer Ketzis, I defined the scope of this project and was then able to begin the writing process. In the initial planning process, I began to understand how a research question is formulated and how it must be matched with an appropriate situation for study. I also recognized that a more concise thesis would lead to a superior result with potential for future development, rather than a vague and potentially useless one. Narrowing my research focus also made the literature review process much more manageable. It slowly became apparent that my objective was to create something tangible and functional to improve how a stakeholder can incorporate a One Health perspective into land-based aquaculture facilities.

The literature review component of this dissertation was eye-opening. It was great to have a lot of research and information available on trials and tribulations on various aspects of land-based aquaculture. I can only imagine how difficult it would have been if aquaculture and One Health weren't popular research topics. The main ways it was helpful were in identifying knowledge gaps, providing the framework for the rubric, and identifying common trends in the aquaculture field, thus making it possible for me to link the two topics more seamlessly.

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