Final Report for the Business Oregon High Impact Opportunity Project:
Development of the Oregon Aquaculture Explorer Platform
January 28, 2022

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EXECUTIVE SUMMARY

In June 2019, Business Oregon approved a $431,246 grant to the Oregon Aquaculture Association to "develop the Oregon Aquaculture Explorer Platform." The project, with partners from VertueLab and Oregon State University, was implemented from July 2019 through December 2021[1]. Over the course of the project, the two principal outputs were achieved: design and piloting of the Aquaculture Explorer and, secondo, using this platform, assessing aquacultural opportunities with the Confederated Tribes of Siletz Indians. Both products along with some of their implications are discussed in the following report and its appendices. Based on results of a Peer review, Beta Testing, and a number of seminars describing the use of the toolbox that is the Aquaculture Explorer, this first-of-its-kind integrated planning instrument was found to be innovative and very useful for individuals wishing to invest in aqua farming as well as those existing operators considering expanding their farms. Moreover, the Platform proved to be a valuable starting point for undertaking the Case Study with the Siletz which resulted in a proposal whereby, initially, 100,000 pounds of fish and 160,000 pounds of vegetables could be produced for Tribal use—at tribal casinos and related facilities, at local food banks, or for sales to the general public. These successful outputs, however, underscore the need for Oregon to invest in a modern, user-friendly aquaculture program. The major barriers to such a program are an education gap among various segments of society as to their understanding of aquaculture accompanied by an equally important lack of political will. The wide-scale use of the Platform, effective outreach, and increasing investments by producers such as the Siletz Community could help address the first constraint. While these same actions will assist in addressing the second constraint, this will be best resolved by elaborating a comprehensive statewide aquaculture strategic plan that will provide the necessary guidelines for realistic expectations for costs and benefits from a broad-based, state-of-the-art program. The upgrade of the state program and the longer-term institutional sustainability of the Platform would also be facilitated by establishing an aquaculture innovation center in Oregon—initial planning for the Pacific Aquaculture Marketing and Innovation Center (PAMIC) being one of the unforeseen positive consequences of project implementation. Through whatever lens viewed, this project has confirmed the assessment that aquaculture is underdeveloped in Oregon and that considerable productive improvement is possible.

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A. Introduction and Background

Aquaculture[2] is a marginalized seafood-producing sub-sector in the US and in Oregon. While aqua farming is a fast-growing industry worldwide[3], nationally and statewide it attracts modest investment at best[4]. This situation exists in spite of Oregonian opportunities[5] and the fact that the State has determined that aquaculture represents food-producing systems with relatively small environmental footprints[6]. Additional history and details are provided in Appendix 1. Distilling all these facts into one overarching scenario, it can be concluded that: *although Oregon has an under-utilized resource base and an extensive market, and although more than half the seafood purchased by consumers globally is farm-raised,* ***the Oregon aquaculture program remains underdeveloped***. Furthermore, a *major reason for this lack of investment is a prevailing* ***knowledge gap***. Aquaculture is complicated and there are few site-specific references to guide investors and educate overseers.

The project proposal states the problem as being: "*Oregon is lagging behind other regions in the country and throughout the world in aquaculture. It lacks a source of vetted, Oregon-specific, easily-accessible, and user-friendly relevant information for entrepreneurs, investors, researchers, aqua farmers, food processors, and regulators that can support investment decisions, site selection, production planning and operations*." Accordingly, this document proposes the solution, and the project **objective**, as developing, "*A novel, open-access knowledge management and decision support system—a business planning model (sets of discrete relational data) to guide and stimulate investment in aquaculture in Oregon*."

To attain this objective, the project was designed to produce two **deliverables** (outputs): 1) *Oregon Aquaculture Explorer Platform*[7]—release 1 (alpha stage), and 2) *Prototype Siletz Case Study and Report*. The products for Deliverable 2 were subsequently modified (April 2021) to read: *Create a report on how aquaculture can generate income, food and jobs using specific locales and specific production methodologies as guided by the Explorer Platform. Present the report to the Siletz for their possible consideration. If possible, create a specific prospectus on the opportunity to produce an equivalent amount of seafood via aquaculture as is consumed by the Siletz*. Table 1 below describes the integrated structure foreseen for the Aquaculture Explorer Platform.

Table 1. The Aquaculture Platform as described in the project proposal.

Oregon Aquaculture Explorer Platform Features			
Web-based User Interface	Geospatial Information Module	Business Planning Module	Resources Library
• User-friendly interface for wide range of users including those frequently underserved • Navigation dashboard for analytical modules and resource library	• Geospatial analysis of climate, energy resources, water resources, land profile, relevant law/regulation, and proximity to supply chain and infrastructure	• Cost modeling of key drivers (feed, seed, energy, labor, transportation) • Scenario analysis • Pro forma financial modeling	• Vetted, Oregon-specific information resources • Case studies • Benchmarks • Stakeholder maps

[2] Broadly defined as the husbandry of aquatic plants and animals.
[3] https://www.fao.org/3/ca9229en/ca9229en.pdf
[4] https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Aquaculture/Aqua.pdf
[5] http://www.oregon.gov/ODA/shared/Documents/Publications/MarketAccess/AquacultureInvestment.pdf
[6] https://www.oregon.gov/deq/FilterDocs/PEF-Aquaculture-ExecutiveSummary.pdf
[7] In the present report, the terms "platform," "explorer," or "explorer platform" are used as synonyms for the Oregon Aquaculture Explorer Platform with full recognition that the overall Oregon Explorer Platform has a number of components over and beyond aquaculture.

The project was implemented through a contract with the Oregon Aquaculture Association (OAA) and subsequent partnerships with VertueLab and Oregon State University's (OSU) Institute for Natural Resources (INR), OSU Libraries and Press, and the OSU Coastal Oregon Marine Experiment Station. The project was active from July 2019 through December 2021 with terminal activities completed in January 2022. The project team was composed of ten specialists representing the partner organizations (specifics are available from the quarterly report archive).

B. Results and Outcomes

Both deliverables (major outputs) were accomplished. Details of activities undertaken in attaining these goals are discussed more in the following section. This section will review the outcomes and impacts from achieving the twin principal outputs.

As a notable and innovative achievement, Deliverable 1, developing the Oregon Aquaculture Explorer Platform, was accomplished[8]. This platform is an integrated toolbox intended to be used during the *pre-investment* stage of establishing a new aquacultural business or when expanding an existing aqua business. The tools include spatial and financial planning instruments that assist users in finding appropriate sites for aquacultural operations and then evaluating the financial feasibility of production at this site using a designated aquaculture system. An aquaculture system is defined as the marriage of a specific crop (organism) with specific production technologies. Systems could include growing channel catfish in ponds, rainbow trout in raceways, oysters on longlines, salmon in cages, or any of a myriad of other possibilities—it is estimated there are over 600 aquacultural crops, each with numerous production options opening the door to thousands of systems from which to choose. In the case of the pilot stage of the Oregon Aquaculture Explorer, three systems were chosen—tilapia in recirculating units (often called "RAS[9]," recirculating aquaculture systems), hybrid striped bass in earthen ponds, and sturgeon in RAS—a distinct toolbox and accompanying background information elaborated for each system. These systems were chosen based on a spectrum of factors relating to their appropriateness to Oregonian conditions—more information is available in Appendix 2. Appendix 3 outlines the Explorer interface and the products a user may obtain from the Platform.

Satisfactory fulfillment of Deliverable 1 has led to several positive impacts directly linked to the Platform:

1. SeaGrant /NOAA has funded a Phase II of the project[10]—this phase initiated in early 2021 and continuing through 2023.
2. The Oregon Department of Land Conservation and Development (DLCD) funded a "sister" component to the Platform, an estuary shellfish tool[11].

The Platform has also served as a catalyst to call attention to yet-to-be-achieved benefits from aquaculture. The functions of the Platform highlight both the challenges of aqua farming as well as the opportunities. The information generated through the different components of the Platform (Appendix 3) helps users understand that aquaculture is difficult but that it is also a set of food-producing systems that is heretofore underdeveloped in Oregon. This realization has called attention to the need to invest in and support more the state's aquaculture program. These catalytic effects resulted in setting-up a working group loosely linked to the project and OAA with the aim of planning an aquaculture innovation center for Oregon. This work expanded to include the three Pacific Coast states and to secure *$190,000 from USDA to plan the* ***Pacific Aquaculture Marketing and Innovation Center****—PAMIC*. PAMIC is an outcome of the increased focus on aqua farming derived from the well-publicized development of the Oregon Aquaculture Explorer Platform. PAMIC will be further discussed later in this report.

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[8] https://oregonexplorer.info/topics/aquaculture?ptopic=2

[9] https://ras-n.org/salmon-ras/what-is-ras/ or for more details, https://www.fao.org/3/i4626e/i4626e.pdf. When integrated with horticulture, called "*aquaponics,*" https://gogreenaquaponics.com/blogs/news/ultimate-aquaponics-beginners-guide

[10] https://seagrant.oregonstate.edu/feature/osu-receives-grant-inform-aquaculture-investment-oregon

[11] https://tools.oregonexplorer.info/OE_HtmlViewer/index.html?viewer=shellfishmariculture

Much as PAMIC planning benefited from the Platform, so did a number of local projects and wider regional linkages. These, perhaps to some extent unanticipated outputs, include:

i. A framework and alliance with the aquaculture programs of the starts of Washington and California.
ii. Aquaculture-related activities underway with the Klamath Tribes.
iii. Activities planned with the city of John Day and the Chamber of Commerce for Tillamook
iv. Outreach to other agricultural programs—specifically horticulture and viticulture
v. New planning efforts and projects with Oregon State University using the Explorer Platform

In the process implementing the activities that have led to the principal outputs as well as those that may have been unanticipated, the project began inventorying both individual stakeholders as well as aquaculture-related institutions or professional groups. These efforts have documented that the aquaculture sub-sector is diverse and larger than foreseen by many.

In regard to Deliverable 2, details of the work with the Confederated Tribes of the Siletz Indians will be discussed in Section D, below. In relation to outcomes and impacts from this portion of the project, it can be concluded that the work undertaken through the project was well-received by Tribal Leadership with activities are continuing into 2022 with a focus on ascertaining precisely how best the Siletz Community can invest in aquaculture in line with the proposals prepared by the project.

C. Activities: Completion of All Performance Measures

Progress toward performance measures was reported quarterly through the life of the project—any one of nine progress reports available upon request. All six elements (activity clusters) leading to the two project deliverables have been satisfactorily completed.

In regard to completion of activities, it may be helpful to review the products incorporated into the Platform—products that have been fine-tuned through comprehensive Peer Review and Beta Testing accompanied by feedback from multiple practical demonstrations to would-be users. These elements are discussed more in Appendix 3. However, to recap, from the Platform's landing page users can generate:

- ✓ An aquaculture site report for any point in the state of Oregon—the report providing the basic information necessary to evaluate a site for initial suitability for aqua farming
- ✓ A financial summary for start-up and operations costs
- ✓ An overall summary indicating estimated profit or loss along with all relevant details of the operation

The user can also access a library of Explorer-specific "articles and stories" pertaining to the Platform's functions as well as access a large volume of reports and publications through the Platform's links to library networks.

It is useful to spotlight that the project's activities have pointed out two potentially far-reaching issues where the Platform can play a pivotal role: (a) repurposing underused or abandoned infrastructure for aquaculture[12], and (b) using aquaculture practices to produce/reproduce organisms that are endangered and/or at risk of losing their natural habitat.

[12] This could be any of a variety of facilities including shuttered lumber industry plants or unused agricultural structures, https://www.seafoodsource.com/news/aquaculture/former-paper-mill-to-house-massive-land-based-salmon-farm-in-maine and https://www.northcoastjournal.com/NewsBlog/archives/2019/02/10/massive-fish-farm-proposed-for-pulp-mill-site-video

D. Siletz Case Study and Follow-up

This field work, guided by the Explorer Platform and serving as a practical example of the Platform's usefulness, consisted of a series of meetings and field visits with Tribal employees and members of the Siletz Community. The work was presented to the Tribal Council on December 17, 2021. The overall conclusions are that there are opportunities for initiating aquaculture enterprises at several sites—present efforts focusing on sites in and around the town of Siletz.

The work outlines the development of three sites in an integrated investment producing both fish and vegetables. While the precise implementation modalities are still a work in progress, it is likely site development would be undertaken sequentially with an estimate of initial annual yields of 100,000 pounds of fish and 160,000 of vegetables from the start-up activities while five to ten full- and part-times jobs would be created.

It is important to underscore that the investment environment has many unique and positive factors derived from having the primary investors being Tribal Communities—factors that, to a greater or lesser degree, apply to Tribal Communities across the state and more widely across the region.

These factors reflect an aggregate opportunity for these communities where the investments in aquaculture are not solely financial in nature, but also have significant social and educational benefits—this trifecta of advantages spreading the costs and the benefits over a wider base. Aquaculture activities could provide products for casinos and other retail outlets overseen by the Tribe. Moreover, products could also enter into existing social and nutritional safety net programs that assist vulnerable members of the community. And, building one component of the integrated operation in conjunction with a local school (or schools) will provide a high-quality teaching lab for a variety of subjects as well as potentially serve as a training ground for people to subsequently gain employment in local aquaculture industries.

Figure 1. Project team at Lhuuke Illahee Hatchery outside the town of Siletz

Follow-up activates will continue in 2022 with the support of the Council. This is planned to involve the establishment of a working group with members representing various aspects of the Siletz Community. With this group, the proposals submitted in 2021 will be reviewed. Where more information is needed, additional field work will be undertaken. The group will assess different implementation modalities including starting with a small pilot in the town of Siletz to demonstrate the technologies and products being proposed. The group will also evaluate different options for funding the investments. It is anticipated this work will result in some recommendations that will apply to Tribal Communities in general while offering specific and targeted guidance to the Siletz.

It is important to emphasize that successful production for any operator will rely heavily on marketing and market development. In a post-COVID setting, demand should increase and new markets for an increasing variety of farmed products emerge. Branding and market recognition will be important. Furthermore, as competition with imports is a critical concern, a "first-through-the-door" strategy will likely yield the best results where early adopters will be able to capture needed demand. With roughly only one-fifth of US adults consuming the recommended eight ounces of seafood per week, the potential market seems large[13].

[13] https://www.cdc.gov/nchs/data/databriefs/db321.pdf

E. Way Forward: Operationalizing and Promoting the Platform

Promoting and operationalizing the Platform really means promoting and operationalizing an *Oregon Aquaculture Program*. There are specific activities that can and have been tackled by the project as well as higher-level activities that are outside the scope of the project but that have significant influence upon the success or failure of aquaculture ventures (e.g., aquaculture regulations and legislation, public sector aquaculture staffing, etc.).

Actions initiated by the project fall in the general category of *outreach*. Outreach activities are organized to serve multiple functions; they inform about aquaculture as an important food-producing subsector, they highlight the opportunities and challenges for investing in aqua farming, and they present the Explorer Platform as an important toolbox available to interested parties—this including demonstrations of how to use the various tools incorporated into the Platform. These activities comprise the elements of an outreach strategy elaborated by the project for use not only by the project, but all engaged in aquacultural extension. An outline for an outreach strategy to support stakeholders is found in Appendix 4. More thoughts on a state program are presented in Appendix 6.

During the course of the project, a number of training or demonstrations sessions were organized for a variety of audiences from university graduate students to researchers and producers. These sessions were culminated by two sessions in January 2022, one for public sector stakeholders and another for stakeholders from the private sector[14]. These two activities constituted the official launching of the Phase I Explorer Platform.

A major project outreach activity, a final *conference*[15], has been postponed multiple times due to public health concerns. To optimize impact, this seminar is designed as an in-person event to demonstrate the Platform and otherwise provide information to encourage people to invest wisely in aquaculture in Oregon. With the funding of Phase II, this has become a combined Phase I/Phase II venture presently scheduled to take place in early fall 2022.

Project outreach activities have also been planned with the Oregon Lottery. A joint assignment, preparing a video showing the applicability of the Platform to expansion at a local fish farm, was initiated in mid-2021 but postponed due to, among others, pandemic effects. It is hoped this work can be revisited in 2022.

In addition to these outreach events undertaken by the project, the project also outlined a broader training matrix to accompany the Platform and to link with a wider audience through a variety of educational sessions planned through 2022/23 during Phase II of the project. This matrix is presented in Appendix 5.

An important part of fostering an environment to promote the Platform is strengthening Platform-related outreach through the OAA. To this end, the project assisted OAA in revamping and modernizing their website[16]. The project also served as an intermediary between OAA, the NOAA Oregon Aquaculture Office, SeaGrant, and OSU to coordinate web-based material to maximize complementarity while providing additional links to the Explorer Platform.

Throughout project operations, the project supported a part-time OAA Information Officer position to backstop outreach and support the Platform. At the end of service for the current project Information Officer, a parttime Outreach Officer will assist OAA through 2022, supported by project funds. Both these individuals are tasked with promoting use of the Platform and educating the public about the realities of aquacultural production.

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[14] The one-and-a-half-hour question-and-answer session on January 26th (2022) targeting the private sector comprised 20 participants including the project team. The mirror-image event on the 27th for the public sector regrouped a total of 24 individuals.

[15] With the shared resources of Phase I and Phase II, this is seen as a preeminent activity for actors, public and private sector, along the aquaculture value chain on the West Coast. Over a period of two days, with the Explorer Platform as the centerpiece, a variety of events are planned to evaluate and enhance investment in aquaculture.

[16] Revisions to the website include a variety of outreach services and mechanisms including the possibility for an on-line stakeholder forum to discuss the key issues affecting aquaculture investment.

The aforementioned PAMIC can also be a critical component in assuring the long-term use and maintenance of the Platform. When operative, the Center will provide a range of services to investors along the aquaculture value chain with a focus on the small- and medium-size operators—the same group that is a prime target for the Explorer Platform.

Concerning maintenance of the Platform, this is assured by INR through similar arrangements as employed for other components of the wider Oregon Explorer (https://oregonexplorer.info). While INR will handle maintenance, expansion of the toolbox to incorporate additional aquacultural systems is planned to take place through close ties between the Platform and graduate studies at OSU—graduate students undertaking class projects that add new systems to the toolbox. These tertiary-institution-Platform linkages may, through time, be extended beyond OSU. Mt. Hood Community College has an aquaculture program and have expressed interest in incorporating the Platform into their work. Similar arrangements may be applicable elsewhere.

A chronology for all these activities is rather challenging sine the Platform is not static. Existing data will need to be updated; new systems will need to be added. This technical work is not to be confused with the maintenance provided by INR. INR will assure the Platform is accessible and that it functions properly with its given set of data—this does not entail updating nor expanding. These latter technical tasks will, as described above, at least partially be accomplished through the incorporation of the Platform into the aquaculture curricula of tertiary aquaculture coursework.

This upkeep requires monitoring, and at times action. In the immediate term this will be provide by Phase II of the project through 2023. With concurrent planning for PAMIC, some long-term technical support could be built-into the Center's functions.

F. Implementation Challenges and Problems

The main challenge to the project was that this project was committed to doing something that had not been done before. While there have been spatial planning and financial planning tools for aquaculture, there has never been an integrated toolbox that links these two sets of instruments. It was a challenge finding ways to create the integrated tools and create them with enough built-in flexibility to be able to accommodate a number of disparate aquaculture production systems. This innovativeness includes the pre-investment orientation of the tools and the accompanying downloadable products such as site reports, financial spreadsheets, and technical fact sheets.

In terms of problems, COVID was the major problem as well as a challenge. The project had originally been designed to have a series of in-person activities from workshops and field visits to staff meetings. As work shifted to being completely on-line, adjustments were required. Nonetheless, needed adaptations were made and the project was able to operate in a new context of normal.

G. Conclusions and Recommendations

G.1 ***Potential for Oregon Aquaculture*** Conclusion: *There is a poorly-recognized yet significant potential for investment in aquaculture in Oregon—but these opportunities are complex and not without risk although they could also be a gateway to considerable profits and foster noteworthy economic growth*. Recommendations: (a) aquaculture opportunities need to be carefully assessed using the best available science-based information; (b) stakeholders need to be educated as to these opportunities; (c) state and local governments should be ready and able to assist stakeholders with "best choice" options.

G.2 ***Aquaculture Explorer Platform*** Conclusion: *The Platform has proven itself to be a valuable set of tools for guiding wise investment in aquaculture—to render maximum service, the Platform must have a solid institutional footing*. Recommendations: (a) the Platform needs to be expanded and strengthened through Phase II; (b) the medium- and longer-term institutional arrangements for the Platform need to be assessed including the possible advantages of building bridges between the Platform and PAMIC if and when the Center materializes.

G.3 ***Tribal Investment in Aquaculture*** Conclusion: *Tribal Communities appear to benefit from several comparative advantages when considering investing in aquaculture—through these, they could be catalytic to the broader state-wide program*. Recommendations: (a) with the approval of the Council, work should continue exploring the best options for the Siletz; (b) additional Tribal Communities should contacted to determine their interest in, and opportunities for investing in aquaculture; (c) for Tribal Communities and elsewhere aquaculture may be an important practice to assist in maintaining a presence of rare and endangered species.

G.4 ***General Investing in Aquaculture in Oregon*** Conclusion: *Large-scale investors will likely leverage the optimum positive impacts from aquaculture investments, both for the investors and civil society—however, in the absence of these laissez-faire ventures, a focus on small- and medium-scale operations integrated with other agricultural enterprise (e.g., horticulture and viticulture) will yield the best results*. Recommendations: (a) for investments of all scales, there will need to be a favorable operating environment including access to needed site-specific information (e.g., via the Aquaculture Explorer Platform) and inputs, unencumbered regulations, along with available skilled staff; (b) further market analyses should be undertaken as these will be crucial for the sustainable operations of small- and medium-scale operators; (c) efforts should be taken to review and potentially attract larger-scale operations; (d) repurposing of under-used or abandoned infrastructure for aquaculture can be an important option at many locales.

G.5 ***Building a Sustainable and Profitable Aquaculture Program*** Conclusion: *there should be a state aquaculture strategic plan—as part of this plan, an investment stimulator such as an innovation center is needed.* Recommendations: (a) all possible efforts should be taken to organize an inter-agency, public-private team to elaborate a state strategic plan; (b) part of this plan should include an innovations center such as PAMIC.

We would like to conclude by thanking our donors, our colleagues at Business Oregon and the Oregon Lottery, as well as the officers of the Oregon Aquaculture Association. We would like to thank all those who have worked hard on developing the Aquaculture Explorer Platform and the Siletz Study including those who have collaborated with our team to make this work possible and especially those who agreed to volunteer their time and energies to assist with the essential tasks of Peer Review and Beta Testing along with those who have devoted so much time to help us understand the opportunities available to the Confederated Tribes of Siletz Indians.

Appendices[17]

1. Aquaculture: Oregon and Beyond
2. Systems Selection and Considerations
3. Key Platform Components
4. Outreach Strategy and Support
5. Training Framework
6. Policy Implications

[17] The Appendices include further details on material covered above in the main body of the report. They also include material generated through the course of the project that impacts upon the sustainability of project outputs.

Appendix 1: Aquaculture: Oregon and Beyond

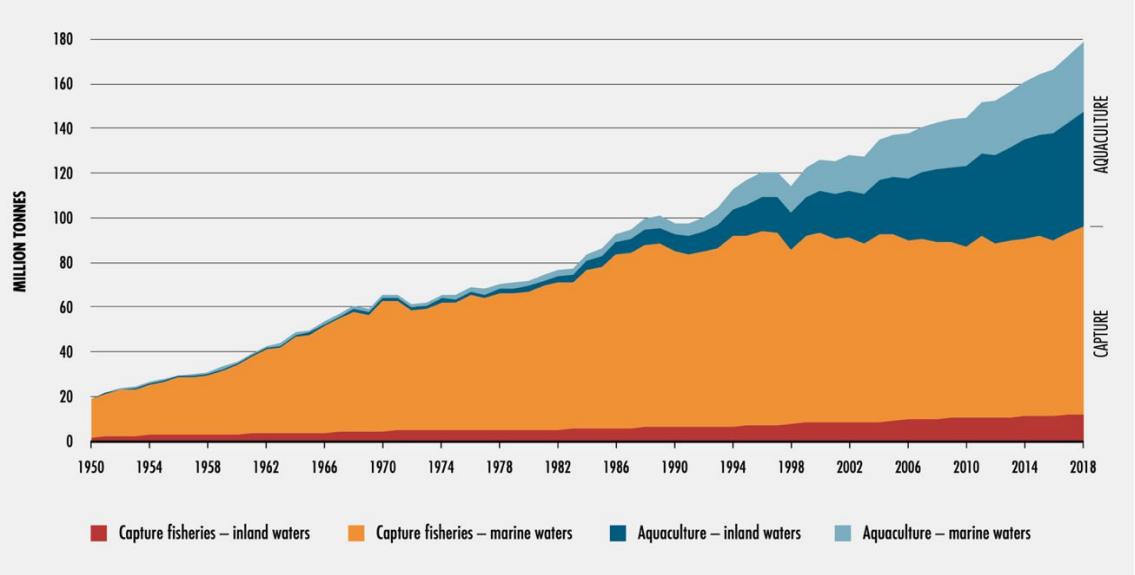
THE DISCUSSION BELOW DESCRIBES A SNAPSHOT OF THE AQUACULTURE PROGRAMS OF OREGON, THE PACIFIC STATES, AND THE US AS THEY RELATE TO THE BROADER WORLD AQUACULTURE INDUSTRY AND MARKET. THE US IS NOT A LEADER AMONG PEERS IN AQUACULTURAL INVESTMENT AND OREGON AMONG PACIFIC STATES IS ALSO NOT THE LEADER—RATHER THE STATE WITH THE SMALLEST AND LEAST DIVERSIFIED PROGRAM. THE OREGON AQUACULTURE EXPLORER PLATFORM PROVIDES SOME OF THE TOOLS TO FACILITATE THE TRANSFORMATION OF THE OREGONIAN PROGRAM INTO A MODERN, DIVERSIFIED, AND INTEGRATED SEAFOOD INDUSTRY. HOWEVER, IN ADDITION TO THE NEEDED TOOLS AND EXPERTISE, THIS TRANSFORMATION REQUIRES POLITICAL WILL AND AN INVESTMENT FORM THE PUBLIC SECTOR.

OVERVIEW: *Globally, as aquaculture increases its market share, the sub-sector is reaching critical mass—transforming from an esoteric, almost sideline conglomeration of activities into a structured body of specialized businesses and an important part of many economies and significant food production schemes. Through this transition to becoming a major actor, the technologies, economics, and impacts of aqua farming are evolving. But this transfiguration is not being applied equally across the globe. The United States still relies heavily on imported seafood and is not among the top aquaculture producers. Within the US, the Pacific states of California, Oregon, and Washington have relatively modest and uniform programs. There are efforts to enhance investment in the three states while, at the same time, diversifying farm-raised products to attract varied markets. The market is, moreover, a principal driver of the expansion of Pacific programs. And during what should otherwise be a period of growth, the worldwide surge of aquaculture has been curtailed by the impacts of COVID. Overall, the hoped-for expansion often relies on the introduction of products, technologies, and/or methodologies that are being produced or practiced in other parts of the country or the world—the adoption of these products, technologies, and methodologies often ecosystem based, following more ecological than political boundaries. Among Pacific states, Oregon remains with the smallest program—a monolithic program based principally on general oyster farming in several estuaries with little crop or technological diversification.*

Worldwide, aquaculture is one of the fastest growing food-producing subsectors, providing high-quality products to markets around the world. In the United States, in 2017, the aquaculture industry produced 313,000 tons valued at $1.5 billion and generating 1.7 million jobs—in 2017, the US was seventeenth in the world in terms of production (NOAA https://coast.noaa.gov/states/fast-facts/aquaculture.html). China, the number one producer, harvested 17,461,000 tons (FAO 2020).

According to FAO (2020), 52% of the seafood consumed by humans comes from farms. The World Bank (2013) estimates that aquaculture will provide over 60% of the world's seafood by 2030. The expanding importance of aquaculture has been foreshadowed for some time. In 1980, Congress declared "*... that aquaculture has the potential for reducing the United States trade deficit in fisheries products, for augmenting existing commercial and recreational fisheries, and for producing other renewable resources, thereby assisting the United States in meeting its future food needs and contributing to the solution of world resource problems. It is, therefore, in the national interest, and it is the national policy, to encourage the development of aquaculture in the United States."* (https://www.usda.gov/topics/farming/aquaculture). Through recent actions including but not limited to the *NOAA Blue Economy Strategic Plan 2021-2025*, the US government has increased support to the aquaculture sub-sector. Yet, according to some sources, the US still imports up to 90% of its seafood (National Fisherman 2018) and per capita consumption is roughly sixteen pounds per person compared to the global average of 45 pounds/person (Stastista).

Figure 1 : Seafood supply from capture fisheries versus aquaculture



Source: SOFIA 2020 (FAO)

US consumption is not only low, it is relatively homogenous, not representing the variety of products available on the world market (https://www.seafoodsource.com/news/supply-trade/us-seafood-consumption-rises-to-the-highest-level-seen-since-2007-but-falls-short-of-usda-recommendations). The Seafood Nutrition Partnership(https://www.seafoodnutrition.org) works to both increase political support for increased seafood consumption as well as to educate the population about the value of an improved seafood diet[18].

Seafood overall supply is not only affected by consumer preferences and consumption. Between 2000 and 2018 commercial fisheries landings fell by 15% (NMFS 2001, 2020). Moreover, since the onset of the COVID pandemic, seafood processors have lost many of their markets. Seafood sales to restaurants make up 60-80% of the sales from some processors—the impacts of COVID reducing or even closing these channels (West Coast Processors Association 2021). Increasing aquacultural production could, therefore, benefit processors as well as consumers[19].

However, given the volatility of both supply and demand as well as the costs inherent with farmed versus wild-caught items, effective marketing and market planning are essential for a successful operation. Identifying markets can be tricky and the necessary prerequisites of a suitable market plan can be a challenge for many would-be operators. There are guidelines available[20,21], but often the best choice is often an individualized approach that can address the nuances of each situation—a choice requiring access to such a service.

While international aquaculture development efforts in the 1970s and 80s focused on crafting and tailoring production technologies, there was a tipping point in the 1990s when the critical role of biotechnology was overtaken by economics—operations, large or small, needed to be sustainable and this generally meant profitable. Concurrently there was increasing awareness that the subsector would not achieve

[18] https://www.forbes.com/sites/margotwilsterman/2020/05/15/eat-seafood-america-a-campaign-to-increase-seafood-consumption-amid-a-national-meat-shortage/?sh=1796154262cd

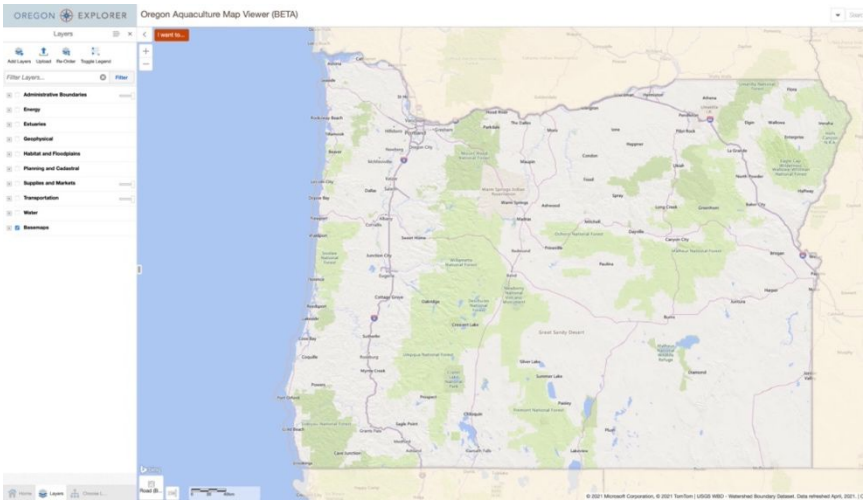
[19] https://www.googleadservices.com/pagead/aclk?sa=L&ai=DChcSEwi_3vyYnvLwAhV0CecKHSi_AHMYABA-BGgJwdg&ae=2&ohost=www.google.com&cid=CAESQOD23fR-tXfNCTZUN-pkiTDo8NBRC6Wyvg9hfqJNSZBuToTx1d3EUWD2KUe94cZ4DTogNg8Rxsu14ru75XtE1UZg&sig=AOD64_0JSm8dh8i-nvnA9k7grtZAddy2gg&q&adurl&ved=2ahUKEwiYqfOYnvLwAhXFi54KHfjxDjoQ0Qx6BAgDEAE&dct=1

[20] https://aquaculture.ca.uky.edu/sites/aquaculture.ca.uky.edu/files/srac_350_small_scale_marketing_of_aquaculture_products.pdf

[21] https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1012&context=ncrac_techbulletins

needed levels of adoption without social license. The developmental pathway led to present paradigm where aquaculture must be technically, economically, and socially sound while recognizing the fact that most often successful operations are market-driven. Unsurprisingly, it is now understood that aquaculture is multidimensional—all aspects requiring attention if viable programs are to be sculpted[22].

As an acknowledgement of the complexities in developing a viable multifaceted program, in 2019 the State of Oregon funded the project: *Development of the Oregon Explorer Platform*. This set of activities elaborated an open-access on-line toolbox to assist investors during the pre-investment stage in financial and spatial planning. These tools are based on aquaculture system options (a system being the combination of the organism and the production technology)—highlighting areas with suitable ecologies, economies, and regulatory frameworks to support a designated system and then outlining the requirements for such an operation such as land area, water availability, production inputs, and capital while making rough estimates of profit or loss. Phase I State support ends in 2021 and a Phase II through 2023 has been funded by NOAA/Seagrant (*The Aquaculture Explorer Platform: Integrated Spatial-Financial Tools to Catalyze Aquaculture Investment*).



The Explorer Platform hopes to guide investors while reducing the aquaculture education gap—this rift having been identified as a major impediment to a better understanding of and expanded investment in aqua farming[23]. However, to use the platform effectively, some basic information is needed. This is encapsulated in the questions, "What can I sell and how do I raise it?" The relatively monolithic nature of many of the aquaculture programs in the Pacific Region means that the answer to this question is currently not readily available. There are many choices with only a subset being highly applicable to the markets and environments of the Region.

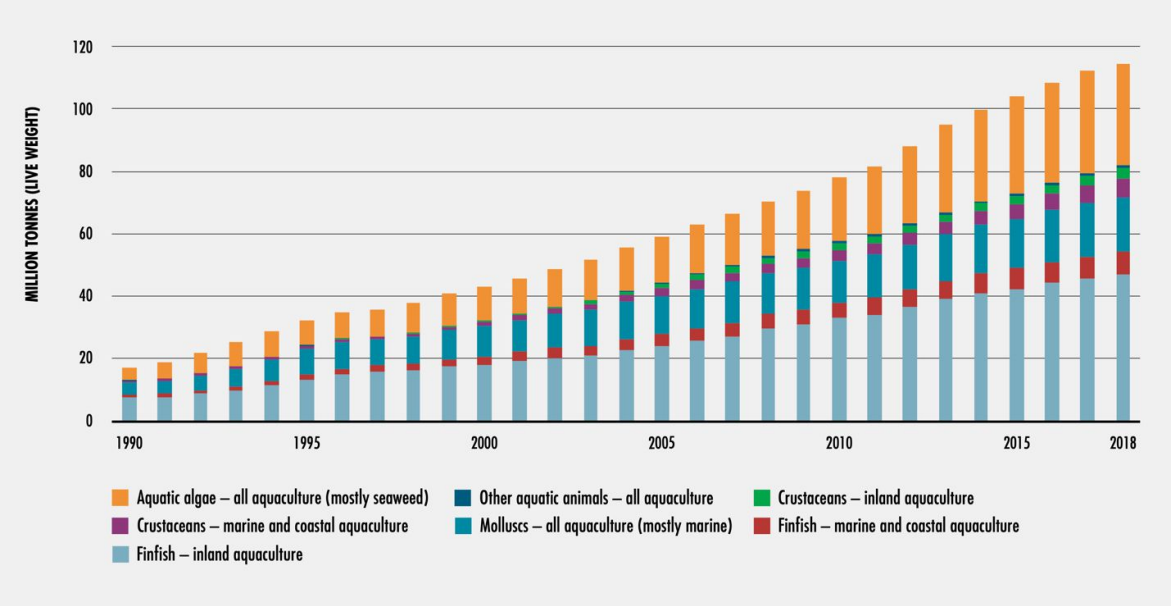
More than 600 aquatic species are cultivated around the world (UN 2016)—these fall into several general categories, Figure 2 below. However, the Pacific states have been focusing on deep-rooted practices and crops. Traditional husbandry by native peoples goes back centuries while more structured propagation dates to the 1800s. The object of this attention has typically been and continues to be salmonids and oysters (USDA/APHIS 1995).

A subgroup of the broader population of aquaculture crops is appropriate for the Pacific Region. Table 1 below reflects some of the important farmed crops in the US and indicates a possible sample of those crops for consideration in the Region—others still to be identified.

The crops/organisms in the table below are grown in a collection of production systems with many shared methodologies. In general, aquaculture involves retaining a volume of water in which the crop is raised. The main variable is the degree of control—the water can be static or flowing, the medium can be that of the ambient environment or manipulated, the organisms can be fed or rely on natural nutrition. Regardless of the specifics, most water farming takes place in earthen ponds, concrete raceways, fiberglass (or similar) tanks, on longlines, or in cages. Thus, with a large number of crops and relatively few production methodologies, there are numerous commonalities between crop production systems.

[22] http://www.fao.org/3/i3363e/i3363e.pdf
[23] https://www.oregon.gov/ODA/shared/Documents/Publications/MarketAccess/AquacultureInvestment.pdf

Figure 2: Composition of crops constituting the global aquaculture program



Source: SOFIA 2020 (FAO)

Table 1: Number of farms raising specific crops

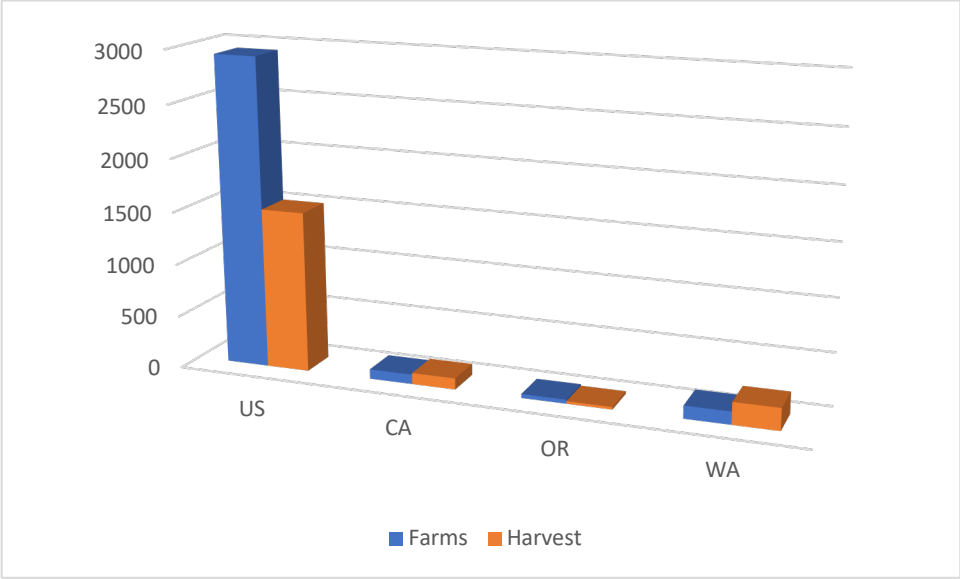
Crop/organism	US	California	Oregon	Washington
Hybrid Striped Bass	62	4	0	0
Catfish	531	35	3	0
Yellow Perch	65	0	0	0
Sturgeon	18	7	0	0
Tilapia	137	9	0	0
Trout	334	15	15	9
Large Mouth Bass	195	17	4	0
Walleye	42	0	0	0
Freshwater Shrimp	13	0	0	0
Marine Shrimp	39	0	0	0
Clams	312	0	2	79
Mussels	33	7	0	6
Oysters	701	17	15	86
Algae	189	1	0	0
Value of total harvest ($)	1,515,680,000	106,031,000	23,668,000	207,685,000
Total number of farms	2,932	91	38	121

Source: USDA 2018 Census of Aquaculture (2019)

Aquaculture has a few other unique aspects. Fish are efficient feed converters (https://www.aquaculturealliance.org/what-we-do/why-it-matters/). Aquaculture can be good for the environment (https://blog.nature.org/science/2019/01/21/aquaculture-could-be-conservations-secret-weapon/) and even facilitate water and land conservation (https://www.theguardian.com/sustainable-business/2016/may/31/california-drought-fish-farming-water-crops-agriculture-southwest, https://www.pnas.org/content/pnas/115/20/5295.full.pdf , https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.666.4320&rep=rep1&type=pdf, http://www.fao.org/3/AB412E/ab412e07.htm).

Figure below indicates the magnitude of the Pacific Regional programs by state vis-à-vis the national program with regard to the number of farms and the total value of the harvest. In the aggregated, the three Pacific states contribute 22% of the value of the national harvest and only nine percent of the total number of aqua farms across the country—two-thirds of the farms in the three-state area devoted to the long-time crops of oysters and trout.

Figure 3: Size in terms of value of harvest ($ 000,000) and number of farms for the three Pacific states versus the national program



Source: USDA 2018 Census of Aquaculture (2019)

Distilling the trends:

- Worldwide, aquaculture is a high-growth sub-sector with potentially positive economic, ecological, and health impacts;
- However, US production and consumption are low and there is a trade deficit due to a significant reliance on imports;
- The Pacific Region, with many markets and probable comparative advantages, appears to be under-investing in aqua farming—a much more diversified and integrated program appropriate for many areas;
- With increased aquaculture investment, as hopefully the pandemic lessens, there are opportunities to resuscitate supply channels, possibly with more varied products, while increasing per capita consumption and reducing the trade deficit; and
- To optimize the impact of the sub-sector, there is a need for coordination, education, and adjusting existing technologies and methodologies for the Pacific Region.

Appendix 2: Systems Selection and Considerations

THE PROJECT ELABORATED A PROCESS TO IDENTIFY THE BEST THREE PILOT AQUACULTURAL SYSTEMS. WHILE THIS METHODOLOGY WAS APPLIED TO THE THREE SYSTEMS TO PILOT ON THE ONSET OF AQUACULTURE EXPLORER ACTIVITIES, THESE SAME MODALITIES CAN BE UPDATED AND SUED TO CHOOSE SUBSEQUENT SYSTEMS FOR INTEGRATION INTO THE PLATFORM.

Three piloted models:

I. Tilapia in recirculating system (RAS)
II. Sturgeon in RAS
III. Hybrid striped bass in earthen ponds

These choices and activities were based activities on the following assumptions:

- Pre-investment systems selected should represent real options for Oregon farmers
- Systems "known" to the marketplace and/or regulators should receive special attention
- Systems will "fit" within the existing structure with minimal fine-tuning
- Rules of Thumb can be found to apply to all selected systems

Within the context of the above, the work was further focused on:

1. Focus on land-based systems
2. Target food-producing systems
3. Concentrate on systems where information is available
4. Concentrate on systems fitting within the prevailing regulatory environment
5. Weigh complex vs. simple systems (scenarios)

The above reflects the decision-making processes undertaken in Phase I.

Numerous options were considered before choosing the three pilot systems. Table 1 lists 24 options for culture organism as well as eight options for production methodologies--accordingly, 192 possible systems. While this list is far from comprehensive, and can be easily adjusted by our group, we need to select the 10 "best" systems for our work. Table 2 uses the same 192 systems, providing assessments of available information, perceived regulatory difficulties in raising, as well as history of use in Oregon.

The highlighted criterion/parameters are those from Phase I that can be transposed to Phase II. Tables 2 and 3 (below) provide indicative catalogues of aquacultural systems that could be suitable for integration into the Platform in Phase II.

Table 1

	Species/crops →	Recirculating	Pond	Geothermal	Flow Through	Cage	Suspended	Plats	Pump Ashore	☜ Production Methods
1	Tilapia	❊	❊	❊	❊	❊				
2	Hybrid Bass	❊	❊		❊	❊				
3	FW Shrimp	❊	❊	❊	❊					
4	SW Shrimp	❊	❊		❊				❊	
5	Sturgeon	❊	❊		❊					
6	Abalone				❊		❊	❊	❊	
7	SW Bivalves	❊			❊				❊	
8	FW Bivalves	❊	❊		❊		❊			
9	Other Molluscs	❊			❊		❊	❊	❊	
10	SW Algae	❊			❊		❊		❊	
11	FW Algae	❊	❊	❊			❊			
12	Trout	❊	❊		❊	❊				
13	Yellow Perch	❊	❊		❊	❊				
14	Walleye	❊	❊		❊	❊				
15	Baramundi	❊			❊					
16	Catfish	❊	❊		❊	❊				
17	Sacramento Perch	❊								
18	Carp (Chinese)	❊	❊	❊	❊	❊				
19	Black Cod	❊							❊	
20	Rock Fish	❊							❊	
21	Flounder	❊							❊	
22	Salmon	❊	❊		❊	❊			❊	
23	Other Crustaceans	❊	❊	❊	❊				❊	
24	Echinoderms	❊							❊	

N.B .: The "❊" indicates an approximation of which production methodologies correspond to which species/crops.

Table 2

	Species/crops ➔	Recirculating	Pond	Geothermal	Flow Through	Cage	Suspended	Plats	Pump Ashore	☚ Production Methods
1	Tilapia	❊	❊	❊	❊	❊				
2	Hybrid Bass	❊	❊		❊	❊				
3	FW Shrimp	❊	❊	❊	❊					
4	SW Shrimp	❊	❊		❊				❊	
5	Sturgeon	❊	❊		❊					
6	Abalone				❊		❊		❊	
7	SW Bivalves	❊			❊		❊	❊	❊	
8	FW Bivalves	❊	❊		❊		❊			
9	Other Molluscs	❊			❊		❊	❊	❊	
10	SW Algae	❊			❊		❊		❊	
11	FW Algae	❊	❊	❊			❊			
12	Trout	❊	❊		❊	❊				
13	Yellow Perch	❊	❊		❊	❊				
14	Walleye	❊	❊		❊	❊				
15	Baramundi	❊			❊					
16	Catfish	❊	❊		❊	❊				
17	Sacramento Perch	❊								
18	Carp (Chinese)	❊	❊	❊	❊	❊				
19	Black Cod	❊							❊	
20	Rock Fish	❊							❊	
21	Flounder	❊							❊	
22	Salmon	❊	❊		❊	❊			❊	
23	Other Crustaceans	❊	❊	❊	❊				❊	
24	Echinoderms	❊							❊	

N.B.: Colored cells around the "❊" estimate the possible level of information available--green for considerable, pinkish for some and light grey for little. No coloration indicates no advance knowledge of possible information availability. In the species' column, lighter highlights are for possibly problematic species, darker highlights are for species with more likely challenges. In the number's column, dark highlighting is for species/crops that have been or are being grown in Oregon.

Geographic Structure

Given the large volume of POSSIBLE data, it MAY be beneficial to taper the depth of the data--i.e., more detail at different locales?

One possible configuration could be:

ZONE 1 = entire state

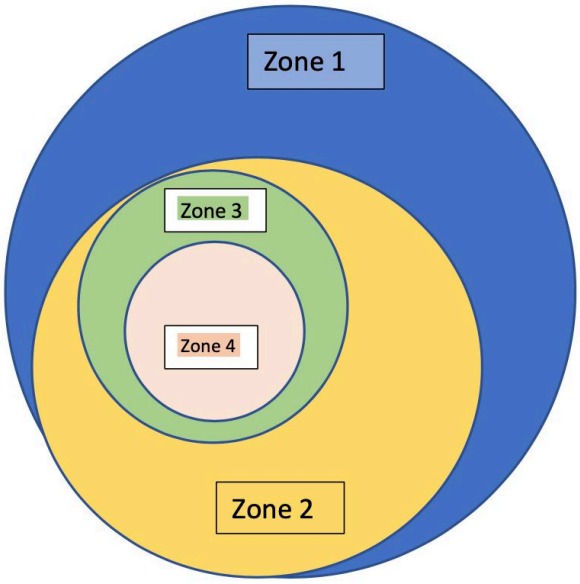
- Watersheds
- Population Density
- Infrastructure (transport)
- Energy
- Regulations
- Rainfall/temps
- Surface waters
- Georeferenced input suppliers, processers, operators and repurposing projects

Zone 2 = subset of state (e.g., specific Regional Solutions' Area or zoogeographic zone)

- Species distribution
- Water rights
- Land/water use
- Soils
- Elevation/insolation

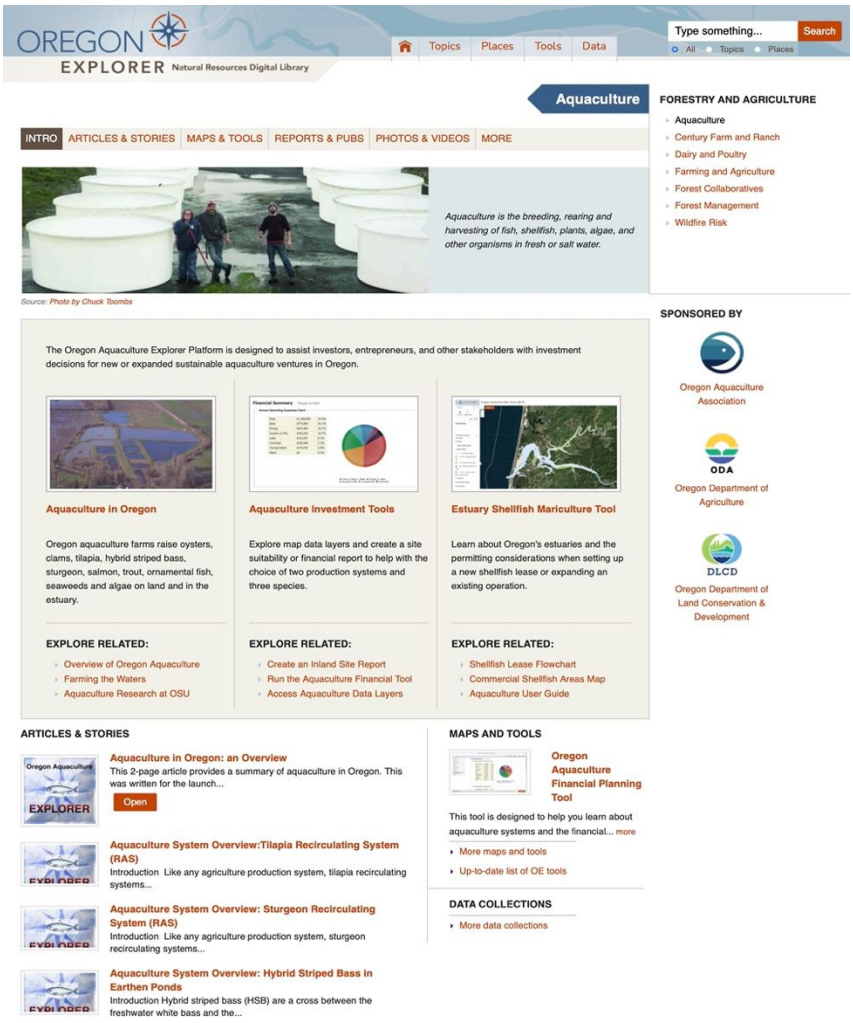
Zone 3 = Pilot systems (all results)

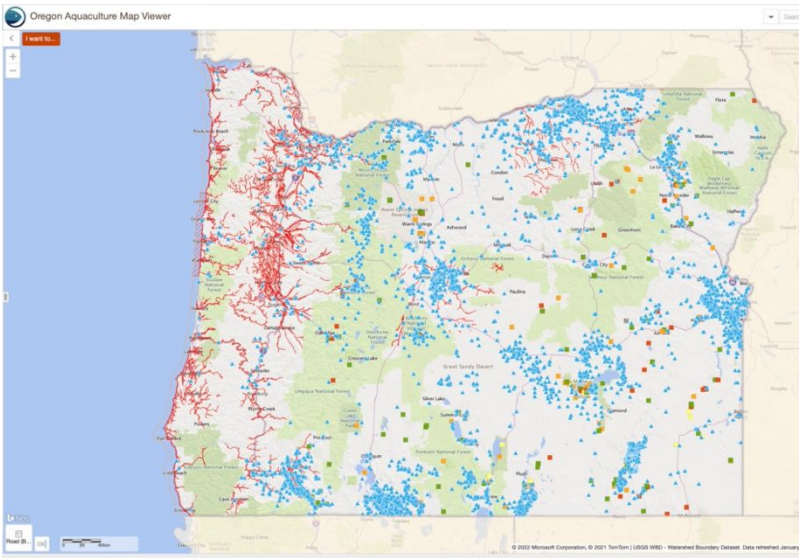
Zone 4 = Case studies (all results)



Appendix 3: Key Platform Components

THE OREGON EXPLORER PLATFORM IS AN INTEGRATED AND DYNAMIC SET OF TOOLS TO ASSIST POTENTIAL AQUACULTURE OPERATORS IN EVALUATING INVESTMENTS INCLUDING EVALUATING THE PHYSICAL POTENTIAL OF A SITE AS WELL AS THE PROFIT POTENTIAL OF A CHOSEN FARMING TECHNOLOGY AND CROP (ORGANISM). THE ENTRY POINT IS THE **LANDING PAGE** (FIGURE TO THE RIGHT) WHICH GUIDES USERS TO VARIOUS TOOLS AS WELL AS TO A VARIETY OF INFORMATION SOURCES INCLUDING A NUMBER OF DOWNLOADABLE PRODUCTS[24]





TO THE LEFT IS AN EXAMPLE OF THE INFORMATION AVAILABLE THROUGH THE MAP VIEWER DATA LAYERS. THIS EXAMPLE SHOWS THE LOCATIONS OF GEOTHERMAL WELLS AND SPRINGS AS WELL AS THE AREAS SUBJECT TO HUNDRED-YEAR FLOODING.

[24] The landing page can be found at https://oregonexplorer.info/topics/aquaculture?ptopic=2

Site report for a location near St. Helens, Oregon

Oregon Aquaculture Site Report

Report Generated: January 9, 2022 05:20 PM Date last updated: June 24, 2020

Latitude / Longitude 45.8764 N -122.8088 W

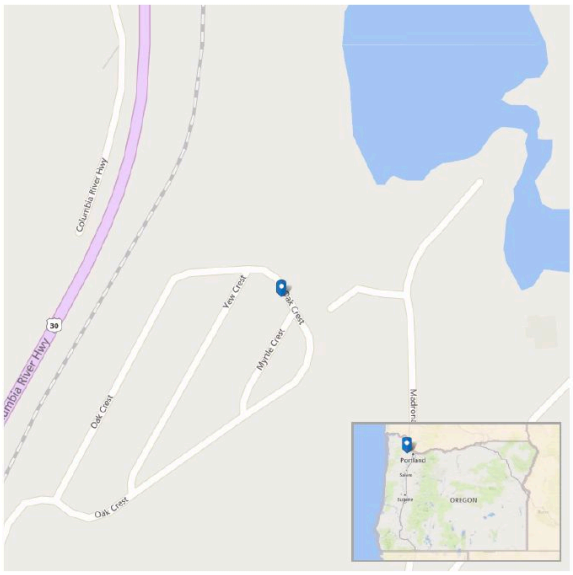
INTRODUCTION

Finding the right location for an aquaculture investment is a critical decision. Like all agriculture, location choice will significantly influence production and marketing opportunities. Financial success will be impacted by such variables as proximity to markets, regulatory and political environments and the geophysical environment which includes the characteristics of land, water and energy resources. These site characteristics, together with the skills and abilities of the operator, will inform the choice of production system, species and markets. It is imperative that potential aquaculture investors thoroughly research and understand these site-related issues before making any business and investment decisions.

YOUR LOCATION

Zoning and Ownership

Zoning:	**Medium Low-density Res.**
Land Ownership:	**Private**
County:	**Columbia County**
City:	**St. Helens**
Urban Growth Boundary:	**Yes**
Land Cover:	**Developed, Medium Intensity**
Protected Area? (GAP Status 1 or 2)	**No**



Zoning and land ownership rules must be taken into account when making aquaculture investment decisions. Oregon has a high proportion of public land owned by municipalities, state and federal government. The rules associated with zoning and ownership will determine whether aquaculture may be an allowable use on a specific parcel of land as well as possibly limiting choice of species, systems, and water use.

Geophysical

Avg. Annual Precipitation:	**42"**
Slope:	**11%**
Elevation:	**84 ft**

The geophysical characteristics of a site are critical in determining potential aquaculture success. For example, each species has an optimal temperature, and this will influence the energy required to heat or cool the water to meet production requirements.

	January	February	March	April	May	June	July	August	September	October	November	December
Average Minimum Temperature (°f)	35	35	38	41	46	51	55	55	50	43	39	34
Average Mean Temperature (°f)	41	43	47	51	57	62	67	68	63	54	45	39
Average Maximum Temperature (°f)	47	51	56	62	68	73	80	82	76	64	52	45

All aqua farming systems will require inputs such as feed and seed. Where these markets are located will impact supply availability and transportation costs. Location of processors and choice of retail markets will influence marketing,transportation, and sales costs.

Markets and Suppliers

Distance to Major Market:	**29.2 miles (Hillsboro)**
Distance to Feed Supplier:	**577.3 miles (Rangen Inc)**

REGULATORY CONSIDERATIONS AND INSTITUTIONAL SETTING

Water and Energy

Closest Water Right	
Distance:	**1.9 miles**
Type:	**SW**
Volume (max rate cfs):	**0.035**
Use Code Description:	**INDUSTRIAL/MANUFACTURING USES**
Within 1 mile of a Water Quality Limited Stream?	**No**
Watershed	**Beaver Creek-Frontal Columbia River (1708000304)**
Basin	**Lower Columbia (170800)**
Distance to transmission line:	**0.2 miles**
Direct Normal Irradiance:	**3171 watt-hours/m2/day**

Habitat and Floodplain

Within 100 year floodplain?	**No**
Within 500 year floodplain?	**No**
Within 1 mile of Essential Salmonid Habitat?	**No**
Within Critical Habitat for Threatened and Endangered Species?	**No**

Regulations and environmental issues associated with local natural resources including water, energy, irradiance, flooding, wild fish, and critical or endangered species must be evaluated as part of the siting and business planning process. Rights to adequate water supplies and access to energy will impact business decisions. Low lying areas may be prone to flooding or located in watersheds with native species, especially salmonids. In these cases, aquaculture choices such as species and production systems may be limited. While all sites are subject to prevailing legislation and site-specific regulations, operators may also wish to select sites where there is proactive support from municipalities, legislatures, and colleges that provide extension and research support. Oversight for, and support of, aquaculture activities can involve all levels of government including local, state and federal. It is important for the investor to have knowledge of relevant agencies and entities with oversight responsibilities.

ADDITIONAL RESOURCES

DEQ Wastewater Permit Database: https://www.oregon.gov/deq/wq/wqpermits/Pages/Wastewater-Permits-Database.aspx
DEQ Ambient Water Quality Monitoring System: https://orwater.deq.state.or.us/Login.aspx
OWRD Near Real Time Hydrographics Data: https://apps.wrd.state.or.us/apps/sw/hydro_near_real_time/
Watershed Councils: https://www.oregon.gov/oweb/resources/Pages/Watershed-Councils.aspx
OSU Extension: https://extension.oregonstate.edu/
Oregon Prospector: https://www.oregonprospector.com/
Oregon Biodiversity Information Center Rare Species Data Requests: https://inr.oregonstate.edu/orbic/data-requests

OREGON AQUACULTURE ASSOCIATION

Oregon Explorer Aquaculture Resources:
https://oregonexplorer.info/topics/aquaculture
Oregon Aquaculture Association:
http://www.oregonaquaculture.org/

OSU Oregon State University Libraries

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https://tools.oregonexplorer.info/OE_HtmlViewer/Index.html?viewer=aquaculture

Financial Report for a RAS Tilapia operation producing 890,000 pounds of fish yearly

Oregon Aquaculture Financial Planning Summary

Scenario 1: Tilapia in RAS

Report Generated: January 9, 2022 05:23 PM

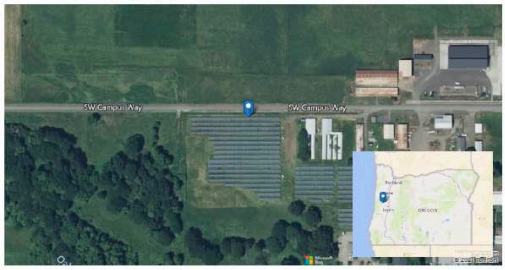
Aquaculture Pre-Investment Scenario for Tilapia in Recirculating Aquaculture Systems (RAS)

(based on inputs and calculations from the Oregon Aquaculture Financial Planning Tool)

FACILITY LOCATION & FINANCIAL SCENARIO SUMMARY

SW Campus Way, Corvallis, Oregon, 97331

Lat/Long: 44.57, -123.30



ANNUAL expense	$4,257,856
ANNUAL revenue	$4,688,250
ANNUAL Net Gain/Loss without Loan Financing	$430,394
Gross Profit Margin Ratio (Profitability %)	9%

SYSTEM, SPECIES & PRODUCTION METHOD

Tilapia in Recirculating Aquaculture Systems (RAS)

As with all aquaculture operations, tilapia recirculating systems require capital, land, and water resources. Critically, in addition to these, the firms require market resources. For many operators, the starting point is the market. It is certainly necessary to identify and evaluate your market before you do anything else. Determining the amount of product needed to address existing demand will allow you to get a clearer view of what the other resource requirements will be. Investors are strongly encouraged to use this "MARKET FIRST" approach.

For tilapia, temperature is a crucial factor. For this reason, the seasonal temperatures at the farm site are important. This will indicate the differential between the external temperature and the temperature required to raise tilapia. As tilapia nearly always require temperatures above normal ambient external conditions, to ensure good growth, tank water must be heated or the entire building much be heated. This heating requires energy and the greater the difference between the external and internal temperature the more energy required.

Tilapia

Tilapia is an introduced tropical species, the lower and upper lethal temperatures are 11-12 °C and 42 °C, respectively, while the preferred temperature ranges from 31 to 36 °C. It is an omnivorous grazer that feeds on phytoplankton, periphyton, aquatic plants, small invertebrates, benthic fauna, detritus and bacterial films associated with detritus. Sexual maturity is reached at an age of 5-6 months. Spawning begins when the water temperature reaches 24 °C. Egg number is proportional to the body weight of the female. A 100 g female will produce about 100 eggs per spawn, while a female weighing 600-1 000 g can produce 1 000 to 1 500 eggs. A common production level in raceways is 10 kg/m3/month. In recirculation units, levels range from 60 to 120 kg/m3 of rearing tank volume.

Recirculating

These units involve nearly complete control by the operator (e.g., temperature, water quality, space all controlled). They reuse water, circulating it through tanks and then filtering to remove solid and some dissolved wastes. They require some freshwater additions daily; ranging from over 30% of the overall volume to less than 5%. These units are expensive, with costs varying on the complexities of the filtration and water quality control features. These units also use more energy than most other production methods. Units can be managed from low intensity to very high intensity; costs and risks increasing with intensity.

Aquaculture Pre-Investment Scenario for Tilapia in Recirculating Aquaculture Systems (RAS)

(based on inputs and calculations from the Oregon Aquaculture Financial Planning Tool)

PRODUCTION

Production Targets

Market size (lb)	1.0 lbs
Target annual production	893,000 lbs

Production Resources

Space required	26,440 sq ft
Building required	41,643 sq ft
Land required	1.002 acres
New water required	48 gal/minute
Flow rate required	95 gal/minute
Total system water volume	684,633 gallons
Harvests per year	2.00
Space available	_____
Building available	_____
Land available	_____
New water available	_____
Max flow available	_____
Average tank depth	4.5 ft

Assumptions & Calculations

Average months to harvest	6.0 mos
Harvest weight	446,500 lbs
Carrying capacity	0.75 lbs/gallon
Production water volume	595,333 gallons
System / production ratio	1.15 ratio
Replacement water	10%
Refill time	5 days
System water surface area	20,338 sq ft
Space size ratio	1.3 ratio
Building size ratio	1.05 ratio
Land size ratio	1.1000 ratio

STARTUP

Startup costs

Cost of land per acre	$2,500
Building cost	$100,000
Water supply cost	$20,000
One-time startup permitting cost	$25,000
Additional startup costs	$0
Land cost	$2,505
Equipment cost	$1,339,500
Engineering / construction cost	$750,120
Other startup costs	$223,250
TOTAL startup cost	$2,460,375

Supporting startup cost calculations

Equipment cost ratio	1.5 $/lb
Engineering / construction cost ratio	0.84 $/lb
Other startup cost ratio	0.25 $/lb

TRANSPORTATION

Transportation Calculatated Inputs

Miles to market	1 miles
Miles to feed supply	632 miles
OTHER Transportation cost	$0
Product pounds	893,000 lbs
Product pounds plus ice	1,339,500 lbs
Feed pounds	1,160,900 lbs
Total feed product shipping cost	$344,834
Total product shipping cost	$496
Total Transportation cost	$345,330

Transportation Parameters

Feed shipping cost per ton mile	0.94 $/ton-mile
Product shipping cost per ton mile	0.74 $/ton-mile

OPERATING

Operating Costs, Revenues, and Profits

Product price	$5.25
Lease	1,000 $/month
Feed price	0.50 $/lb
Seed price	0.35 $/unit
Water treatment cost	0.05 $/gal/day
Water price	70 $/acre-foot
Contingency	10%
Overhead expense per month	$7,442
Labor expense per month	$17,116
Feed expense per month	$48,371
Seed expense per month	$28,650
Water expense per month	$445
Water treatment expense per month	$102,695
Oxygenation expense per month	$3,721
Energy expense per month	$25,912
Supplies/Misc expense per month	$14,883
Transportation expense per month	$28,778
Contingency expense per month	$30,779
Total MONTHLY expense without contingency	$307,791
ANNUAL expense prior to operating loan	$4,062,840
Operating loan interest rate	6.0%
Operating loan annual expense	$195,016
ANNUAL expense including operating loan	$4,257,856
ANNUAL revenue	$4,688,250
ANNUAL Net Gain/Loss without Startup Loan Financing	$430,394
Gross Profit Margin Ratio (Profitability %)	9%

Supporting operating cost calculations

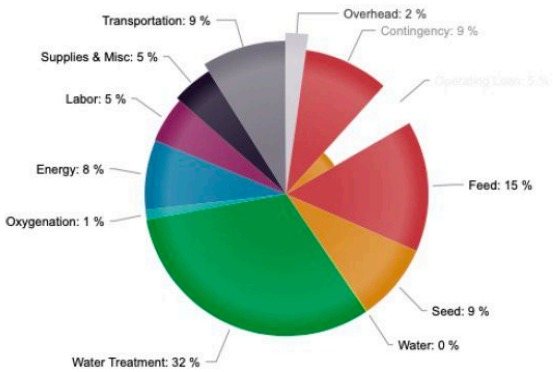
Labor expense per pound	$0.23
Labor expense per harvest	$102,695
Feed conversion ratio (FCR)	1.3 ratio
Oxygenation expense ratio	0.05 ratio
Mortality rate	10%
Supplies/Misc ratio	0.10 $/lb
Overhead ratio	0.05 $/lb

FINANCING

Financing costs

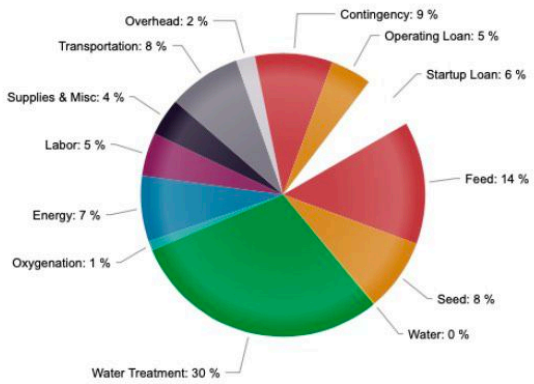
Loan %	80%
Equity %	20%
Loan Interest rate	6.00%
Term of loan in years	10 years
Total start up cost	$2,460,375
% funded with equity	90%
% funded with debt	10%
Equity investment required	$492,075
Loan amount required	$1,968,300
Loan Interest rate	6.00%
Term of loan	10 years
MONTHLY loan payment	$21,852
ANNUAL loan expense	$262,226
ANNUAL Net Gain/Loss with Loan Financing	$168,168

Annual Operating Expenses Without a Startup Loan



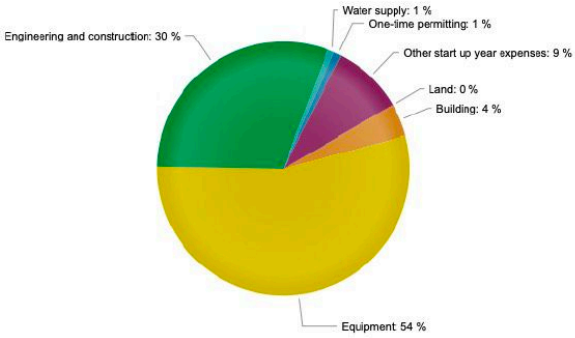
Water Treatment	$1,232,340	31.6%
Feed	$580,452	14.9%
Contingency	$369,348	9.5%
Transportation	$345,330	8.9%
Seed	$343,800	8.8%
Energy	$310,944	8.0%
Labor	$205,392	5.3%
Operating Loan	$195,016	5.0%
Supplies & Misc	$178,596	4.6%
Overhead	$89,304	2.3%
Oxygenation	$44,652	1.1%
Water	$5,340	0.1%

Annual Operating Expenses With Startup Loan



Water Treatment	$1,232,340	29.6%
Feed	$580,452	13.9%
Contingency	$369,348	8.9%
Seed	$343,800	8.3%
Transportation	$345,330	8.3%
Energy	$310,944	7.5%
Startup Loan	$262,226	6.3%
Labor	$205,392	4.9%
Operating Loan	$195,016	4.7%
Supplies & Misc	$178,596	4.3%
Overhead	$89,304	2.1%
Oxygenation	$44,652	1.1%
Water	$5,340	0.1%

Start up Costs



Equipment	$1,339,500	54.4%
Engineering and construction	$750,120	30.5%
Other start up year expenses	$223,250	9.1%
Building	$100,000	4.1%
One-time permitting	$25,000	1.0%
Water supply	$20,000	0.8%
Land	$2,505	0.1%

Appendix 4: Outreach Strategy and Support

THE PROJECT ELABORATED AN **INTERNAL** OUTREACH STRATEGY TO GUIDE HOW THE PROJECT TEAM WOULD PROMOTE AND SUPPORT THE USE OF THE AQUACULTURE EXPLORER PLATFORM. USING THIS AS A STARTING POINT, IN COLLABORATION WITH THE OREGON AQUACULTURE ASSOCIATION (OAA), THE PROJECT THEN DRAFTED AN **EXTERNAL** STRATEGY, JUSTIFYING AND PROPOSING KEY ACTIONS RELATING TO AQUACULTURE OUTREACH AND EXTENSION ACROSS THE STATE. THIS EXTERNAL STRATEGY, DISSEMINATED THROUGH OAA, IS COPIED BELOW.

PROMOTING AQUACULTURE IN OREGON COMMUNITIES

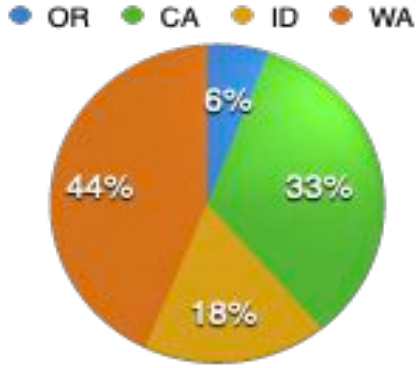
Key Points:

- ✓ **Market-driven aquaculture expansion**
- ✓ **Three abiding sustainability principles**
- ✓ **Explorer-assisted planning**
- ✓ **One-stop-shop**

Intent: In the rapidly evolving world of aquaculture, the Oregon Aquaculture Association (OAA) has recently (February 2020) updated and amplified the Association's vision of its role in a growing and diversified state aquaculture program. Building on this vision, this document outlines the need for aquaculture expansion in Oregon, highlights the expected outcome of such an expansion, and presents a methodology for accomplishing this expansion. The document also highlights key stakeholders at all levels of integration and collaboration.

Current status of Oregon Aquaculture and Future Projections: As we enter into the third decade of the twenty-first century, aquaculture is becoming increasingly important in the United States and globally. The World Bank estimates that by the next decade aquaculture will provide over 60% of the seafood supplied to consumers around the world. Note however, that at current rates, only 7% of this total production is expected to be generated by North America.

Figure 1: Total Value of



This implies that we will be consuming more and varied aquaculture products and as underscored by the current $14 billion seafood trade deficit, more of these products will be coming from off our shores.

Within this setting, and in contrast to national and worldwide trends, we have seen the Oregon aquaculture program shrink by 20% in terms of number of producers and by 3% in farm-gate sales. Oregon has the lowest aquaculture production of all West coast states (see Figure 1, left). Furthermore, nearly 90% of the state's aquaculture sales come from a single aquaculture sector--the oyster industry. In short, Oregon has a relatively static and undiversified aquaculture industry.

Vision and Outcome

OAA VISION: In 2020, the aim of the OAA is to mobilize investment and diversify production to bring responsible aquaculture into the group of agricultural enterprises that makes meaningful and sustainable economic contributions to the State of Oregon and her citizens.

OUTCOME: Increased and expanded aquacultural production will: (a) provide a variety of high-quality foods to local markets as well as develop specialized exports; (b) enhance the sustainable use and conservation of increasingly scarce land and water resources; (c) create new Oregonian markets for 21st-Century technologies such as alternative energy sources along with cutting-edge biological and AI technologies; (d) catalyze new and innovative education pathways for the State's youth; (e) link synergistically with sister agricultural industries (e.g., horticulture and viticulture) to improve both profits and resource use; and, (f) offer opportunities to repurpose shuttered industries while generating investment and employment in rural communities.

Methodology: To promote these objectives, OAA is launching a campaign to widen its membership and partner with other relevant associations. These partnerships will also provide a broader range of aquacultural operations which in turn will help to facilitate a coordinated and diversified Oregon aquaculture program covering the full spectrum of aquacultural crops—a program that, working with local, regional, and national partners, can compete in the marketplace, coordinate with government agencies, and attract new businesses while facilitating supportive public services.

The core of this campaign is to institute methodologies and promote sustainable practices that will lead to these outcomes. This requires a coordinated **market-driven** effort to focus human, financial, and natural resources where they will derive the most sustainable returns in terms of profitable high-quality aquatic products for domestic and external markets. This methodology embraces all forms of aqua farming, from commercial and industrial to the hobbyist, that can assist the state-wide program in achieving its goals.

This strategic approach requires marrying resources to achieve the **three abiding sustainability principles** of being economically, socially, and environmentally sound. It requires careful pre-planning, sharp targeting, and inter-institutional support facilitated by the Association.

The new **Oregon Aquaculture Explorer** platform will be a vital tool in these aquaculture expansion efforts. The Oregon Aquaculture Explorer is part of a larger system called the Oregon Explorer (www.oregonexplorer.info). This place-based digital library aggregates data and supporting content for multiple topics through a collaboration between the Oregon State University Libraries and Press and the Institute of Natural Resources, and in partnership with various organizations and agencies including OAA. The public-accessed Oregon Explorer provides users with information and tools relating to communities, localized and statewide natural resource issues and planning and extensive research from a broad base of institutions.

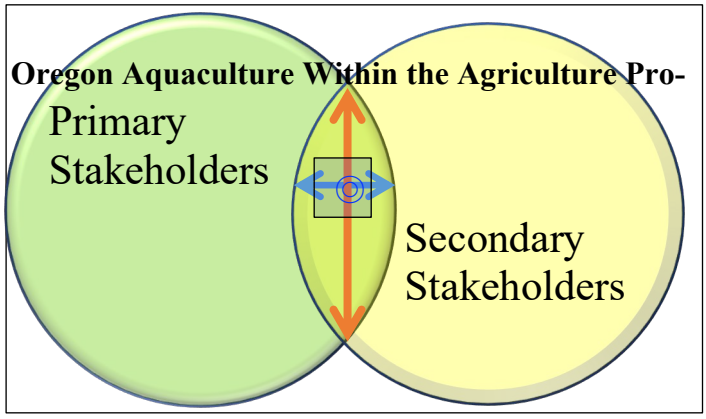
When fully operational, the Oregon Aquaculture Explorer will be the entry point for an expanded state program—providing guidance for expanding existing operations along with recommendations for those planning aquaculture start-ups. The Oregon Aquaculture Explorer will be the nucleus of an integrated outreach program that is actively facilitated by OAA. **Explorer-assisted planning** should be one of the first steps when investing in aquaculture.

Oregon Aquaculture Explorer will not be effective in isolation. For this reason, part of the strategy is to promote and actively engage with a **one-stop-shop** where primary public agencies, universities, and other organizations will be able to interact with operators and investors via a unique portal linked to the Oregon Aquaculture Explorer. This portal will provide information on prevailing regulatory requirements, research and extension activities, and financial and market data.

Key Stakeholders: Aquacultural expansion requires participation and engagement from all levels of aquaculture stakeholders across a spectrum of communities. If one investigates aquaculture supply chains, public agencies, and civil society organizations, there are many aquaculture stakeholders. While a complete census of all stakeholder groups would require a lengthy accounting, for strategic purposes stakeholders can be divided into two groups: Primary and Secondary.

This dichotomy can be applied to the overall agricultural sector. **Primary stakeholders** may be referred to as economic actors who play a critical role in agricultural value chains and whose livelihoods are directly tied to production generated by the agricultural sector. These stakeholders are largely market-driven and include farmers, transporters, suppliers, processors, sellers, public agents, and technical researchers and educators.

Secondary stakeholders are those with an interest in aqua farming but whose livelihoods are not derived from aqua farming. These members are non-market driven and include those engaged in civil society organizations, general education, resource management and conservation, consumption, public health, and others.



Individuals and groups may move from one group of stakeholders to another depending upon their form of engagement at a specific point in time, as a particular group can have both market and non-market motivations based on differing motivations and project foci.

These groups are represented by the two circles below; the circles depicting the total state agricultural program and the overlapping portion of the circles representing that portion of this program that is devoted to aqua farming.

The objective is to maximize this area of overlap—expanding and diversifying the aqua farming program.

To achieve this objective, different tactics are required for each of the two major groups. Primary aquaculture stakeholders are businessmen and women seeking on market share and profit and striving for economic and financial viability. While all three principles of sustainability are important, economic sustainability is especially critical.

Outreach tactics are different for secondary stakeholders. This group places particular importance on social and environmental sustainability principles.

Thus, an integrated outreach strategy is required to address the priorities of different stakeholder groups while sustainably expanding aqua farming programs.

<u>Call to Action</u>: As an addendum to the OAA Vision, current events have placed a high priority on **food security** and **reliable local food supplies** that can optimize available resources and infrastructure. A key strategy to attain these priorities is to enhance efficient, use and conservation of water resources through water productivity through aqua farming activities. In short, there are strong justifications for expanding aquacultural production. Yet, these actions must be built upon the best available **science-based knowledge and information** delivered through strategic outreach channels that help to grow aquaculture investment while generating public and community support.

Pivotal Stakeholder Actions

- ✓ **All relevant associations and civil organizations working together for the greater good**
- ✓ **Identifying and communicating funding opportunities to OAA as relevant**
- ✓ **Seeking to grow and diversify OAA membership through already established networks and relationships**
- ✓ **Striving to strengthen lines of communication at all levels of stake-**

<u>Appendix 5</u>: Training Framework

Oregon Aquaculture Explorer Project: Training/Outreach Framework

Setting

The Explorer Project represents partnerships between the Oregon Aquaculture Association (OAA) and a number of other entities including the larger Orogen State University (OSU) community. One of the core missions of this consortium is to perform outreach and training to catalyze the growth of Oregon's aquaculture sector. Training sessions will be organized through 2022 and the first half of 2023 as joint exercises of the Project and OAA along with other partners. Sessions may be virtual or in-person—actual organizational arrangements depending upon prevailing public health protocols. Venues for in-persons activities will be chosen to optimize access for session participants.

Structure

Training sessions center on **three key themes**:

A. Site selection
B. Production Options
C. Marketing and Business Management

Each theme will have a **focal point** and a support team.

Content

Each theme includes a spectrum of **topics**. Indicative topics for each theme include but are not limited to the following:

- **THEME A**—selection criteria, regulatory issues, extension support, environmental stewardship.
- **THEME B**—physical facilities and techniques/methodologies for production with an initial focus on recirculating systems covering choice of facilities, facilities design, facilities operations, and facilities upkeep and maintenance.
- **THEME C**—identifying markets and market demand, determining profitability, record keeping, input supplies.

The specific organization and content of ease theme will be finalized by the team responsible for this series of training sessions.

Organization

The chart below is to help categorize and outline the outreach and training calendar for 2022-2023

Theme	Topic	Description	Learning Outcomes	No. Sessions	Length of Sessions	No. Attendees	Primary Session Lead
A **SITE SELECTION AND REDGIULATORY CRITERIA**	*1. Site Criteria*	1.1 Overview of site selection	Ability to understand the basic requirements for aqua farming and the type of farm you may be able to have based on the site	1	60 Minutes	8-12	Kellen Parrish
11 sessions		1.2 RAS sites	Specific Site requirements for RAS systems	1	45 minutes	8-12	Kellen Parrish
		1.3 Pond Sites					
		1.4 Sites for other production methods					
		1.5 Sites and markets	Understanding the different supply chain and marketing factors that apply to selecting you aquaculture farm site	1	45 minutes	8-12	Kellen Parrish
	2. Oregon Aquaculture Regulations						
		2.1 Overview: review of current, past, and potential interaction between government agencies and Oregon's aquaculture sector, including contacts and strategies for navigating regulatory and permitting processes	Ability to identify and contact the necessary offices and personnel to make progress on securing permits and other legal permission for their enterprises	2	90 minutes	10-15	Kellen Parrish
		2.2 Regulatory processes: summary of local, state, and federal regulations and monitoring systems	Understanding aquaculture-specific regulations in Oregon and overviewing the permitting process for starting a farm.	2	90 minutes	10-15	Kellen Parrish
		2.3 Regulatory processes: approval and compliance					
		2.4 Environmental Stewardship	Regulations surrounding farm discharge, TMDL and point source pollution in waterways in Oregon	1	60 minutes	8-12	Kellen Parrish
		2.5 Social license					
		2.6 Research and Extension	Overview of Extension Resources and important contacts for technical support	2	40 Minutes	8-12	Kellen Parrish

B **PRODUCTION OPTIONS FOR OREGON PRODUCERS**	1. General considerations	1.1 Factors dictating the type of production system required.	Ability to determine the site requirements for pond vs tank RAS Systems.		45 minutes	30 - 40	Thomas Losordo
16 sessions	2. Pond culture	2.1 Critical considerations of the pond aquaculture production of cool and temperate water fish species.	Ability to identify the key factors for successful pond-based aquaculture farming.		60 minutes	30 - 40	Thomas Losordo
	3. Recirculating systems operations	3.1 Critical considerations of RAS production systems.	Ability to determine the important technical aspects of RAS production systems.		90 minutes	30 - 40	Thomas Losordo
		3.2 Tank hydraulics and settlable solids removal in RAS systems.	Ability to understand the benefits of circular flow tank-based systems.		60 minutes	30 - 40	Thomas Losordo
		3.3 Suspended solids removal technology.	Ability to determine the best technology to remove suspended solid waste from RAS systems.		45 minutes	30 - 40	Thomas Losordo
		3.4 Nitrification processes and biofiltration components.	Ability to understand the basic function and requirements of biological filtration in RAS.		45 minutes	30 - 40	Thomas Losordo
		3.5 Aeration and oxygenation processes in RAS systems.	Ability to determine the best technology to use in providing oxygen to an RAS production system.		45 minutes	30 - 40	Thomas Losordo
		3.6 Carbon dioxide control in intensive tank-based production systems.	Ability to determine the best approach to controlling carbon dioxide buildup in RAS.		30 minutes	30 - 40	Thomas Losordo

		3.7 Fine and dissolved solids control in RAS production systems.	Ability to appreciate the requirements for foam fractionation and ozone contact systems.		45 minutes	30 - 40	Thomas Losordo
		3.8 Planning and building an RAS production system.	Ability to appreciate the key aspects of site preparation and building and system installation used in RAS.		45 minutes	30 - 40	Thomas Losordo
		3.9 Denitrification technology used in RAS production systems.	Ability to understand the need and complexity of very closed RAS systems.		45 minutes	30 - 40	Thomas Losordo
		3.10 Management and operations of RAS production systems.	Ability to appreciate the daily and long-term tasks required to operate an RAS production system.		45 minutes	30 - 40	Thomas Losordo
		3.11 Advances in solids waste capture and treatment in RAS production.	Ability to understand the requirement of treating or disposing of solid waste from RAS production.		60 minutes	30 - 40	Thomas Losordo
	4. Aquatic animal health	4.1 Disease prevention and control in tank-based production systems.	An appreciation for the need for biological-security in RAS design and operation.		45 minutes	30 - 40	Thomas Losordo
	5. RAS Design	5.1 Production considerations in RAS design.	Ability to appreciate the need to match design with market demands.		45 minutes	30 - 40	Thomas Losordo
		5.2 A sampling of RAS designs and layouts in commercial fish production.	Ability to discern good designs from flawed designs to avoid common mistakes.		45 minutes	30 - 40	Thomas Losordo

C **Economics of Aquaculture**	The Economics of an Aquaculture System	Use the Explorer Platform to learn about the key components of aquaculture farm systems and their interaction, estimate economic costs,, and develop system strategies to maximize benefits and minimize costs.	Ability to understand and identify aquaculture farm system components and their interactions, learn to estimate costs and benefits, and economically optimize system design and operations.	1	60 minutes	5-50	Gil Sylvia
3 sessions	Input costs and supply-side Economics	Use the Explorer platform to identify supply side and input cost categories, both fixed and variable. This will include types and range of costs, interaction of cost categories, and strategies for reducing and managing costs.	Ability to understand major cost issues in building and managing an aquaculture farm. Learn basic financial concepts. Understand how system cost components are related. Understand Oregon Explorer financial spreadsheets.	1	60 minutes	5-50	Gil Sylvia
	Marketing Economics	Use the Explorer Platform to understand the importance of output markets and developing a marketing management plan. Lear to develop markets and integrate with production strategies to deliver optimal products that will maximize potential for aquaculture success.	Understand the basics of aquaculture product-market demand. Determine the potential demand for product characteristics. Understand concepts including branding and value-added. Learn to integrate demand and supply components as part of an optimal marketing management strategy.	1	60 minutes	5-50	Gil Sylvia

Appendix 6: Policy Implications

THE INTENT OF THE OREGON AQUACULTURE EXPLORER PLATFORM IS TO ASSIST OPERATORS AND WOULD-BE OPERATORS IS DESIGNING AND IMPLEMENTING SOUND AQUACULTURE INVESTMENTS ACROSS THE VALUE CHAIN. THE IMPACT OF THE USE OF THE PLATFORM WILL BE AN EXPANDED AND DIVERSIFIED AQUACULTURE PROGRAM FOR THE STATE OF OREGON—A TWENTY-FIRST CENTURY PROGRAM THAT IS NECESSARY IF THE STATE IS TO KEEP PACE WITH ITS NEIGHBORS AND KEEP UP WITH GLOBAL TRENDS IN THE SEAFOOD INDUSTRY.

HOWEVER, IF THESE NEW INVESTMENTS, NEW ENTERPRISES, AND NEW PRODUCTS ARE TO BE SUSTAINABLE AND HAVE THE HOPED-FOR ECONOMIC IMPACT, THE STATE OF OREGON MUST MODERNIZE AND RATIONALIZE ITS PROGRAM INCLUDING UPDATING AND STREAMLINING THE LEGAL AND REGULATORY FRAMEWORKS. SUCH NECESSARY COMPONENTS AS A LEAD STATE AGENCY AND A ONE-STOP-SHOP FOR INVESTORS HAVE BEEN DISCUSSED FOR YEARS BUT ARE STILL TO BE OPERATIONALIZED.

A SUITABLE STARTING PINT IN THIS REVISIONARY PROCESS WOULD BE TO CRAFT A STATE **AQUACULTURE STRATEGIC PLAN**. THIS GUIDING DOCUMENT COULD BE CRAFTED BY A LEAD STATE AGENCIES OR AN INTER-AGENCY WORKING GROUP WITHOUT, AT LEAST INITIALLY, REQUIRING LEGISLATIVE ACTION. THIS IS A PROCESS THAT HAS BEEN UNDERTAKEN BY NUMEROUS STATES ACROSS THE COUNTRY.

AS A PRECURSOR TO THE AQUACULTURE EXPLORER PROJECT, IN 2018, A GROUP OF NEARLY ONE HUNDRED STAKEHOLDERS DISCUSSED THE PRACTICALITIES OF DEVELOPING AN OREGON AQUACULTURE STRATEGIC PLAN USING AS A FOUNDATION THE EXPERIENCES OF THE STATES OF MASSACHUSETTS, OHIO, NEW JERSEY, AND MICHIGAN—REVIEWING THESE STATE GUIDELINES AND ACCUMULATING ELEMENTS THAT WOULD BE APPLICABLE TO THE OREGON SITUATION. THIS WORK IS PRESENTED BELOW.

Introduction: why a strategic plan

Aquaculture is an increasingly important sub-sector; both around the world and across the United States. As the US seafood trade deficit soars, there is growing pressure to expand aquacultural production. This increase should lead to many benefits, including augmenting local food supply and generating employment. Unfortunately, aqua farming operations have not always proven to be good stewards of the resources upon which they rely—nor reliable suppliers of high quality products upon which the public relies. These missteps need to be understood in order to create the right framework for Oregon and guide today's investments. This strategic plan will provide such guidance. In creating it, we aim to propose the best and most sustainable use of natural, human, and financial resources to achieve the expected outcomes of expanded local seafood supply and improve overall economic development while safeguarding the ecosystems that make this possible.

Background & Setting

Oregon has a very modest aquaculture program consisting mostly of oyster producers and trout farms for stocking private lakes and ponds. Past analysis[25] of this program has concluded that the Oregon aquaculture program is "under sized" given the existing natural and economic resources. There is room for the program to be significantly larger and more diversified. With noteworthy local and external markets, generous aquatic assets covering a spectrum of environments, and ever-improving technologies, there is potential for a considerably larger aqua farming program in Oregon. Failure to capture these opportunities has often been attributed to a sizeable knowledge gap regarding aqua farming in the state. This shortfall in awareness covers a wide range of areas from a lack of academic instruction on aquaculture to a scarcity of science-based facts to counter a negative legacy to an insufficiency of data to demonstrate the bankability of investing in aqua farming in Oregon.

[25] http://www.oregon.gov/ODA/shared/Documents/Publications/MarketAccess/AquacultureUsersGuide.pdf
http://www.oregon.gov/ODA/shared/Documents/Publications/MarketAccess/AquacultureInvestment.pdf

This strategic plan sets forth actions to address constraints and optimize opportunities.

Strategic Structure/Core Requirements

Strategies describe the ways and means to reach targets or objectives. They also describe the roles and responsibilities of the various stakeholder groups comprising the sub-sector such as the public and private sectors as well as civil society. Strategies answer the questions ***"who"*** and ***"how"***? Plans are more detailed than strategies; answering the questions of ***"where"*** and ***"when"***. This strategic plan draws on both strategic and planning aspects.

To be successful, we need a common program to encompass Oregon aqua farming; and although aquaculture is undertaken in a broad mix of environments and with an assortment of organisms, there are many common denominators. For economies of scale and uniformity of action, it is important this strategic plan cover the entire Oregon program. This will undoubtedly require crossing institutional, political, and traditional borders. Thus, an integrated approach is needed, and our strategic plan will facilitate this methodology[26].

Central Issues

Through reviewing similar strategic documents from established programs, we recognized four central issues or **themes** to consider when building a resilient program:

1) Strong institutions;
2) Suitable legal and regulatory framework;
3) An enabling environment; and,
4) An educated citizenry

These themes form the structure of our strategic plan. Each theme is subdivided into a group of factors that, in the aggregate, contribute to the theme's impacts.

Crosscutting Elements

In addition to the themes, there are crosscutting matters. While most of the components of an aqua farming program are to some extent intersecting, the chief subject for the current discussion is education. Education enters into all dimensions of the program—including formal education, extension, media, and other conduits.

Crosscutting elements may well affect many of the factors composing each theme.

Organizational Framework

For each of the levels of this strategic plan, a common framework is applied. Each theme will be assessed from two vantage points:

- Context and guiding principles, and
- Strategic approach

Proposed Goal

The aim of this strategic plan is to identify the pathway for expanding and diversifying the Oregon aquaculture program. Specifically, the target is to expand the program by fivefold, reaching to total statewide value of the aquacultural harvest of $60M[27]. At this magnitude of economic activity, aqua farming would be roughly at a par with the crab fishery—enough of a contribution to the state's economy to pull-down services and bring-in investment.

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[26] Additional reading: https://onstrategyhq.com/resources/how-to-write-a-strategic-plan/ , https://www.thebalance.com/strategic-plan-elements-2276139 , http://www.balancedscorecard.org/BSC-Basics/Strategic-Planning-Basics , http://www.dummies.com/business/strategic-planning-kit-for-dummies-cheat-sheet/

[27] USDA (2013) cites the value of aquaculture sales for Oregon as being $12M (Idaho $48M, California $83M, and Washington $233M). ODA (2017) indicates the value of the state's hops harvest as $65M, crab harvest is $56M, and pear harvest $33M. The proposed level of $60M is in the range of mid-sized agricultural activities.

Theme 1: Strong Institutions

Context & Guiding Principles

Institutions including public and private organizations and agencies that have both direct and indirect impacts on the state's aquaculture activities are key to building a program. Yet, it is the activity itself that must achieve a certain level of relevance for these institutions to invest their time and energy into support efforts. In other words, there is a production threshold the aquaculture must be capable of reaching before the institutional actors judge that their intervention is warranted.

The Goal of this Strategic Plan is to create the conditions where statewide aquaculture production will increase to a level suitable to attract the necessary institutional support.

Evaluations of the current status of aquaculture in the state have noted a lack of coordination. This is attributed to both the large number of actors and the relative marginalization of the program due to current low levels of production.

Strategic Approach

Given many institutions have a stake in a statewide aquaculture program, it is necessary to formally designate a lead institution. Similarly, in view of the quantity of actors, processes need to be established where operators can have a designated ***exclusive entry point*** *initiate contact with the state program. Throughout, it is essential to build processes that reinforce* ***private-public partnerships****–ensuring participation and inputs from all stakeholders. Taken together, these steps should improve the program's* ***coordination*** *and accountability.*

State Agencies

Context & Guiding Principles

A number of state agencies are directly involved in the aqua farming program (Appendix 4). Many of these have a regulatory or monitoring role (Theme 2). In Oregon, aquaculture is agriculture. This is the core principle. It is also important to cater to the clients' needs (Theme 2)—i.e., state agencies need to provide services and not solely be overseers.

Strategic Approach

As **aquaculture is agriculture**, Oregon Department of Agriculture (ODA) should be the lead agency. Inter-agency structures are needed, revolving around this nucleus and organized to provide the investor with a clear path to developing aqua businesses. A state level "**pre-investment conference**" or similar mechanism, regrouping the investor(s) and agencies, has been used both previously in Oregon and elsewhere to align all the actors and spotlight the pathway ahead. Outreach and extension (Themes 3 and 4) are key functions at state level. Moreover, state agencies need a common platform and tools to address the needs of the program in a uniform, coordinated, and efficient manner.

Local Government

Context & Guiding Principles

In the current context, aquaculture is considered as agriculture but, when new investments are accorded at the state level, these are "conditional" on the corroborative approval from local governments (e.g., county, city, etc.). It is reported that most often the local authorities do not have the expertise to review proposals and revert to their state colleagues—this process adding to the time required to evaluate a new project.

Strategic Approach

Local inputs should be sought without delaying processing and without relying on expertise that is not available at local levels.

Other Public-Sector Actors

Context & Guiding Principles

There is a variable group of other government actors that interface with aqua businesses ranging from federal to Tribal, and in some cases regional. These participants need to be identified, their roles clearly spelled-out, and their processes articulated.

Strategic Approach

The nomination of a lead agency would cover the full array of public-sector actors—the non-state component needing to be folded-into the expedited **one-stop-shop** and their key parameters including in any monitoring systems.

Private Investors

Context & Guiding Principles

Given the current exiguous state aqua farming program—both in terms of overall production and diversity of products—attracting private investment is major aim. This need notwithstanding, it is a basic principle that aqua farming operations need to be responsible and sustainable. While economic and financial viability are fundamental, symbiosis with the ecosystem is equally basic—this covering social and ecological compatibility within the operational environment.

Strategic Approach

Investors require **science-based knowledge** and, once this knowledge has been used to make a positive decision, **user-friendly processes** to follow that do not overly burden the would-be operator. Additionally, investors need to be partners in the monitoring of any operation. It is not realistic to rely totally on public agencies to collect data and monitor events—a part of the investment approval process needs to be stipulations as to **reporting responsibilities** for investors.

Civil Society/Sharing the Commons

Context & Guiding Principles

Aquatic and many terrestrial resources are part of the commons. This reality much the taken into account when planning and implementing aqua farming operations. Stakeholders—real and perceived—need to have avenues to review actions, receiving adequate assurance that the resources of the commons are secure.

Strategic Approach

Transparency and **knowledge** are the key to satisfactorily sharing the commons: shared responsibilities and shared benefits. Stakeholder groups need to be identified, quantified, and brought into the discussions.

Civil Society/Organizations

Context & Guiding Principles

The aquaculture program engages directly and indirectly a number of civil society organizations. The leaders in direct involvement are operator associations. In the case of Oregon, this presently includes the *Pacific Shellfish Growers Association* (PSGA), the *Oregon Aquaculture Association* (OAA), and the *National Aquaculture Association* (NAA). These groups have indispensable functions in supporting operators technically (e.g., chiefly by facilitating access to appropriate information) and politically (e.g., lobbying for favorable policies and regulations). PSGA and OAA have been essential to supporting the program to date and their efforts need to be bolstered and structures so as to optimize impact and

sustainability. There are also a number of other organizations which may have a vested role in specific operations at a specific site—these needed to be incorporated into planning and operations as suitable.

Strategic Approach

Many core functions of a program can be facilitated by, or even overseen by OAA and/or PSGA—these **functions** need to be **formalized** and necessary **tools** put at the disposal of the associations. These directly-engaged groups need to have a **seat at the table** whenever aquaculture is under discussion—indirectly-involved groups also having a seat when warranted.

Education/Research/Extension-Outreach

Context & Guiding Principles

The trio of actions—education, research, extension—is typically a traditional role of Sea Grant and Land Grant institutions—in the case of Oregon: Oregon State University. At present, there are considerable research actions, albeit these undertaken with limited human and financial resources. Extension, on the other hand, is nearly absent—aqua farming outreach totally absent from all but some limited coastal areas. The current *Marine Studies Initiative* should strengthen these functions as they relate to aquaculture.

Strategic Approach

These traditional functions need to be **reinforced** and **linked** to the needs of the Oregon aqua farmer. This will likely entail joining hands with other institutions—both public/educational and private/operational.

Theme 2: Suitable Legal & Regulatory Framework

Context & Guiding Principles

Appropriate legal and regulatory frameworks are necessary. Given the small and relatively monolithic structure of the Oregon program, the current regulatory arrangements do not accommodate optimally many current scenarios. Moreover, a number of the legal and regulatory issues were drafted years ago—in the interim, many concerns have arisen including shortages of what once were abundant resources (e.g., water and land).

Realistic regulatory and legal "packages" would, by necessity, involve a number of local, state, and federal agencies; probably as well as civil society. This array of actors and actions needs effective coordination.

Strategic Approach

*New rules are needed to fit new circumstances and new situations. Additionally, as indicated for Theme 1, an **exclusive entry point** should be built into the program to facilitate upstream and downstream flow of information as well as minimize difficulties for investors.*

*Oregon is not operating in isolation—many states have been supporting large aquaculture programs for years. Furthermore, many national and international organizations provide oversight, identifying **best practices** as well as practical tools for promoting and following these practices. Existing elements should be folded into the present work.*

*Monitoring of the application of rules requires comprehensive and current **data sets**. Present data collection, collating, and analysis is incomplete and inefficient—better approaches are needed. Moreover, defining rules is an iterative process that changes with a rapidly changing program. Those engaged in these processes need mechanisms to update and revise elements as need be.*

Responsible Action

Context & Guiding Principles

Aquaculture must be done responsibly. It is understood this obligation is a moving target—aquaculture technologies are changing rapidly, often negative sides of otherwise positive innovations only visible after

a considerable gap. It is frequently not possible to act preemptively. Nonetheless, it is possible to try to include best practices in all operations.

Strategic Approach

Incorporation of **best practices**, appropriate and holistic **oversight** including good record keeping, combined with prerequisite monitoring **tools** are all needed to be promote and follow responsible action.

Conservation & Development—the "Oregon Way"

Context & Guiding Principles

What may be considered as the "Oregon Way", may also be seen as wanting the best of both worlds. While conservation of resources in as close to a natural form as possible is a high priority, using these resources to launch economic growth is also a high priority. This teeter-totter requires careful balance on the part of all actors; facilitating responsible investment while maintaining the resource base.

Strategic Approach

Achieving a program that is acceptable to the citizenry requires identifying strategic action that maintains the delicate **equilibrium between growth and conservation. Science-based knowledge** is the best starting point. Effective and expeditious **channels of communications** (feed-forward and feedback) are essential—these operating over the medium- and long-term.

Legislation

Context & Guiding Principles

Aqua farming engages a multiplicity of legal "zones"—federal, state and local. As a program develops, the roles of various levels of legal authority become more apparent; the direct and indirect impacts (positive and negative) more visible. However, in the present case with no substantive program, much of the consideration as to the roles of various levels of government is purely speculative—often based on incomplete information.

Other more advanced and diversified programs may serve as models, but ultimately the links between different levels is an arrangement that needs to be specific to the state and her unique agencies, with established mandates.

Strategic Approach

A **one-stop-shop approach** should be highlighted as the aim. This will formally link those agencies, at all levels, that are involved in aquaculture oversight. The entry point should be at the state level through ODA given aquaculture is agriculture. This would likely require an iterative process starting with a formally established **pre-application conference** for each operation. Steps need to be planned for this relatively generic conference to evolve into a more multifaceted one-stop-shop.

As **process** is addressed, **content** also needs to be upgraded to meet the current needs of major stakeholder groups. This regards formal legislature-passed legislation as well as prevailing rules and standards. This can be challenging sine once size does not fit all—we are dealing with a large number of possible production systems and operating environments. Legislative and regulatory measures need to be flexible enough to adapt and adopt to this business model.

Protocols & Best Practices

Context & Guiding Principles

While aquaculture is new, it is no longer in its infancy—producing roughly half the aquatic products eaten by people around the world. Over the past five decades, many ventures and adventures have been tried. There is now a growing body of solid information about what works and what does not—what is

responsible and what is not. A number of organizations[28] have been funded to identify and assist with implementing best practices. There is also data available as to prevailing protocols and regulations[29].

Strategic Approach

It is incumbent on planners in the current exercise to review existing **science-based information** to incorporate a foundation that incorporates **relevant best practices and policies**.

Food Safety/Consumer Protection

Context & Guiding Principles

This subject is of growing importance, with considerable effort invested in traceability and, eventually organic aquaculture products (USDA does not currently recognize organic aquaculture). Oregon through ODA has a good base with the on-going investment in food safety for shellfish products. It could be assumed (verification required) that this base could be expanded to include the full range of aquatic produce grown in the state.

Strategic Approach

As with best practices, the relatively low level of current aquacultural development facilitates the incorporation of **state-of-the-art tools** with a **shared responsibility** between operator and oversight agent.

Monitoring & Oversight/Personnel

Context & Guiding Principles

Assistance and surveillance are important parts of an aquaculture program—assisting in identifying the best way to raise and market a crop while overseeing the process to ensure it is applied responsibly. Typically, these functions fall on the government aquaculture extension service—something that does not exist in Oregon. Present dedicated personnel are limited to food safety.

Strategic Approach

It seems unlikely in the near-term, and improbable in the longer term, that a fully-staffed state extension service will be established. These functions will likely require well defined **public-private partnerships** engaging not only public agent and private operators, but also civil society organizations such as the Oregon Aquaculture Association and other structures regrouping stakeholders (e.g., watershed councils[30], STEP volunteers[31], FFA Oregon[32], ports[33], etc.). Strategically, it is necessary to craft multifocal **surveillance mechanisms** that provide the needed data and feedback without hampering operations. It is unclear if these arrangements can be applied to technical assistance?

Monitoring & Oversight/Tools & Record Keeping

Context & Guiding Principles

Monitoring and oversight are not only about collecting needed verifiable data and promoting responsible farming; these are also key components of an aqua farming program that wants to benefit optimally from high-value markets. Issues such as certification and eco-labeling become important economic questions that require substantiating data and oversight. Current record keeping, however, is woefully incomplete.

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[28] https://www.bapcertification.org, https://www.aquaculturealliance.org/what-we-do/bap-certification/, http://www.seafoodwatch.org

[29] http://www.fao.org/fishery/collection/nalo/en, https://www.epa.gov/npdes/npdes-aquaculture-permitting, http://nationalaglawcenter.org/research-by-topic/aquaculture/, https://fishculture.fisheries.org/resources/federal-aquaculture-regulations/, https://www.fisheries.noaa.gov/topic/aquaculture/regulation-policy

[30] http://www.oregonwatersheds.org

[31] http://www.dfw.state.or.us/fish/step/

[32] http://www.oregonffa.com

[33] http://www.oregonports.com

Composite figures for the Oregon program can only be found from USDA—these with an uncertain margin of error.

Strategic Approach

Public-private partnerships are probably the avenue needed to apply many of the available monitoring tools including **spatial analyses** and **significantly expedited access** to existing information sources. Yet, there is need for a focal point, a common repository. Logically this would fit within the mandate of ODA—practical measures needed to be able to achieve this aim.

The Investor as the Client

Context & Guiding Principles

While a plan needs to promote responsible operations and safeguard resources, it needs to also attract investment—the investor is a client of those agencies and groups supporting aqua farming across the state. This, in some cases, may require a change in approach. Investors proposing aquaculture ventures have often been vilified. To obtain our goals, we need to work with investors, fostering high levels of interest while channeling these energies in ways that are best suited to local conditions.

Strategic Approach

Oregon needs to attract investors. This means a user-friendly plan that provides the needed buffers and guardrails while still offering the needed economic stimuli.

Theme 3: Enabling Environment

Context & Guiding Principles

Aqua farming is an innovation in Oregon. At this embryonic stage of programmatic development[34], it is crucial to foster an enabling environment that promotes responsible aquaculture across the state.

Investment opportunities exist at the nexus of a variety of components that make up this supportive environment. Chief among these are markets (of several forms), technologies, knowledge, and capital[35]. Experience has shown that in many cases, markets are of paramount importance.

Oregon may be categorized as a state with sub-optimal natural conditions for growing a variety of aquatic crops; frequently judged as being too cold for warm-water culture and too warm for cold-water. However, rapidly advancing technologies allow for considerable buffering against unsuitable prevailing climates—these technologies at times also offering buffers against undesirable impacts on the natural ecosystem. The choice of systems to employ in Oregon is of the utmost importance.

Strategic Approach

*A positive environment enables investment and investment is **market-orientated**—thus, activities need to be market-driven. In addition to prerequisite markets for aqua products, among the inputs (e.g., land, labor, water, seed, feed, equipment & supplies, etc.), labor at various skill levels is necessary to build a viable program. Oregon, through **Measure 98** offers an opportune political environment to craft academic pathways to train people in aqua farming.*

*As with other themes, good **record keeping** combined with easy access **science-based information** are fundamental.*

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[34] While global aquaculture is maturing—no longer in its infancy—Oregon is still far behind the world-wide growth curve.

[35] This follows the trajectory of many aquaculture programs around the globe where there are often reports of the "Big 5" key requirements for investors: (a) access to high-paying markets; (b) access to good quality and affordable feed; (c) access to good quality and affordable seed; (d) access to affordable capital; and, (e) access to high quality and current information.

Markets/Demand & Supply

Context & Guiding Principles

Historically, developing aqua farming is often seen as finding the right production system to fit the prevailing physical environment. We have now learned that while the physical environment is important, the critical component for success is to find the right fit within the targeted market. Production needs to be market-driven—supplying an identified demand (often through import substitution). Identifying the market to target is a one of the first paramount steps. We need to develop a program that can supply a spectrum of markets from high-end specialty products to high-volume institutional foods.

Many aqua farming ventures have failed in spite of good technical operations. These have often, knowingly or unknowingly, had a philosophy that, "it you grow it, they'll buy it". Not true. Operations need to be based on a well-documented and quantified demand.

Strategic Approach

A **market-first approach** is employed. This requires current and factual **market data**. This also requires **skills and tools** to be able to analyze existing demand and forecast growth. Oregon has unique niche markets, access to profitable international markets, and a diverse populace providing opportunities for several of the nearly 600 aquatic crops grown around the world[36].

Markets/Inputs & Logistics

Context & Guiding Principles

Inputs—chiefly feed and seed but also a wide variety of other specialized aquacultural items—are obviously necessary for any operation. Feed is typically up to two-thirds of variable costs. Bio-Oregon[37] is a "local" aqua feed provider specializing in salmonid diets. It is similar to other feed millers in neighboring states[38] whereby Oregon is currently not a major client and diets are prepared for crops that may not be the best for Oregonian aqua farming. Seed supplies (hatcheries/nurseries) follow a similar pattern as feed: in-state providers are few beyond the time-honored crops of salmonids and oysters. Other specific aquaculture supplies and materials are considered esoteric by most and largely unavailable locally.

Logistics are critical for both inputs and outputs. High transport costs dictate an economic zone within which products can be profitably moved—outside this area, profitability is challenging at best.

Strategic Approach

A market-first approach means that (see above) the demand for the food item is the key driver. Accordingly, while logistics relating to this market are part of the early analyses, availability of needed inputs in examined later in the process—frequently leading to scenarios where needed inputs are **not** currently **available locally**. Thus, **attracting** needed **suppliers** is critical. A bit tangentially, if there are choices in which crops to grow, the principle is to row an organism low on the food chain where diets require less protein. Specialty crops may require **specialty diets** that are hard to find. The same difficulties could apply to seed and other inputs.

Markets/Quality Control & Branding

Context & Guiding Principles

Competition is keen. Often the aim may be import substitution. Concurrently, standards for aquatic crops are increasing and the industry is always under scrutiny. Oregon growers are new entries into the market place and will need specific comparative advantage if they are to be successful.

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[36] http://www.fao.org/aquaculture/en/

[37] Headquartered in Washington State: https://www.bio-oregon.com

[38] https://www.starmilling.com/products-fish.php, http://www.rangen.com and https://www.skretting.com/en-ca/

Strategic Approach

Initially, when the state program is still small, Oregon producers will need to prove **exceptionalism**—through quality, transparency, or novelty. This will require innovative **market strategies** to increase the market share for made-in-Oregon products. This will also require greatly improved **record keeping** including **access** to these data in a variety of formats.

Markets/Processing

Context & Guiding Principles

At the early stages of program development, it may be opportune to think of products that require minimal processing—e.g., whole or even live products. However, as the program grows, it will require considerable diversification of products—supplying processed products in a variety of forms. In some cases, under capacity in fish processing plants may be addressed by initiating processing of farmed products as long as they fit within the requirements of the specific plant. Longer value chains will have greater economic impact but require the ability to produce the prime product at a relatively low competitive price.

Strategic Approach

Stand-alone aquacultural **processing infrastructure** will require a certain minimum **economic program size** before it can be justified. The Oregon program has probably not yet met this threshold. In the interim, options include dovetailing with existing commercial fisheries processing, repurposing existing infrastructures, and/or using out-of-state facilities.

Technological Innovation/Systems & Species

Context & Guiding Principles

Aqua farming crops are dynamic. The choice of crops and methods for raising them is changing rapidly—new organisms domesticated, current crops able to be grown under increasing intensification, new technologies being identified, and old technologies being refined. A strategic plan is not a census of current operations nor solely a trends analysis predicting options for new products. Given the inherent volatility in addressing specific production systems, plans need to be generic, at time prescriptive—able to be interpreted and applied to a wide variety of systems and species.

Strategic Approach

Categories of systems are probably most useful (e.g., ponds, raceways, cages, recirculating, etc.)—the nexus for strategic action being the combination of a given crop, grown using specific methods, in a specified environment. However, given the number of permutations, this much be addressed in a more **generic** way where different general categories of combinations can be prioritized and assessed. The plan is expected to provide **guidance** as to the best choices in terms of systems and species for Oregonian situations—not provide detailed information as to which crops and systems can be used where and how.

High Potential Zones

Context & Guiding Principles

Siting operations is important[39]. While water of varying qualities is a common denominator, different crops have different requirements—often developing sites to provide the needed requirements a costly process. There are, therefore, economies of scale in developing aqua farming operations. To attain the

[39] http://www2.ca.uky.edu/wkrec/AquacultureSiteSelection.PDF, http://www.fao.org/docrep/field/003/AC170E/AC170E00.htm,

minimum threshold, it may be necessary to cluster operations around a common resource or set of resources (e.g., an aquaculture "park"[40])—effectively establishing an aquaculture zone based on ecological conditions.

Zones may also be a development option when non-ecological factors are prominent in the decision-making process. Sites may cluster around a large market. Sites may, for regulatory and monitoring purposes, be clustered. Sites could be clustered in one watershed while excluded from others.

Strategic Approach

Concentrating effort ("**aquaculture parks**") may have advantages. **Targeting** zones of concentration requires thorough analyses including **tools** (e.g., spatial analyses) to delineate the zones and monitor their operations.

Information Management

Context & Guiding Principles

Knowledge is crucial to development. A significant knowledge gap has been attributed to the slow growth of the program. This knowledge needs to be enhanced by access to validated, science-based information. There is a wide variety of aquaculture information available today to the consumer. Unfortunately, as aquaculture may be seen by some as a "sext" topic, there is a large body of misinformation intertwined with the larger body of data and material available. There are a number of reliable sources[41]. Nonetheless, it is often difficult to filter out the "good" from the "bad".

Strategic Approach

Reliable and verifiable information is needed. Yet, there is an acknowledged shortage of information specific to **Oregon conditions**. In the short-term, wider access to that portion of the large body of information that is relevant to Oregonian investment could perhaps be best provided via the efforts of the **OAA** and its partners—posting the most appropriate material on-line. The information needs include **spatial information** tools[42] and oversight. Data from the broader global pool needs to be complemented with Oregon-specific information which, in turn, requires improved **record keeping**, collation, and analyses.

Finance & Credit

Context & Guiding Principles

Finance and credit are necessary for most enterprises. Aqua farming, as a new activity, is often challenged when seeking funding—the rate of failed investments higher than successes. Funding requires good market and business plans for the firm requesting the financing. The raw data to prepare such necessary documents is often lacking.

Strategic Approach

"Real-life" case studies of **bankable aquaculture investments** in Oregon along with verifiable Oregon-specific data sets are needed. These will be required to justify lending necessary for capital investment in

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[40] https://digitalcommons.lsu.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=3923&context=gradschool_dissertations, https://thefishsite.com/articles/government-receives-environmental-license-for-aquaculture-parks, https://www.africaportal.org/publications/national-investment-policy-for-aquaculture-parks-in-uganda/

[41] For example: http://www.fao.org/fishery/factsheets/en, https://fishculture.fisheries.org/resources/regional-aquaculture-centers/, https://www.worldfishcenter.org/publications-resources, http://sfaas.auburn.edu/international-work/publications/, http://aquafishcrsp.oregonstate.edu/publications

[42] https://www.uwsp.edu/cols-ap/GIS/Pages/Research/wisconsinAquacultureAssessment.aspx, http://www.seagrant.wisc.edu/Home/AboutUsSection/PressRoom/Details.aspx?PostID=1657, https://dnr.wi.gov/maps/Get-GISData.html

the state program. These will also serve not only as needed **templates** for use by would-be investors, but also set benchmarks for what should be a growing population of potentially profitable aquacultural operations.

Infrastructure

Context & Guiding Principles

Infrastructure—both general public and specific aquacultural—is another requirement for a viable aqua farming program. Farm-to-market transport is of the utmost importance for perishable aqua products. The network of public and private hatcheries, currently focusing on salmonids, could possibly be diversified to produce seed for other crops.

Strategic Approach

Oregon's infrastructure may be considered as above average. However, it is necessary to review investment options in light of **infrastructure pros and cons**. Infrastructure, therefore, needs to be built into **spatial planning analyses**.

Governance

Context & Guiding Principles

Good governance implies an openness to all stakeholder groups and a decision-making process that is built on verifiable science-based information. It requires educated actors at all levels and the needed instruments within which to operate.

Strategic Approach

The current **strategic plan** is the first of several steps to reinforce good governance. **Information dissemination** and **education** are key partners in these processes. Effective governance requires considerably improved **coordination** between all the various actors in the state program.

Theme 4: Educated Citizenry

Context & Guiding Principles

Education and overcoming the knowledge gap are major issues for the aquaculture program. These cover the gamut, as has been stated, of formal and informal education. These also incorporate information systems which are part of education, but also integral to many other segments of the overall Oregon program.

Oregon has a chain of high quality institutions from secondary through tertiary levels that have assets to add value to a state aquaculture program. Measure 98 offers some momentum to use these new interventions to develop a cadre of skilled entry level aquaculturists.

Strategic Approach

There is a negative legacy for aqua farming that must be addressed with ***science-based education****, shining a light on the most current and best practices.*

Tangible ***links*** *need to be forged between all education levels from primary school through graduate studies, including other partners active in supporting these scholastic actions****. Land and Sea Grant*** *tripartite structures linking university studies, research, and extension are important parts to shape and meld into the state strategic plan.*

Formal Education/Primary & Secondary

Context & Guiding Principles

Aquaculture is not a component of many primary or secondary curricula. The ODF&W egg to fry program[43] is the major entry point for a good number of schools. A few secondary schools have more comprehensive aquaculture or aquaponics instruction[44].

Strategic Approach

Existing programs and curricula provide a good base, formulated within the overall context of **Measure 98**, to develop appropriate learning tools for primary and secondary levels and ultimately to develop career paths (high school diploma) for skilled labor to support the hoped-for growing Oregonian aqua farming program. Other avenues and **strategic partnerships** may include FFA[45], 4-H[46], and importantly the Agriculture in the Classroom Foundation[47], as well as others.

Formal Education/Tertiary & Beyond

Context & Guiding Principles

The major actor for tertiary education is Oregon State University—increasing its role through the recent *Marine Studies Initiative*. Eastern Oregon University has expressed interest in aqua farming. Mount Hood Community College has a program focusing on salmonid hatchery operations. Other community colleges (e.g., Chemeketa, Clackamas) have had some aquaculture-related activities. The Oregon Institute of Marine Biology (University of Oregon) is engaged in some aquaculture-related work, as well.

Strategic Approach

Networking is important. The base of existing local knowledge is limited with inadequate exchange of information and **coordination** of efforts. A **network** linking all educational institutions from primary to graduate would be beneficial both to the institutions, the students, and the wider populace.

Extension

Context & Guiding Principles

Oregon has had aquaculture extensionists. However, at present, there is no full-time extension support albeit there are fulltime staff working on the food safety portion of the value chain. Yet, extension support, offering technical production advice to current and new operators, is effectively lacking.

Strategic Approach

Technical guidance and support are necessary for investors. This requires extension. Extension is expensive. **Land** and **Sea Grant** programs offer a framework for extension. Nonetheless, even if fulltime staff are available, looking at programs in other states, it is unlikely direct **on-site support** would be available for the majority of Oregon investors. Extension services, if established, are going to need to reply on **information tools** (including spatial analysis to target effort) and **partnerships** to get the job done.

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[43] http://www.dfw.state.or.us/fish/STEP/resources-education.asp

[44] BTI is an example of a school with specialized courses/instruction https://webspm.com/articles/2015/11/01/aquaponic-teaching-tools-examples.aspx

[45] http://www.oregonffa.com

[46] http://oregon.4h.oregonstate.edu

[47] https://oregonaitc.org

Informal Education & Outreach

Context & Guiding Principles

Today's citizenry has access to a multitude of information sources. The need for verifiable information is unquestionable. The risks of supporting and/or disseminating unsubstantiated/unscientific messages are real—leading at the very least to financial losses for those following erroneous pathways.

Strategic Approach

Vetting information entails highlighting messages and messengers providing **verifiable and traceable data**. This will demand a **coordinated effort** from public and private actors as well as channels to publicize these data in a **user-friendly**, and if possible, **interactive** way. A **common portal** may be the most useful for the investor.

Media

Context & Guiding Principles

Media is awash with aquacultural information. The media is both a benefit and a bane. At times, it seems for every piece of solid bankable data there are five pieces of miraculous empty wishes. The challenge is to find ways and means to filter the available information and then make that that if found to be of value available to operators on an open-access forum that is well publicized, supported, and controlled.

Strategic Approach

Open-access media will be an important tool in **closing the knowledge gap**. **Quality control** and maintaining **current material** is the difficult challenge.

Information Tools & Feedback

Context & Guiding Principles

Efficient and vetted information flow up and down the value chain is critical. The tools and media constituting these channels are rapidly changing. Among the most important are spatial analyses.

Strategic Approach

It is incumbent on planners to identify the **latest information technologies**, building the use of these into their works. These will most probably require pathways that **cut across** public and private networks and data management systems. **Common standards**, **definitions**, and **tools** are important.