

Developing Additional Investment in Aqua Farming in Oregon: a roadmap for sustainable development

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The author¹ wishes to express appreciation for the support offered by all engaged in this activity; those who have contributed knowledge and those who have contributed imagination. Aqua farming in Oregon has been a lonely undertaking engaging only a handful of pioneers, often unable to blaze permanent trails through entangled pathways.

The contributors to the present work have shown with their enthusiasm that it is now the right time to build on these pioneering efforts and develop a well articulated program that can meet expectations of all.

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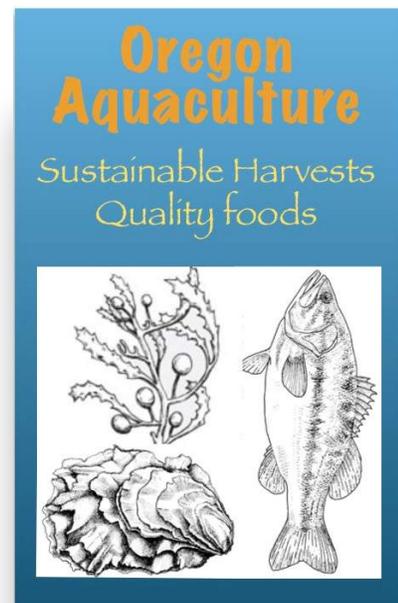
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Executive Summary

The work encapsulated in the present report represents an effort to examine how more investment could be made in the Oregon Aqua Farming Program to significantly increase this program's impact on the State's economy and the livelihoods of its citizens. The program was analyzed in terms of its current activities and future possibilities. This analysis included summarizing issues affecting the growth of the program as well as offering options for how this growth might be accelerated. These analyses reviewed the institutional setting of the program, incorporating processes and compliances necessary for investors to undertake aqua farming.

The report has a comprehensive set of twenty conclusions and recommendations which have been integrated into the five key takeaway points below:

1. *Aqua farming is in consonance with the Oregon Way, a significantly larger program possible through expansion, intensification and diversification. A target value of \$22.8M is proposed for a strengthened statewide program (current value of \$12.1M). To achieve this, the state must optimize her natural endowments.*
2. *There are more commonalities than differences among core issues affecting aquatic crop production statewide, regardless of the ecosystem — issues for which practical and responsible solutions exist.*
3. *Misinformation leads to exaggerated fear of unfounded dangers provoked by aqua farming as well as to poor investments founded on unrealistic and ill-founded hopes.*
4. *Collaborative action is needed with a centralized coordinating unit [ODA] serving as the focal point with the private sector playing an active role. Together these partners need to develop tools to increase responsible investment.*
5. *To guide this evolution, a state aqua farming plan is needed to, among others, target education, research and extension/outreach services — this requiring additional human and financial resources.*



The State's shellfish industry is monolithic, oysters the only crop, and the driver of the state program. Inland aquaculture as a producer of food for the table is a nascent enterprise in the State which has yet to achieve any critical mass whereby operators can influence policies or processes.

Over recent months momentum has been achieved with important milestones such as establishing the *Oregon Shellfish and Inland Aquaculture Advisory Group (OSIAAG)* to identify ways and means to amplify the State's aqua farming program. Concurrently, the global market for aquatic products is growing as are technologies to responsibly and profitably farm a wide variety of marine and inland waters. Given this convergence of market op-

portunity and access to innovative technologies, the Oregon program is at an important juncture. The stage is set for existing farmers to increase their production while newcomers enter the program producing a wide array of aquatic products. However, for this economic growth to happen, there must be immediate political and financial support. Specific aquaculture-flagged funding is necessary in 2015 if these opportunities are not to be lost. This funding can be from regular state fiscal resources, be extra-budgetary or a combination of the two. It is urgently needed.

OSIAAG needs to be the lens through which a new program is viewed and the filter through which this program is formed. Careful assessment and planning, through OSIAAG, is critical before any major new regulations are introduced: there are simply too many outstanding questions at this time to know how best any new regulation/legislation should be formulated or how existing regulations should be modified or adjusted. From the present work, it can be concluded that, while existing rules and regulations are not overly oppressive; many serving well understood and appreciated functions, but others requiring major updating.

Thus, funds should be used to design and implement a short-term *Support to Oregon Aqua Farmers* that will, in collaboration with OSIAAG: (i) undertake a comprehensive review of the *status quo* [building on the present document]; (ii) actively promote investment in aqua farming; (iii) elaborate a state aqua farming plan (**Plan for Sustainable and Responsible Aqua Farming Development in Oregon**); and, (iv) identify legislation required for the implementation of this Plan.

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List of Acronyms

AIS — Aquatic Invasive Species
ARS — Agricultural Research Service of USDA
ASC — Aquaculture Stewardship Council
BPA — Bonneville Power Administration
CITES — Convention on International Trade in Endangered Species
DEQ — Oregon Department of Environmental Quality
DSL — Oregon Department of State Lands
EEZ — Exclusive economic zone
EPA — US Environmental Protection Agency
ESA — Endangered Species Act
ESH — Essential salmon habitat
FAO — Food and Agriculture Organization of the United Nations
FCR — Feed conversion ratio
FDA — US Food and Drug Administration
FERC — Federal Energy Regulatory Commission
FIC — Food Innovation Center
FSA — USDA's Farm Service Agency
FSP — ODA's Food Safety Program
FWS — US Fish and Wildlife Service
HACCP — Hazard analysis and critical control points [systematic preventive approach to food safety]
HMSC — Hatfield Marine Science Center [Newport, OR]
LUCS — Land use compatibility statement
NAA — National Aquaculture Association
NIFA — USDA's National Institute of Food and Agriculture
NMFS — National Marine Fisheries Service
NPDES — National Pollutant Discharge Elimination System
NOAA — National Oceanic and Atmospheric Administration
NWP — Nationwide permit
MCS — Monitoring, Control & Surveillance — typically applied to capture fisheries but applicable to aquaculture
OAA — Oregon Aquaculture Association
OSIAAG — Oregon Shellfish and Inland Aquaculture Advisory Group
ODA — Oregon Department of Agriculture
ODF&W — Oregon Department of Fish and Wildlife
ODLCD — Oregon Department of Land Conservation and Development
OSU — Oregon State University
PCN — Pre-Construction Notification — USAEC requirement for new permits
PCSGA — Pacific Coast Shellfish Growers' Association
R&D — Research and Development
SBA — Small Business Administration
SCS — Soil Conservation Service
SHPO — State Historic Preservation Office
USACE — United States Army Corps of Engineers
USDA — United States Department of Agriculture
USFWS — United States Fish and Wildlife Service
WRD — Water Resources Department of Oregon
WRI — World Resources Institute
WWF — World Wildlife Fund



Often the difference between a successful person and a failure is not one has better abilities or ideas, but the courage that one has to bet on one's ideas, to take a calculated risk – and to act. – Andre Malraux (French author, 1901-1976)

Developing Additional Investment in Aqua Farming in Oregon: a roadmap for sustainable development

Introduction

There is little investment in aqua farming in Oregon. Although aquaculture is predicted to be the supplier of two-thirds of the aquatic food products consumed worldwide by 2030², this subset of food producing activities is not presently an important industry in the State. With the exception of oyster farming, which has been practiced for generations in the State's estuaries, the husbandry of aquatic organisms has been spotty and basically insignificant.

It is difficult to justify this benign neglect in any precise terms as, in most instances, it seems as though the aqua farming sub-sector was simply ignored in spite of regional, national and global trends³. This may, in part, be due to the traditional abundance of aquatic foods available to the fisher and gatherer; to this day Oregon's coast offering a cornucopia of foods to the exploring consumer.

When the wild marine harvest is added to the State's bounty of freshwaters, seen as being filled with salmon and trout, there may seem to be little impetus to invest in growing what occurs naturally.

However, aqua farming as an industry is more than a way to put food on the family's plate. The industry creates jobs, makes productive use of un- and under-used resources, generates high-value export crops while operating at high levels of biological and energy efficiency.

This is not to paint a perfect picture of aquatic farming. As with other forms of agricultural production, there has been abuse and even best practices are challenged by rapidly changing technologies and norms.

Nevertheless, in spite of noteworthy growing pains in the 1980s and 90s [demonstrating the newness of this industry], there has been considerable global effort invested in defining methodologies for responsible and sustainable water farming to the extent that today the negative footprint left by the industry is shrinking while the production of healthy and environmentally friendly aquatic foodstuffs is expanding around the world.

Globally, aquaculture has emerged from the shadows of the hobbyist and the isolated grower to an industry which is one of the fastest growing in many economies, as well as being one of the most transparent.

However, Oregon remains largely on the sidelines.

But, those who hesitate now lose market share. Many Oregon-consumed aquatic products that could be grown in-state are imported from other states or internationally. It is time for all to take a look at aquaculture and decide how Oregonians might take advan-

² http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2014/01/31/000461832_20140131135525/Rendered/PDF/831770WPOP11260ES003000Fish0to02030.pdf

³ It is estimated global aquaculture production will continue to increase, by 2022 the world crop being 85M tons, a 35% increase over today's harvest (http://www.fao.org/3/a-i3822e.pdf?utm_content=buffer55610&utm_medium=social&utm_source=linkedin.com&utm_campaign=buffer)

tage of the dynamic developments in this increasingly important agriculture sub-sector.

Preamble

This document discusses issues relating to getting Oregon off the sidelines, increasing investment in the State's aqua farming program. It is organized into three main sections roughly corresponding to the present, past and future — the past and present influencing future investment. The first section describes the industry as it exists today. It then examines how this industry is viewed by the public, including its impacts on society and the environment. The section concludes by looking into some possible new crops for Oregon growers as well as putting forth proposals as to how the industry could grow.

The second section characterizes the institutional environment which oversees investments in the State's aqua farming program. It highlights the state, national and local agencies that engage aqua farmers, describing new pathways as well as proposing roles for the public and private sectors.

The final section summarizes the opportunities and constraints and within these, proposes a way forward to enhance investment the State's program.

1. Situation Analysis

This section looks at aqua farms in Oregon today. How many are there and what do they raise? It attempts to answer the question of how these farms are viewed by the public as well as summarizing major social and environmental impacts from aqua farming. Within this overall situation, the section concludes by offering options for what could be done differently from a farming perspective; speculating on how these changes could affect the scope of the State's aqua farming program.

Guiding Principles

The aqua farming situation is analyzed within the context of several basic assumptions; guiding principles.

Before moving to these, it is worthwhile to define aquaculture. It is generally considered that aquaculture is the husbandry of aquatic organisms and that aquaculture is agriculture. To the farmer, this husbandry has elements of raising both plant crops and livestock; waters can be fertilized as terrestrial fields, animals are bred and seed is supplied.

The critical determinant when deciding whether or not an activity is aquacultural is the degree of control exercised. If the operator controls the aquatic environment and/or the organisms, it is considered as aqua farming.

Most often, the comparisons drawn for aquaculture are with "fisheries"; aquaculture, indeed, frequently being categorized as a component of the fisheries sector. Yet, fishers engage in fishing and fishing is akin to hunting. Others who may also call themselves fishers are more correctly engaged in gathering wild stocks. Those in the fisheries arena are hunter-gathers. Those in the aquaculture theater are husbandryists, even if they are raising crops caught in the wild.

The novelty of aquaculture accompanied at times by reputed paradoxes, can, and has led to periodic ambiguity as to how the sub-sector is seen and managed. Administratively, operating at the water-land interface can lead to confusion; stakeholders in small programs often operating in areas of grey. These cloudy guidelines can block planning horizons, only vanishing if and when aquaculture solidifies into mainstream agriculture.

critical mass

Decision making is about prioritization; there is a large array of investment options, a wide number of topics which may or may not receive political support. For most public agencies, prioritization is greatly influenced by impact; social, environmental, political and economic impact. Significant numbers of stakeholders and/or high productivity tend to push activities up the priority ladder.

Just as there is a minimum financial size for a firm, below which it is not profitable, there is a minimum size for a program; operating below this level making it difficult to justify the prerequisite public and private services required to support the program. This needed size is the program's critical mass; the amount of production it must achieve, the number of stakeholders it must incorporate, the level of political capital it can generate.

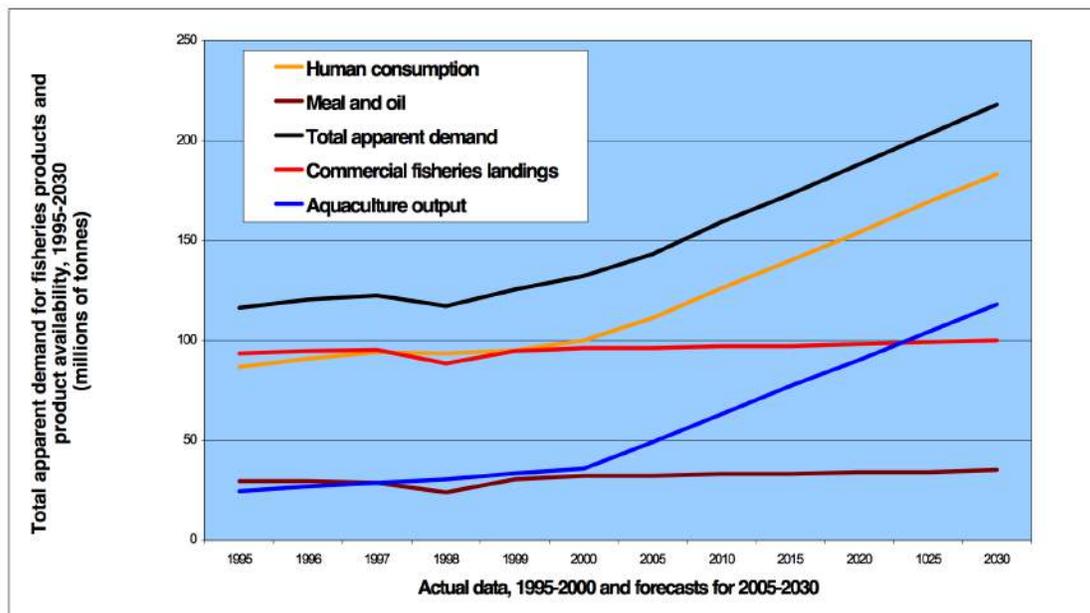
It can be very difficult to precisely estimate critical mass. However, its numeric value is less important than its recognition as a guiding principle; programs not able to achieve critical mass being in jeopardy of disappearing from the economic and political landscapes — perhaps justifiably so.

market-driven

In the case of productive enterprises such as aqua farming, economic efficiency is the pivotal factor. While a program needs to be market-driven, flexible and inclusive, a core of market- and profit-driven operations must reach the accepted critical mass for the program to be justifiable; the needed public and private investments offset by the derived productivity (e.g., harvest value, employment creation).

The market is the driver. NOAA reports: “*The United States imports up to 90 percent of its seafood, about half of which is from aquaculture. This results in a large and growing annual seafood trade deficit of more than \$10.4 billion.*” (http://www.fishwatch.gov/farmed_seafood/outside_the_us.htm). Although per-capita fish consumption fell from 2010 to 2011 by 0.8%

Figure 1: Demands for fishery products relative to foreseen supply from aquaculture and fisheries (in <http://www.dfo-mpo.gc.ca/Library/272059.pdf>). Additional analysis available from <http://www.ifpri.org/sites/default/files/publications/oc44.pdf>.



Source: Gilbert (2002)

(from 15.8 to 14.9 pounds, <http://www.aboutseafood.com/about/about-seafood/statistics/all-statistics>), as seen in Figure 1, globally demand is predicted to rise for the foreseeable future.

Over the coming two decades, it is suggested that among protein products, seafood will be the fastest growing; growing faster than beef or poultry (<http://pdf.gaalliance.org/pdf/gaa-johnson-oct03.pdf> and <https://www.was.org/Documents/MeetingPresentations/WA2005/WA2005-780.pdf>). Within the seafood menu, three of the top four products are important aqua crops, encouraging the consumption of farm-raised products nationwide (http://seafoodhealthfacts.org/seafood_choices/overview.php).

Status Quo

Investment in aqua farming in Oregon is low. As stated at the onset, investment is principally focused on growing oysters. While 17 of the reported 37 aqua farms in the State raise oysters, the more than \$10 million value of this crop gives it an almost seven fold advantage over its nearest aquatic competitor, trout food fish. The state program is more fully described by the four figures below, based on the most recent statistics for Oregon aqua crops as per the USDA 2013 Census of Aquaculture (June 2014).

● Mollusc ● FW Food Fish
● FW Sport Fish ● Ornamental Fishes

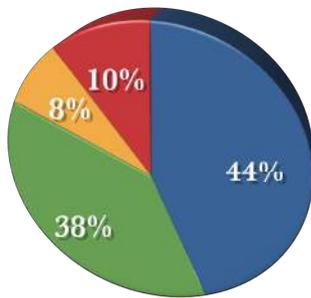


Figure 2: Relative number of aqua farms in Oregon with different aquatic crops (USDA, 2014)
FW = freshwater

● Mollusc ● FW Food Fish
● FW Sport Fish ● Ornamental Fishes

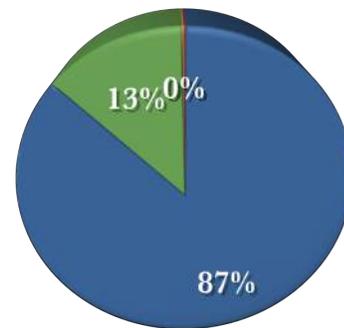


Figure 3: Relative value (\$000) of different aquatic crops (USDA, 2014)

● Marine ● Freshwater

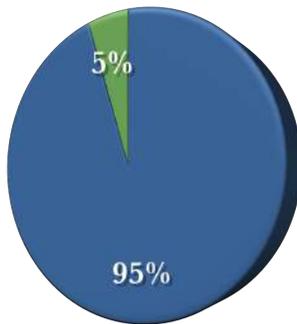


Figure 4: Relative area (acres) of aqua farms in Oregon in marine and freshwater environments (USDA, 2014)

● Oysters ● Trout ● Tilapia
● Catfish ● Salmon

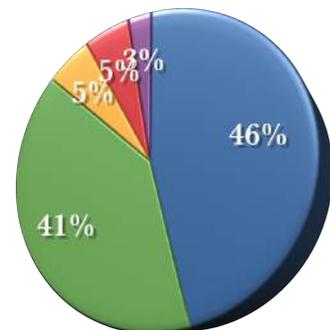


Figure 5: Relative number of farms growing different aquatic crops (USDA, 2014)

From the above, it is clear the marine zone is more active in aqua farming than freshwater areas. This fact notwithstanding, in addition to a 363-mile coastline with 22 major estuaries, it is estimated there are 1,400 named lakes, 1,300 large mainstream reservoirs, 10,000 small dams and 111,610 stream miles including the 309-mile Willamette River [State of Oregon Water Resource Department, 2007].

In spite of these resources, according to the USDA data for the period 2005 to 2013, the overall state program shrank by 20% in terms of number of farms and 3% in terms of total cash value. While farm number declined, farm size increased with a 46% and 83% increase in the area cultivated in the marine and freshwater environments, respectively; this change, as seen elsewhere, likely indicating an increase in the economic size of farms.

It may put these data in clearer perspective to note the 2014 Census specifies nine trout farms sold a total of 245,000 food fish (192 tons). A trout processing plant in Idaho (Idaho Trout Company) processes 15 tons/day — the entire Oregon harvest able to be processed in 13 days.

However, it should be emphasized the above figures do not tell the whole story. The Oregon Department of Fisheries and Wildlife (ODF&W) operates 32 state aquaculture facilities: salmonid hatcheries. In the aggregate, these units produce over 40 million salmon, steelhead and trout annually that account for 70% of the sport and commercial fish harvests and have an estimated total economic value of \$904 million (Oregon Fish & Wildlife: Inland Fisheries — Hatchery Management, January 22, 2013).

Perceptions

Aqua farming is viewed through many lenses. It is worth remembering that aquaculture as a food producing sub-sector is a relatively recent innovation. Although aquatic farming in others parts of the world has a much longer tradition, in the United States aquaculture only dates to the mid-1800s, focusing principally on sport fisheries, mainly salmonids, until the early 1960s. Parker provides a more detailed history (<http://www.aces.edu/dept/fisheries/education/documents/HistoryofAquaculture.pdf>). The newness of farming waters in the US has contributed to a scenario where technologies change rapidly⁴; at times, perceptions having a hard time to keep up.

Proponents note the opportunities from rapidly growing demand for aquatic products due to accelerating population growth vis-à-vis declining supply from wild stocks that favors aqua farming. Aqua farming as a set of growth industries continues to have successes. NOAA has documented successes in California, Hawaii and Washington (http://www.nmfs.noaa.gov/sfa/reg_svcs/Council%20stuff/council%20orientation/2007/2007-TrainingCD/TabY-Aquaculture/02_AquacultureSuccessStories_June%202007.pdf). To cite a few, other successes are documented for Idaho (<http://www.federallabs.org/flc/success-stories/?id=14>), Florida (<http://www.careersourcerc.com/employers/success-stories/397-florida-organic-aquaculture>), Virginia (<http://www.aquaculturemag.com/magazine/october-november-2014/2014/11/01/blue-ridge-aquaculture-story>), West Virginia (<http://pdf.gaal-liance.org/pdf/GAA-Simmons-June01.pdf>) and Canada (<http://www.aquaculture.ca/files/economic-benefits.php>).

However, all is not rosy. Opponents caution that aquaculture, like agriculture, engages in harmful [to the consumer and/or the environment] practices that are all the more worrisome as they directly affect essential waters. Ken Stien's article in *Time* ("Fish

⁴ Current discussions on aqua farming technologies can be found on Twitter at #aquaculture

Farming's Growing Dangers", September 19, 2007) summarizes well the core concerns:

"Unless the [aquaculture] industry finds alternatives to using pelagic fish to sustain fish farms... the aquaculture industry could end up depleting an essential food source for many other species in the marine food chain... There are other collateral problems created by industrial scale aquaculture: the destruction of coastal habitats through waste disposal, the introduction of diseases and the possible escape of exotic species that can threaten indigenous breeds."

As highlighted by Stien, there are real technical issues inherent in raising aquatic organisms which could provoke concerns. Nonetheless, again perhaps exacerbated by the sub-sector's newness, there is a considerable knowledge gap among the general public. It is frequently difficult for the observer to thoroughly grasp the interrelationships to know if an issue is, or is not a problem. When faced with uncertainty, the fall-back is to err on the side of conservation.

Accordingly, public perceptions of aqua farming often see the introduction of a new underwater form of farming as too risky. An example of a less measured perception is the following emphatic statement:

"Fish farms, or 'aquafarms,' discharge waste, pesticides, and other chemicals directly into ecologically fragile coastal waters, destroying local ecosystems. And aquaculture farms that raise fish directly in fenced-in areas of natural waters kill off thriving natural habitats by overloading them far beyond their capacity. Waste from the excessive number of fish can cause huge blankets of green slime on the water's surface, depleting oxygen and killing much of the life in the water." (<http://www.peta.org/about-peta/faq/is-aquaculture-bad-for-the-environment/>)

Unbalanced or overgeneralizing reporting often dominates the information which is available to the observer. As another example of strong opposition focusing on off-shore culture:

*Offshore fish farming, also known as open ocean aquaculture, involves giant cages located about 30 feet under water anywhere from three to 200 miles off the coast. Here are 10 reasons why this is so problematic: **Competing/Conflicting Interests**, open water aquaculture facilities could cause conflict of interest — areas of current significant competing economic use or public value must be eliminated for consideration for open ocean aquaculture;*

THE INDIANA MODEL: the state of Indiana is slightly south of Oregon (i.e., 37-41° latitude vis-à-vis 42-46°). However, it has greater temperature fluctuations: 16-89° F for Indiana and 33-83° F for Oregon (http://www.netstate.com/state_geography.htm). At one time aquaculture was not part of the Indiana economy (<http://www.indystar.com/story/news/2014/10/17/ketzenberger-fish-farming-indiana-longer-far-fetched/17271463/>). Today aquaculture thrives. A 2003 study, *Economic Importance of Aquaculture Industry in Indiana*, concluded: *"While aquaculture is not the most well-known industry in Indiana's agriculture sector, it is definitely present and very important to the state's economy. The industry has seen steady growth over the past few years, and it is important to know exactly how much economic activity is associated with aquaculture in Indiana.*

Because of the money generated within the state, people being employed, and taxes generated for the state, the Indiana economy benefits from the aquaculture industry. There are 280 citizens of Indiana who have jobs that are supported by this industry, and \$37,892,895 worth of output is generated through the local economy because of this industry. Employees in the state are paid \$7,541,867 annually in the aquaculture industry and other industries supported by aquaculture. The aquaculture industry generates \$19,484,193 worth of total value added to the state's GDP annually. These are jobs and revenue that could possibly disappear if the aquaculture industry were non-existent in Indiana. These results show the importance of the industry to Indiana's economy, which will enable industry professionals and those interested in aquaculture to better justify investments into further research and development of the aquaculture industry. This is important for the future growth and sustainability of the industry as it continues to expand and keep up with aquaculture in the rest of the country and the world." <http://www.ecs-ga.org/Pages/Sustainability/ShumwayWASarticle.pdf>

Escapement, offshore aquaculture of finfish uses cages or pens — these containers, even if well engineered and built, will allow some fish escapes into the open ocean; **Growing Exotic / Mutated Species**, several problems are associated with aquaculture production of non-native species; **Growing Genetically Modified / Transgenic Organisms (GMOs)**, farm raised fish are bred for profit, thus, those that have certain marketable traits are the most desirable — selecting and only breeding fish with advantageous characteristics (e.g. largest and fastest growers) is one means to alter genetic composition over time; **Habitat Impacts**, use of the U.S. EEZ for aquaculture requires construction of appropriate facilities and in some areas could include severe habitat impacts; **Inefficiency** cultured species are fed wild species — this is an inefficient use of wild fish; **Water Pollution**, water pollution concerns include the following excess food, feces, cage materials and antibiotics/other cleaning/algal growth prohibiting chemicals; **Mitigation Plans for Hazards**, a number of threats to wildlife and the environment can come from open water aquaculture; **Human Health Concerns**, studies indicate that farm-raised fish contain higher levels of chemical pollutants than wild fish, including PCBs, which are known carcinogens; and, **Unexpected Environmental Harm and Abandoned/Bankrupt Facilities**, open-ocean aquaculture depends on various factors, including weather, currents, disease control and human precision. (<http://www.foodand-waterwatch.org/common-resources/fish/fish-farming/offshore/problems/>)

While the above examples of the risks of aqua farming vary in presentation and drama, there are common threads that reflect real issues (e.g., competition for space/water/energy/markets, chemical/biological pollution, disease, loss of bio-diversity/introductions (escapes)). However, like agriculture, aquaculture is varied and, in its breadth, cannot be encapsulated in a few stereotypic phrases. Culture systems and organisms cover a wide range of vertebrate and invertebrate species including plants and micro-organisms. When done improperly, these farms can have negative impacts; when done well, these enterprises can replace imports, stimulate local economies and provide nutritious foods to consumers.

Perhaps with an eye to both sides of the equation, a more forward-looking approach is adopted by the World Wildlife Fund (http://wwf.panda.org/what_we_do/how_we_work/businesses/transforming_markets/solutions/certification/seafood/aquaculture/impacts/), endorsing joint efforts with aquaculture stakeholders through ASC (<http://www.asc-aqua.org>), the world's leading certification and labelling program, to address core issues to the mutual benefit of all parties. This objective sciences-based approach is shared by Greenpeace (<http://www.greenpeace.org/usa/global/usa/report/2008/3/challenging-aquaculture.pdf>) and should form the basis for objective assessment of aqua farming operations and be the source of the best practices that should be applied by Oregonian aqua farmers.

When implemented using best practices, producing certified products, aqua farming may not have minimal negative impact, it may be a net plus — recent technologies tagged *climate smart aquaculture* address “the multiple needs and desires of societies, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by the aquatic ecosystems” (<http://www.climatesmartagriculture.org/35176-092e6d8319a9d7c9143a99d8aacc1f51df.pdf>).

Environmental & Social Dimensions

While the perceptions of aquaculture and aqua farming may have often been harsh, this scrutiny has led the global industry to develop and pursue best practices and standards of performance that address negative issues affecting aquaculture's image, performance and impact (e.g., <http://www.aquaculturecertification.org>, <http://www.gaalliance.org>, <http://www.gaalliance.org/cmsAdmin/uploads/BAP-SalmonF-611.pdf>, <http://www.fao.org/docrep/005/v9878e/v9878e00.htm#9>). The driving forces behind the adoption of best practices are frequently the operators themselves, who see the clear need to educate the populace and safeguard the environment that is the source of their livelihood.

The key to overcoming much of the negative perception of the wider program is

education and responsible utilization. The public in general needs to have a better-founded understanding of the science behind aqua farming; the real pluses and minuses of sustainable use of the State's aquatic resources. Moreover, as a diversified program is still in its infancy, it is relatively easy at this time to apply best practices and standards of performance that have been established through several globally recognized certification programs. Application of high standards to agricultural enterprises is very much in line with the way the State's farming programs function, the transference of these approaches to aqua farming a logical step.

A recent study recognizes the advantages of increased investments in aquaculture, but also acknowledges these must be undertaken with specific attention to key socio-economic and environmental factors (*Improving Productivity and Environmental Performance of Aquaculture*, World Resource Institute [WRI] Working Paper, June 2014). Specifically, the report recommends: (1) increasing investment in technological innovation and transfer, especially in breeding and genetics, disease control, nutrition/feeds/feeding management, and low-impact production systems; (2) using spatial planning and zoning to guide aquaculture growth at the landscape and seascape level; (3) shifting incentives to reward improvements in productivity and environmental performance; (4) leveraging the latest information technology to drive gains in productivity and environmental performance; and, (5) shifting fish consumption toward low-trophic farmed species.

While there are trade-offs and many farming systems need to be evaluated based on the objective pros and cons, the WRI study found, "*Of all species groups, only bivalve mollusks (e.g., oysters, clams, mussels, scallops) performed well across all environmental impact categories*". This conclusion has been echoed by the Pacific Coast Shellfish Growers Association which found shellfish enhance water quality and habitat (<http://pcsga.org/wprs/wp-content/uploads/2013/05/ENVIRONMENTAL-BENEFITS-OF-SHELLFISH-FARMING.pdf>)⁵.

However, the benefits are not restricted to shellfish. NOAA states aquaculture makes environmental sense (http://www.noaa.gov/features/resources_0109/aquaculture.html), while PBS provides examples of innovative aqua farming (<http://www.pbs.org/kqed/oceanadventures/episodes/amazon/indepth-fishfarming.html>). Feeding aquatic crops terrestrial diets also leads to a series of ecological and health gains (<http://28vp741fflb42av02837961yayh.wpengine.netdna-cdn.com/wp-content/uploads/2012/09/aquaculture-marketing-brochure.pdf>).

Drilling down into specifics influencing investments in Oregon's aqua farming, most publicized concerns are being addressed. Teams of state and federal researchers⁶ at the Hatfield Marine Science Center are investigating a variety of topics relating to aqua farming in coastal areas (<http://hmsc.oregonstate.edu/research/research-partnerships>) assisted by the Oregon Sea Grant program (<http://seagrant.oregonstate.edu/sustainable-aquaculture>). These actions dovetail with regional, national and international research agendas that are tackling a variety of questions including identifying replacements for fishery products in aqua feeds as well as mitigating the impacts of disease and maintaining high water quality. Overall, the majority of the burning issues are being examined and solutions found.

⁵ A complementing report found at <http://www.ecsga.org/Pages/Sustainability/ShumwayWASarticle.pdf>.

⁶ National Strategic Plan for Federal Aquaculture Research 2014-2019 (http://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/aquaculture_strategic_plan_final.pdf)

Social impacts of aqua farming are less well defined⁷ and at times more difficult to solve. Aquaculture has been criticized as “visual pollution”; aqua farming facilities disrupting pristine land- and/or seascapes. Throughout the value chain, aqua foods require land, water and energy — inputs for which there is keen competition. Facilities may generate by-products that may be considered as unpleasant by some, unacceptable by others. In this context, investing in aqua farming is no different than investing in any other enterprise that has social costs and impacts: how do these costs balance with the benefits?

Aqua farming will consume resources and even the most environmentally friendly will result in some changes that will inevitably make some segments of society unhappy. Aqua farming will also make jobs, produce food and generate taxes. Evaluation of the trade-offs should a part of any plan for investment.

Options (marine and in-land)

The Oregon program is monolithic. It is narrow and quite small. One insider noted that, of the oyster farms on record, only seven are commercial growers. Complexities in the bureaucracy (following section) make it difficult to corroborate or repudiate this statement. Nevertheless, it is clear the State’s aquaculture program is limited and there could be doubts as to whether or not critical mass has been achieved.

The diminutive size of the program is a function of multiple factors including climate and public perceptions. The large diurnal and seasonal swings in temperature make the outdoor (uncontrolled) raising many aquatic crops difficult, while indoor (controlled) culture adds significantly to the cost. Land-based units are competing with many users for high-value agricultural and coastal plots while water-based operations are confronted with numerous special regulations and requirements. Overarching all, from time to time there has been an impression that both the general public and her representatives would be just as happy if the aqua farmers went elsewhere.

Importantly, these conditions are not absolute obstacles. Many western and mid-western states with more capricious climates than Oregon have more diversified aquaculture programs. Over recent decades, aquaculture as a family of husbandries has grown tremendously with an increasing number of crops now able to be cultured over a wider range of environments⁸. Unquestionably, this list of options includes crops that could be grown in Oregon to expand the program. Table 1 provides a list of selected crops that would appear to be appropriate for the State’s biological and social environments.

What makes a crop suitable?

As one looks to tap these opportunities, the starting point for the investor is the market. Newcomers, both in terms of operations and products, need to start with a market study. Is there a market — where, how big and for what specific product? Products may be for human consumption, ornamental or, among others, ingredients in animal feed including aqua feeds.

Markets may be domestic or export; the former heavily influenced by consumer preference. While the tastes of Oregonians are rapidly changing, there are numerous options that would fit biologically but would not attract adequate market share. Value addition and speciality niche markets will offer modest opportunities, but a core of significant

⁷ Few specific references have been found for the US program and none for Oregon. An analysis, however, was undertaken for Europe which provides a good guideline: <http://archimer.ifremer.fr/doc/1991/publication-3705.pdf> .

⁸ It is estimated there are 600 aquatic species worldwide that are cultured (FAO SOFIA 2014)

Table 1: Organisms which could be key components of a diversified Oregon aqua farming program.

Marine	Freshwater
<p>Manila clams http://www.innovativeaqua.com/Publication/clam.pdf http://www.extension.org/sites/default/files/Small-scale%20clam%20farming%20for%20pleasure%20and%20profit%20in%20Washington.pdf http://bcsga.ca/about/industry-encyclopedia/clams/</p>	<p>Sturgeon http://www.dfw.state.or.us/resources/fishing/docs/Sturgeon%20Manual.pdf http://ec.europa.eu/fisheries/documentation/publications/factsheets-aquaculture-species/sturgeon_en.pdf https://www.youtube.com/watch?v=6R4NjHXqdnU</p>
<p>Little neck clams https://seagrant.uaf.edu/map/aquaculture/shellfish/presentations/Introduction%20to%20clam%20farming.pdf http://www.nwrc.usgs.gov/wdb/pub/species_profiles/82_11-078.pdf</p>	<p>Hybrid striped bass https://www.extension.org/mediawiki/files/4/42/Hybrid-Striped-Bass-Production-Markets-and-Marketing.pdf http://www.ncagr.gov/markets/aquaculture/Bass01.pdf http://www.extension.org/mediawiki/files/a/a3/Hybrid-Striped-Bass-Pond-Production-of-Foodfish.pdf</p>
<p>Mussels http://www.penncoveshellfish.com/Farming/farm_clams.html http://vimeo.com/14639047 http://www.fishwatch.gov/seafood_profiles/species/mussels/species_pages/blue_mussel_farmed.htm</p>	<p>Yellow perch https://www.extension.org/mediawiki/files/4/4a/Yellow-Perch-Culture-Guide.pdf http://www.uwsp.edu/cols-ap/nadf/Project%20Results/Project%20Reports/Production%20of%20Yellow%20Perch%20-%20Technology.pdf http://www.ncrac.org/book/export/html/43</p>
<p>Abalone http://www.montereyabalone.com/farming.htm http://www.sfgate.com/recipes/article/Abalone-s-luster-grows-Eco-friendly-aquaculture-2614648.php http://aqua.ucdavis.edu/DatabaseRoot/pdf/ASAQ-A10.PDF</p>	<p>Tilapia http://www.aces.edu/dept/fisheries/aquaculture/docs/worldtilapia.pdf http://www.extension.org/mediawiki/files/9/9a/Tilapia-Farm-Business-Management-nad-Economics-A-Training-M.pdf http://www.ncrac.org/NR/rdonlyres/47992607-C5F4-4425-B7DA-1B71764C46DA/0/whitepapertilapia.pdf</p>
<p>Algae http://www.seaweed.ie/aquaculture/noricultivation.php http://www2.ca.uky.edu/wkrec/AlgaeGrowNRAC-160.htm http://www.uniquemainefarms.com/uniquemainefarms.com/Ocean.html</p>	<p>Carp http://www.fao.org/fishery/culturedspecies/Cyprinus_carpio/en http://fisheriesjournal.com/vol2issue1/Pdf/24.1.pdf https://www.sfos.uaf.edu/fitc/teaching/courses/fish336/materials/Common%20Carp.pdf</p>
<p>Sea cucumbers http://www.fao.org/docrep/007/y5501e/y5501e0x.htm http://www.worldfishcenter.org/resource_centre/WF_3033.pdf http://www.spc.int/DigitalLibrary/Doc/FAME/InfoBull/BDM/18/BDM18_18_Chen.pdf</p>	<p>Shrimp [marine in inland systems or freshwater] http://css.snre.umich.edu/css_doc/CSS09-15.pdf https://www.was.org/documents/MeetingPresentations/AA2009/AA2009_0384.pdf http://www.fao.org/3/a-y4100e.pdf</p>
<p>Sea urchins http://ccag.tamu.edu/mariculture-port-aransas/superintensive-sea-urchin/ http://www.ccar.um.maine.edu/PDF/Urchin%20farming%20Brochure.pdf</p>	<p>Walleye http://www.ncrac.org/NR/rdonlyres/0C08D68B-49AC-4367-BD5D-36148952B9A8/129151/WFS116secure.pdf http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_023619.pdf http://www.ncrac.org/NR/rdonlyres/428E5B09-FA80-4D7B-BD0F-A5D51E675878/0/Chapter9.pdf</p>
<p>Purple Varnish Clam http://www.dfw.state.or.us/mrp/shellfish/bayclams/ClamID.asp http://www.netartsbaytoday.org/html/clams_.html http://faculty.washington.edu/cemills/Nuttallia.html</p>	<p>Ornamental fishes and plants http://www.fao.org/fishery/topic/13611/en http://aquafind.com/articles/Ornamental-Fish-Culture.php http://fisheries.tamu.edu/files/2013/10/International-Trade-in-Live-Ornamental-Fish-in-the-U.S.-and-Florida.pdf</p>

demand for several Oregon-produced aqua products is probably necessary to develop the needed critical mass.

For new crop options with favorable market results, the next step in the investment preparation process is to determine the status of the crop to be raised: is it indigenous to Oregon, introduced to Oregon but established or exotic to the State and needing to be introduced? If, through whatever channel, the crop can be raised, what production system

would be used and what inputs are required? Systems could include ponds, raceways, tanks, trays, cages, longlines or any of a variety of other methods using static or flowing [flow-through or recirculating] waters, being indoors or out.

At this point, well before breaking ground, the would-be investor should have enough information to do a comprehensive business plan. The aspiring aqua farmer should only begin project development after drafting a positive business plan; the first step in the implementation process being addressing the required administrative and regulatory work (following section) needed to have an approved project, whereafter ground can be broken.

It is important to appreciate that many of the systems required to establish an aqua farming operations are appropriate for Oregon's rural communities. In fact, finfish production is currently taking place in Dayville, Scio and near Christmas Valley. Aqua farming offers these rural areas opportunities to generate revenue and create jobs.

Expansion

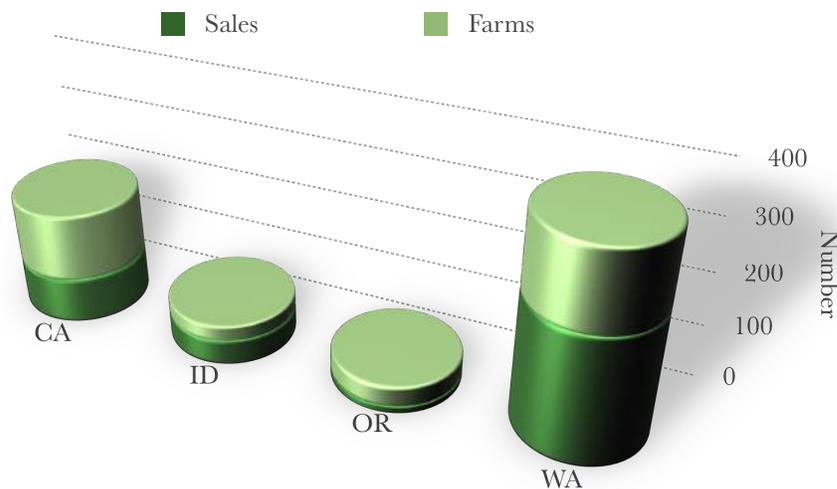
As can be seen from the section above, there are numerous options for new aquatic crops to be incorporated into the existing state program. To ensure critical mass is achieved, it might be useful to have an aggregate target for the State's program. What would be a realistic aim for an expanded program?

FAO reports that in the Americas 15% of fish supply comes from aquaculture (<http://www.fao.org/3/a-i3720e.pdf>). With this guideline and Oregon's \$152M catch (http://www.nass.usda.gov/Statistics_by_State/Oregon/Publications/facts_and_figures/facts_and_figures.pdf), **a target of \$22.8M seems feasible; reflecting a 90% increase.**

From where would this increase come?

Referring to Figure 6, it would seem that Oregon has considerable unused potential given the size of programs in neighboring states. Furthermore, referring to the USDA figures cited above, the State's total 2013 aquatic harvest, evaluated at a \$12.1M, was centered around the State's oyster industry which is typified by bottom culture with some long-lining. There are a number of production technologies currently not widely used in

Figure 6: Comparison of Pacific Coast state aquaculture programs. These can be taken in consideration to the national program with 3,093 farms and a total harvest valued at \$1.4 Billion (USDA Census of Aquaculture).



the state (e.g., stake, rack and bag, etc. <http://wsg.washington.edu/mas/pdfs/smallscaleoysterlr.pdf>) which would seem to offer considerable potential for intensification on some farms. Through expansion and intensification, the oyster industry could achieve meaningful increases. A target for the immediate-term could be a 20% increase in the value of the oyster component of the industry⁹.

Moreover, with a streamlining of legislation and regulations, it is plausible, as has happened in California and Washington, new marine crops would enter the field. Clams, mussels and abalone are indigenous, with well-known and practiced culture systems. Other invertebrates and algae would also be candidates, but would perhaps fit less seamlessly into the marine aqua farming culture as it exists today.

The freshwater environment¹⁰, with a total value of \$1.6M [\$1.5M attributed to trout], is little used, offering noteworthy opportunities for expansion. However, it is questionable if trout could or should be the sole building block for this expansion. Trout food fish markets are supplied by Idaho, Chili and cages from the Columbia River system in Washington; it is uncertain if large-scale Oregon trout farming could compete in these exchanges. There will continue to be niche trout food fish markets, but with big actors like Idaho (having trout sales totaling \$45.2M — 41% of overall US trout sales (USDA)) in the back yard, it is hard to capture major market share without innovation and high efficiency.

Trout for stocking waters for sport fisheries is an important product, today supplied by public hatcheries. These facilities are facing a number of challenges including funding and fish health. Over the course of the medium-term, it may be advantageous to see how much of this supply could be shifted to private operators.

Beyond trout, there are a number of alternative freshwater crops where the State's aqua farmers could have more of a comparative advantage in the marketplace. Sturgeon is a native fish with high-value flesh and eggs. Tilapia and yellow perch are introduced fishes already established in the State; fishes also with established markets. Carp are found throughout the State. Carp are one of the world's chief aquaculture crops — valued at \$33M and representing 14% of the total global harvest (http://www.fao.org/fishery/culturedspecies/Cyprinus_carpio/en). While Oregon consumption is paltry and global carp prices have been falling, there are growing opportunities for niche markets in urban areas for the common carp and/or other Chinese carps.

Of the immediate-term target of a \$22.8M program, an aim should be to have a minimum of 33% of this harvest come from inland waters (inland waters currently accounting for 13% of the total value of the Oregon program (USDA)). Figures 7 and 8 graphically illustrate the foreseen changes in the State program over the medium-term.

Expansion embraces farming new waters, growing new crops and employing new techniques for both new and existing crops. Figures 9 and 10 show the systems, or production technologies, categorized by the USDA Census and their relative use.

Figure 10 refers to recirculating and non-recirculating systems. In the former, the water is reused, passing through filtration to remove deleterious products; additional water used to replace any seepage and evaporation losses. In the latter, the water is used only once for the crop.

⁹ USDA (2014) reports a 112% increase in oysters in Washington over the period 2005 to 2013.

¹⁰ Of the global food fish harvest (66.6M tons valued at \$137B), two-thirds is from inland aqua farming (FAO SOFIA 2014).

● Marine ● Freshwater

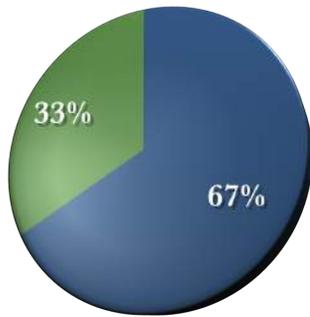


Figure 7: Projected balance between marine and freshwater systems in the medium-term (Figure 4 presents the current situation)

● Oysters ● Other shellfish
 ● Other marine crops ● Trout
 ● Other freshwater

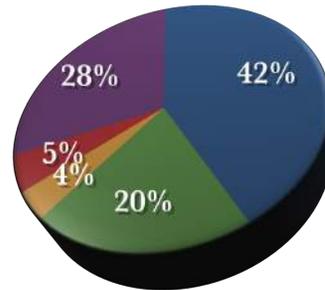


Figure 8: Projected composition of the State aquaculture program in the medium-term

● Bottom ● Floating trays
 ● Rack & bag ● Long line
 ● String ● Rafts
 ● Other

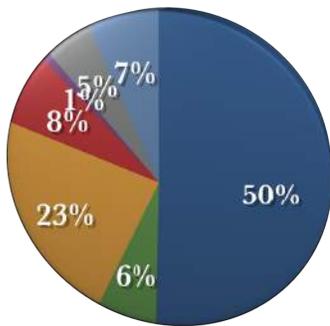


Figure 9: Farms using different shellfish production systems reported nationwide.

● Ponds ● Raceways
 ● Recirculating ● Non-recirculating
 ● Cages/pens ● Aquaponics

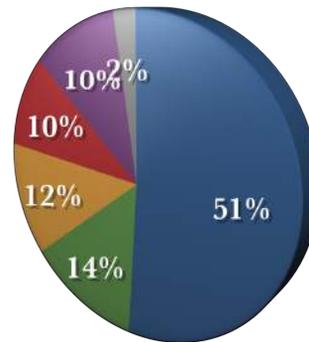


Figure 10: Farms using different finfish production systems reported nationwide.

Figure 11 relates to aquaponics; with 71 farms nationwide (i.e., 2% of the overall program), this is a minor component but one of growing visibility. Aquaponics is simply the merging of aquaculture and hydroponics¹¹. In the majority of successful cases, fish are introduced into farming systems where the horticultural portion is already profitable. As these systems are complex, requiring quite a lot of hardware, they can be expensive to build and operate — profitability not guaranteed. Aquaponics is more a methodology that can be applied to a variety of systems

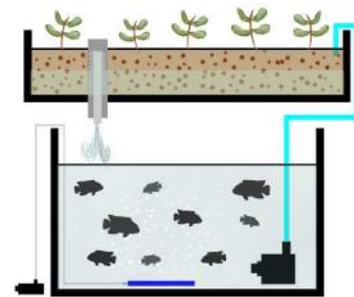


Figure 11: Schematic of aquaponics (<http://www.hydroponicsworld.co.za/aquaponics/>)

¹¹ <http://ucfoodsafety.ucdavis.edu/files/198180.pdf>

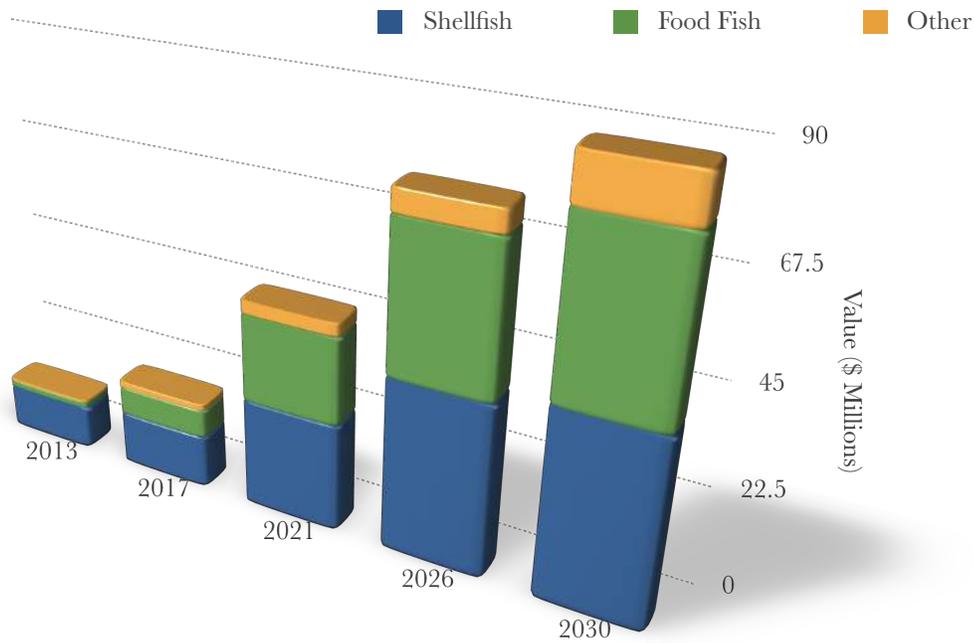


Figure 12: Possible trajectory of an expanded, diversified and intensified Oregon aqua farming program showing total dollar value of the program divided among shellfish, food fish and other crops.

in a variety of ways. A recent review is available at <http://www.fao.org/3/contents/362f364a-b0d1-4b3b-8aa6-a725dac6515e/i4021e.pdf>.

Before leaving the topic of systems, there are two groups that merit highlighting as probably minor but potentially noteworthy. Ornamental plant and animal production can be a good investment. These markets are very competitive and often controlled by big companies operating in more factorable climates. But there are niches to be supplied and these systems can be very compact: space and energy efficient.

Small dams and impoundments may become increasingly important for multiple uses in changing hydrological conditions driven by changing climate. Among the multiple uses of these waters is aquaculture and fisheries, for recreational and/or productive use. They represent not only a water resource but also an economic resource, being clients for specialized service providers. In some states small businesses have evolved to fill this farm pond service niche.

Returning to the overall state program, Figure 12 presents a schematic of how the state program could grow, building on the current shellfish base. The component of “other” is initially very minor, but expands rapidly. This would include the culture of seaweeds and algae, crops composed of invertebrates raised for animal feeds, crops with industrial uses, etc. This schematic does not include the value of producing fish seed for stocking public or private waters for commercial fishing or recreation. Culturing stocking material is, as has been shown, an important part of the program; a part generating considerable economic value. While producing this stocking material is aquaculture, much of it is more closely allied with ODF&W operations. From a programmatic perspective, this segment is fully recognized as important, but the focus of the current work is food production.

The increases in aqua farming output proposed here-in would be easily assimilated since the Oregon seafood market will likely increase as people become more aware of the advantages of these foods in their diet and as alternative protein sources become more expensive. Nation-wide, the current consumption (2009) of fish and shellfish is 3.5 oz/person/week¹² — only one-half the USDA recommendation (http://www.nmfs.noaa.gov/aquaculture/faqs/faq_seafood_health.html). Forecasters predict increasing per capita consumption over the coming decade (reference footnote 1).

Synopsis

Oregon's aquaculture industry is to date a minor piece of the State's agriculture mosaic and, with the exception of oyster harvesting which dates to the 1860s (<https://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/24985/SGNO13.pdf?sequence=1>), an amalgam of new and fragmented activities. Among western states (west of the Rockies), only Nevada and Utah generate lower revenue from the sale of food fish.

Those food fish raised in the State are cold water salmonids — principally trout. The State is, however, also home to major sturgeon populations¹³; a high value crop raised in neighboring states. Moreover, of 15 warm water fishes listed for the State (http://www.dfw.state.or.us/resources/fishing/warm_water_fishing/how_to_catch.asp), three are cultured in other states (i.e., channel catfish, hybrid striped bass and yellow perch) while the culture of six others (i.e., large and small mouth bass, walleye, black and white crappie, Sacramento perch) has been defined; these fishes suitable for stocking waters for sports fishing and possibly as food fish. This underscores the point that aqua farming offers opportunities not only for food production but for raising ornamental aquatic plants and animals as well as animals for stocking natural waters for recreation or restoration.

The coastal zone has access to an even longer list of culture options including a wide variety of finfishes, shellfish beyond oysters and other marine invertebrates as well as algae. Shellfish will likely remain a cornerstone of the state program and offer, at present, the broadest base upon which to build. However, the mariculture sub-program will only achieve its potential when it diversifies, integrating an expanded number of culture options.

The logical conclusion is that the State has significant un- and under-utilized aquaculture resources. Investing in these could reap multiple benefits including enhanced economic growth.

Unfortunately, due at least partially to disparaging publicity and an important information gap, Oregon has not been seen as a welcoming partner for the aqua farming investor. Some investors have moved farms out-of-state when confronted with inhospitality while others grow their crops outside Oregon and bring them here to process. At the same time, given the lack of a well established aqua farming presence, a variety of promoters of questionable aquatic systems target the State as being a susceptible client unfamiliar with the realities of cultivating her waters.

There are real benefits from being at the bottom of the list. The aquaculture sub-sector is growing (<http://www.globalaginvesting.com/news/blogdetail?contentid=1439>) and

¹² This is the equivalent of 5.2 kg/p/yr. compared to a global average of 19.2 kg/p/yr (FAO SOFIA 2014)

¹³ The green sturgeon (*Acipenser medirostris*), is listed in CITES Appendix II and is an ESA species of concern: <http://www.nmfs.noaa.gov/pr/species/fish/greensturgeon.htm> and <http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E09K>

significant gains can be made with relatively modest investments¹⁴. The State has the natural aquatic resources. The State has relatively inexpensive land and energy with good infrastructure connecting farms to major West-coast urban markets. The State's populace has a fish-eating tradition and an exploratory cuisine that offers opportunities for innovative aqua farmers. The State also has a multifaceted agricultural sector that encompasses a wide variety of enterprises from micro- to industrial-scale. Accordingly, the foundations for a significantly expanded aqua farming program are in place. What will be built on this foundation?

¹⁴ A single abalone farm in California produces, by value, 20% of the Oregon shellfish harvest while finfish farms in Virginia and Indiana produce more from a single farm than the state's current food fish output (<http://www.blueridgeaquaculture.com/aboutus.cfm>, <http://www.indystar.com/story/news/2014/10/17/ketzenberger-fish-farming-indiana-longer-far-fetched/17271463/>, <http://www.bellaquaculture.com>) while hog sheds have been covered into high value aqua farms in Iowa (http://www.iowafarmertoday.com/news/livestock/hog-buildings-converted-to-fish-farming/article_3747f8ac-e133-11e3-bdf3-0019bb2963f4.html).

2. Processes

This section examines what aqua farmers have to do to get into the business and stay in the business. It looks at the processes in place for supporting and overseeing these farmers, with a particular emphasis on those processes that could or should assist newcomers who will be pivotal to the expansion of the State's aqua farming program. Those public agencies involved in assisting and/or monitoring the program will be highlighted as will the documents necessary for aqua farmers to set-up and operate their farms. New methodologies for these agencies to work together will be suggested as will roles for the public and private sector. Finally, key issues relating to these processes will be underscored; issues that affect the ability of the state program to expand in a timely fashion.

Authorization & Regulation

Aqua farming investments must be acceptable and viable. As we saw in the previous section, acceptability entails growing a crop in a suitable environment; doing so in a way that is in line with social norms, generating economic growth and minimizing negative impacts while optimizing positive attributes.

The administrative processes through with an investor must travel are, in principle, intended to ensure that this optimization is achieved; that the activity is in concert with accepted practices that will derive a net benefit not only to the investor but to the state. These processes involve the authorization and regulation of the aqua farming investment.

An **authorization** constitutes access rights to resources. Some resources, such as air and water as well as, in some instances, land, are state-owned. Other resources are privately owned. The investor obtains the ability to use these resources through **permit**, **lease** or **purchase** agreements. However, access is not adequate to start a business.

Use is subject to governmental control and monitoring. This control is generally achieved through the application of **regulations** (rules issued by agencies in the executive branch) and **laws** (requirements issued by the legislature). Among these, a **license** is often required. This is an agreement between the issuing agency and the aqua farmer, granting permission, often within specified conditions and/or limitations and frequently with a specified validity period. Some activities require **certification**. This is a confirmation of competency. It refers to the existence of required technical skills, conditions and/or hardware to be able to perform a task, or series of tasks, as required.

The government structures overseeing aqua farming are part of the institutional matrix through the investor must weave to establish an approved aqua business.

Institutional Arrangements

The institutions affecting investment in aqua farming are both public and private; governmental and societal. However, the major factors impacting on the investor, as seen in the previous section, are from the public sector; these being moulded by the opinions and perceptions of the populous as well as by political priorities and political will.

Informal actions or challenges by members of society may directly affect the investor. But, more often it is the government that interacts directly with the investor; establishing requirements, setting standards and setting-forth rules — these actions, in principle, reflecting society's concerns. Thus the prime interlocutor is most often government.

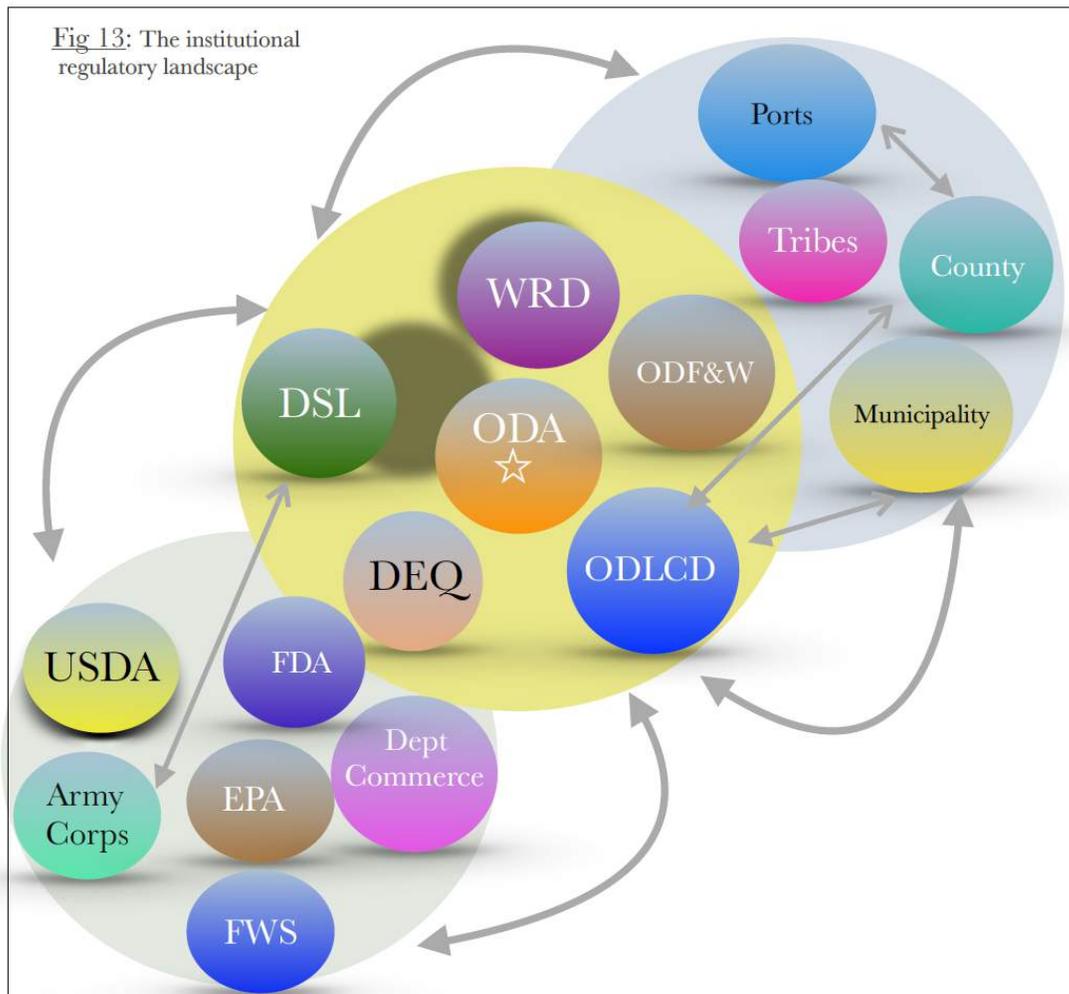
For those investing in aqua farming in Oregon, there is a wide array of governmental interlocutors from the local to the national levels. The key set of agencies is at state level. These include:

- ✱ ODA: with the mission to ensure food safety, provide consumer protection, protect

natural resource base, promote economic development and expand market opportunities.

- * DSL: focusing on sound stewardship of lands, wetlands and waterways.
- * WRD: practicing and promoting responsible water management.
- * ODF&W: aiming to protect and enhance Oregon’s fish and wildlife and their habitats.
- * DEQ: being the leader in restoring, maintaining and enhancing the quality of Oregon’s air, land and water.
- * ODLCD: [among others] to conserve coastal, farm, riparian and other resource lands, encouraging economic development, ensuring equitable application of regulatory programs.

Given aquaculture is agriculture, the fulcrum for the state aqua farming program is, by formal designation, ODA. However, current arrangements are rather fluid (see below), ODA not always assuming a coordinating and harmonizing role. There are a multiplicity of agencies at all levels involved in approving and overseeing aqua farming as seen in Figure 13.



It is important to note that an investor will not necessarily deal with all the groups listed in Figure 13; each type of aqua farming attracts a specific subset of agencies and partners. Table 2 and Annex I take the interrelationships into account; the annex, based on the table, presenting flowcharts for the marine and inland systems showing the sequence of steps an investor should follow to start operations. Inasmuch as the oyster industry is the major part of the current program, it is not surprising that the steps for raising oysters are more clearly outlined and standardized than for systems of less economic importance.

For oyster farmers the coordination does indeed come through ODA which will approve plats for public grounds on behalf of DSL. ODAs role is bifurcated. At the beginning of the process ODA serves as the pivot point for the approval of the operations. Subsequently, the Department's Food Safety Program has specific delegated powers in regard to shellfish food safety¹⁵.

Although some oyster plats have been approved for the cultivation of other shellfish¹⁶, oysters are effectively the essence of the current marine sub-program as well as the overall state program. When plats are allocated, this approval may be very specific, designating the species of oyster, the method of culture and the means of harvest. This high degree of specificity, decreed by statute, discourages shellfish growers from expanding to other bivalves, even when these have good markets and would grow well.

The shellfish program is constrained by available area for expansion. The Oregon coastline is rugged and high-energy, with limited estuaries suitable for aquaculture. As seen in Annex II, these estuaries are further limited as several are classified as "prohibited". This prohibition, a reaction to limited resources, is a constraint. Further human and financial resources would be needed by ODA to be able to certify and monitor all estuaries. Moreover, it would be logical to first undertake a comprehensive assessment of the State's estuaries, determining which are suitable for which crops and pose what risks, before evaluating the resource needs.

As oysters [and other shellfish] are often consumed raw, the food safety aspects of raising and marketing a crop are consequential. As filter feeders, shellfish can concentrate organisms and products that could cause illness in consumers. These potentially dangerous products can be microbes from domestic or industrial discharge [e.g., sewage treatment plants, septic tanks, etc.], toxins generated by seasonal algal blooms or deleterious components of industrial effluents. To safeguard consumers, ODA/FSP certifies areas where shellfish farming can be allowed; this certification, following FDA mandated standards, based on several years of water sampling and charting areas of estuaries where there are, and where there are not potential contaminant problems. Once certified, water sampling in approved areas continues to monitor any changes in quality that could affect the crop.

Certification and monitoring are expensive, requiring both staff and funds. It is principally for lack of these resources that some areas have been designated "prohibited".

ODA is currently involved in initial plat approval for public lands that fall under

¹⁵ Shellfish Safety Hotline, Food Safety, 635 Capitol St NE, Salem, OR 97301, Phone: 800-448-2474

¹⁶ In June 1997 regulations relating to oyster plats/leases on state lands changed. Prior to this date, these lands were exclusively for oysters. As of this date, existing plats could apply for permits to raise clams and/or mussels on an area not greater than 20% of the total area leased. However, new leases issued as of this date were exclusive to oysters. The exclusion of specificity of culture organism did not apply to non-state lands and these specifications were determined by the land owner (e.g., port authority, county).

Table 2: Documentation need for aqua farming in Oregon. General agency contacts in italics. Key: “A” required annually, “O” once-off and “E” every time the event occurs.

Document	Agency	Cost (\$)	Period	Notes
Building Permit	County			
Conditional Use Approval	Municipality County ODA Others		O	Conditional use required for aquaculture and issued by local authorities as well as, under some conditions, state agencies. <i>ODA</i> — 635 Capitol St. NE, Salem OR 97301-2532 Phone: 503-986-4550 Email: info@oda.state.or.us
Lease for use of State-Owned Land	ODA for shellfish DSL for other	750 + rent	A	Rent = \$0.47/ft ² or 5% riparian land value per ft ² . Fee and rent different for use of state-owned uplands. Processing 120 days. Potential insurance and/or security bond required.
Removal-fill permit	DSL	720 to 1,155	O	Requiring 120 days. Cost is application fee and dependent upon the amount of fill. Any mitigation cost is additional. DEQ and DLCD may be involved in evaluating these permits. <i>DSL</i> — 775 Summer St. NE Suite 100 Salem, OR 97301-1279 Phone: 503-986-5200 Email: dsl@dsl.state.or.us
Fish Propagation License	ODF&W	127/yr	A	Apply to private hatcheries and <i>de facto</i> to most operators, requires from one to several months to obtain. <i>ODF&W</i> — 4034 Fairview Industrial Dr SE, Salem OR 97320 Phone: 503-947-6000 or 800-720-6339 Email: odfw.info@state.or.us
Sturgeon Propagation Permit	ODF&W	3,000/yr	A	Must have a Propagation License in addition; requires from one to several months.
Fish transport permit	ODF&W	12/event	E	Including marine organisms, on-line application only for operators with propagation permit. Includes permit to import live fish or eggs. Time required varies from one day to several weeks.
Grass Carp Permit	ODF&W	102/event	E	
Salmonid Health Certification	ODF&W	variable	A	Annual testing for whirling disease. Conditions apply.
Grower Certification (Shellfish Food Safety)	ODA/FSP	variable		http://www.oregon.gov/ODA/programs/FoodSafety/FSLicensing/Pages/CommercialShellfish.aspx
Distributor Certification (Shellfish Food Safety)	ODA/FSP	variable		<i>Food Safety</i> , 635 Capitol St. NE, Salem, OR 97301 Phone: 503-986-4720
Shucker-packer Certification (Shellfish Food Safety)	ODA/FSP	variable		

Document	Agency	Cost (\$)	Period	Notes
Water Rights	WRD	≈ 2,000	O	WRD — 725 Summer St. NE # A, Salem, OR 97301 Phone: (503) 986-0900
Nationwide Permit 48 (NWP 48) for Shellfish Aquaculture	USACE	variable		USACE — P.O. Box 2946/333 SW First Ave., Portland OR 97208-2946 Phone: 503-808-4510
Individual Permit for Shellfish Aquaculture	USAEC	variable		Requires Pre Construction Notification (PCN — http://www.saw.usace.army.mil/Portals/59/docs/regulatory/regdocs/Permits/PCN1-4-2009interactive-reader-enabled2013-06.pdf) or general application ENG Form 4345
Works in navigable water or wetlands	DSL USACE	variable		Section 10 of the Rivers and Harbors Act (33 U.S.C. 401 et seq.) requires authorization for the construction of any structure in or over any navigable water, the excavation/dredging or deposition of material in these water or any obstruction or alteration in a "navigable water" .
Pollutant discharge (NPDES 300J: Fish Hatcheries)	DEQ	348 + 497/yr	A	Filing fee plus annual charges. Requires EPA forms 3510-1 and 3510-2B and LUCS. DEQ — 811 SW 6th Avenue, Portland 97204-1390 Phone: 503-229-5696 or 800-452-4011 Email: deq.info@deq.state.or.us
Pollutant discharge (NPDES 900J: Seafood Processing)	DEQ	219 + 497/yr	A	Filing fee plus annual charges. Requires EPA Form 1 and Form 2D plus LUCS
Stormwater Permit (1200C)	DEQ	to be calculated	A	If more than an acre is disturbed during construction activities Requires filing fee plus annual charges. See DEQ's website for current fees (http://www.oregon.gov/deq/pages/index.aspx).
Onsite system permit for wastewater treatment	DEQ	to be calculated	A	Needed if a municipal wastewater system is not available. Filing fee plus annual charges. See DEQ's website for current fees.

DSLs jurisdiction and where the Legislature has confided approval in ODA. Shellfish operations also occur on lands controlled by port and county authorities. In these instances, initial approval for use is determined by the relevant authority: the port or the county. However, food safety and conservation measures apply equally to all lands. In some instances, land use may be subject to Tribal approval if the farming units are planned for tribal lands.

While aqua farming is agriculture and ODA has a pivotal role, DSL is an important actor on the stage. DSL is involved in both approving and regulating an aqua farm-

ing investment as the steward for state lands (including those submerged, encompassing open ocean to the State's three-mile limit along with ODLCD and other agencies¹⁷). As there is no open-ocean farming, DSLs purview embraces submerged and some submersible lands as well as the bed and banks of declared water ways, meandered lakes and wetlands. Their regulatory authority concerns any significant alternation of beds or banks of state waters¹⁸. This includes a zero tolerance for estuaries and any essential salmon habitat (ESH). This is accomplished through the removal/fill permit, applied to any process (e.g., halting or harvesting crops) or structure (e.g., pilings, docks, anchors, etc.) impacting on the water body's physical state and the greater impact of this on the overall ecology.

In addition to FDA oversight of food safety issues, there are a number of federal agencies implicated in aqua farming processes. The Army Corps of Engineers, a key piece of the puzzle, (<http://www.nasac.net/USACE%20Federal%20Aquaculture%20Regulatory%20Fact%20Sheet%20Series.pdf> and http://www.coralreef.gov/aquaculture/ACOE_Aquaculture_Reg.pdf) is responsible for navigable waters and has to approve any structures through the Rivers and Harbors Act that may effect this navigation (e.g., pens, cages, rafts, docs, etc.) as well as any necessary dredging or fill (i.e., implementation of the Clean Water Act). The Corps is also the focal point for the nationwide shellfish permit (http://www.ecsga.org/Pages/Issues/Army_Corps/Army_Corps.htm with http://www.ecsga.org/Pages/Issues/Army_Corps/NWP2007_proposed_FR_Notice_Aq.pdf and http://www.ecy.wa.gov/programs/sea/fed-permit/pdf/corps_2012_final_nwp_48_spn.pdf). The latest issuance of the nationwide permit (NWP 48) was made on February 13, 2012 (http://www.usace.army.mil/Portals/2/docs/civilworks/nwp/2012/NWP_48_2012.pdf). All shellfish farmers must be covered by an Army Corp permit; either through the nationwide permit or as an individual permit.

Farmers not qualifying for the nationwide permit must go through the comprehensive individual permitting process. In this mechanism, USACE will contact NMFS, USFWS, SHPO, DEQ, ODLCD and the Tribes; each entity inputting into the process before USACE will issue the permit. For the investor, a core part of this activity is producing a Biological Assessment (BA) which reviews the impact of the proposed investment, especially regarding endangered species. Based on the BA, NMFS will issue a Biological Opinion (BO) that will recommend if the action should progress, and with what required mitigation. DEQ is tasked to issue a certification (CWA 401 Water Quality Certifications) with conditions as appropriate to protect water quality. Other actors attest as to the suitability of the proposed action. This process is complex. Applicants often engage consultants to prepare the BO and other needed documentation. Overall, the procedure can require at least nine months and cost thousands of dollars.

A partial presentation of the Corps' view of the Oregon Program is presented in Annex III based on a proposal of May 2014. USACE is, in this proposal, suggesting the authorization of oyster long-line, rack-and-bag, stake, suspended and bottom cultures as well as littleneck clam ground and bag cultures — this an expansion of both culture methodologies and organisms given the *status quo*.

In the Department of Commerce, NOAA is responsible for seafood inspection

¹⁷ http://www.oregon.gov/LCD/OCMP/docs/ocean/otsp_1-a.pdf, http://www.oregon.gov/LCD/OCMP/docs/ocean/otsp_1-d.pdf, http://www.oregon.gov/LCD/OCMP/docs/ocean/otsp_1-c.pdf and http://www.oregon.gov/LCD/OCMP/docs/ocean/otsp_1-e.pdf

¹⁸ Significance refers to removal or fill of more than 50 yd³ of stream bed or bank.

programs, HACCP as well as import/export certification (<http://www.ppi.noaa.gov/ngsp/>). NOAA's NMFS (http://www.fisheries.noaa.gov/aboutus/our_mission.html) houses the Office of Aquaculture which liaises with the Army Corp and EPA while regulating aquaculture in federal waters. This Office also has responsibilities in aquaculture science and research along with outreach and extension (http://www.nmfs.noaa.gov/aquaculture/about_us/office_priorities.html). Federal and other requirements have been summarized by NOAA in http://www.nmfs.noaa.gov/aquaculture/docs/policy/shellfish_permitting_factsheet.pdf.

EPA touches the aqua farming program in relation to aquatic biodiversity and the control of effluents from aquatic animal production industry (<http://www.epa.gov/agriculture/anaquidx.html> with <http://water.epa.gov/scitech/wastetech/guide/aquaculture/index.cfm> and <http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/biocriteria/index.cfm>). FWS comes into play in regard to aquatic animal drug approval (<http://www.fws.gov/fisheries/aadapt/home.htm>).

For additional information, a specific and detailed *Guide to Federal Aquaculture Programs and Services* is found at http://www.whitehouse.gov/sites/default/files/microsites/ostp/NSTC/federal_aquaculture_resource_guide_2014.pdf.

It is worth noting that as an aquaculture industry grows, authorizing and permitting procedures may be streamlined as aqua farming develops a constituency. DSL has the latitude to establish General Permits (the state equivalent of the nationwide permit) which could expedite the bureaucratic processes.

A final observation on the institutional setting for shellfish operators; much as Idaho dwarfs Oregonian trout food fish production, Washington State is the dominant force for Pacific shellfish with seven times the number of farms producing a crop that is worth 14 times Oregon's and considerably more diversified (USDA Census of Aquaculture, 2013)¹⁹. Furthermore, the principal shellfish industry representative, PSCSGA (<http://pcsga.org>), supporting the industry along the Pacific Coastline, is located in Washington, close to the epicenter. The Shellfish Institute, providing shellfish research and information services for the U.S. West Coast (<http://www.pacshell.org>) is also headquartered in Washington State.

It remains to be proven that the proximity to these support services disproportionately strengthens the Washington State program. Yet, this program cultivates more varied crops using more varied technologies. By comparison, the Oregon shellfish industry is less well organized. Accordingly, an argument could seemingly be made to reinforce the Oregon industry²⁰.

The entry point for the present discussion has been the shellfish industry, specifically oyster farming. While some of the agencies and/or partners affecting the institutional processes are active in either the marine or the freshwater environments, with others covering both ecosystems, the processes for freshwater (upland/inland) aquaculture (Annex I) are less clear-cut since this segment of the program is much smaller with fewer precedents and often a more *ad hoc* methodology. Oyster farming has created a critical mass whereby there is more continuity in the application of processes whereas inland

¹⁹ This is in no way to imply Oregon should or could emulate the Idaho or Washington aqua farming programs. The programs in these two states are founded upon unique sets of natural endowments these states have attempted to optimize for aquatic production (e.g., large volumes of artesian well water and large estuarial areas). While Oregon cannot replicate the exact production systems, she can adopt the philosophy of resource optimization.

²⁰ The post of extension officer to support the Oregon shellfish industry was closed in 2014.

aqua farming, being fragmented and more insular, is often approached on a “one-off” basis in terms of the institutional arrangements²¹.

Most inland activities have historically related to hatcheries for the propagation of trout and salmon for stocking the State’s waters. This explains the issuance of a base “propagation license” as opposed to a growers’ license (Table 2). Inland aquaculture as a producer of food for the table is a nascent enterprise in the State which has yet to achieve any critical mass whereby operators can influence policies and processes.

As indicated, DSLs inland focus is major waters and ESH. For qualifying waters, a removal/fill permit is required. For smaller waters, there is a fill threshold of 50 yd³ before this permit is required.

DEQ can also require a discharge permit if process water is generated. However, WRD will be a crucial partner for investors as water rights become challenging; particularly in areas where supplies are stagnating or underline while demand is surging.

It is useful to return to the flowcharts in Annex I and the issue of ODA as the fulcrum of the state program. Annex I depicts the most common situations for coastal and inland aqua farming. However, there are many permutations. While ODA is a common denominator for food producing farms, in many instances its role is principally in the latter stages through food safety actions; i.e., ODA may not have a role in the design, siting or set-up of an aqua farm. This seems an ineffective role for a coordinating agency and it is recommended, as depicted in the flowcharts, that ODA be the first port of call even if the Department is subsequently engaged on food safety issues.

New & Evolving Pathways

The aquaculture program is a complex web involving many entities with different immediate objectives. Nevertheless, the ultimate objective for all is to shape an expanded program that can optimize resource use to produce high value aquatic products that have a growing demand worldwide. Producing these products will develop value chains that have the potential to stimulate economic growth in depressed coastal and rural communities. However, this production must be done sustainably; the products available to consumers as healthy ingredients in both conventional and luxury markets.

Given this breath of interests, a neutral forum is necessary to examine how to shape this program while catering for needs of different stakeholders. To this end, ODA has established the Oregon Shellfish and Inland Aquaculture Advisory Group (OSIAAG), assembling representatives of private and public operators in the State program as well as delegates representing civil society organizations. OSIAAG is, in effect, a filter through which ideas are passed and existing processes titrated to be able to distill the elements of a program that addresses the concerns while fulfilling the expectations.

OSIAAG reports to the Director of ODA, meeting periodically as an *ad hoc* assemblage of interested parties officially joined through the Group. This flexible and malleable structure is very suitable for these early stages of programmatic development. A more permanent public-private structure may be more effective in latter stages once the expanded program is under implementation.

²¹ Oregon Sea Grant has a thumbnail sketch of the history of Oregon aquaculture: <http://seagrant.oregonstate.edu/confluence/2-1/connections>

Roles for the Public & Private Sectors

The State has several key roles to fulfill if the aim of an expanded aqua farming program is to be realized. These roles cut across all phases of building an aqua business:

- * **Technical Assistance** — advising would-be investors on how to start a business, helping new start-ups with their production systems and advising seasoned growers on new developments. This assistance is achieved through multiple channels including extension/outreach along with the use of electronic and printed media.
- * **Quality Assurance** — safeguarding the environment and the consumer²².
- * **Monitoring** — collecting collating and analyzing data describing the program's growth and impact.
- * **Research & Development** — identifying innovations that may improve production or lessen negative impact.
- * **Education** — targeting both the public at large and those engaged in the program, explaining the best science-based principles and techniques while imparting new and relevant skills or explaining processes.

The private sector should be in the driver's seat as the program expands and metamorphoses into a diversified sub-sector of significant economic importance. This implies the private sector must assume responsibility for its actions, but that it must also have the ways and means to engage in and impact upon policies and legislation that affect the development of the industry.

Roles and responsibilities are a direct result of legislation. In Oregon, aquaculture is legally and formally part of the agricultural sector. Accordingly, the parent state institution is ODA. Aquaculture is, moreover, an acknowledged use for exclusive-farm-use zones over which the State (ODA) has authority²³. However, unlike any other forms of agriculture, for someone to undertake an aqua farming activity in such a zone, **conditional land use approval** is required (Annex I). For aquaculture operations that are planned for sites outside farm-use zones, a **conditional use approval** is required from the relevant local jurisdiction (e.g., municipalities, county).

The conditionalities covering the state aquaculture program as part of the state agriculture program may, and should be addressed at multiple levels of government to ensure all concerns are examined. Looking forward to streamlining processes, however, it may be advantageous to have one government agency act as the interlocutor; this agency consulting with other entities at various levels of governance. Given ODAs legal mandate over agricultural use, it is logical this Department serve as the coordinating unit throughout the approval and permitting/regulatory processes²⁴. Furthermore, given the specific complexities in aqua farming operations as seen from different vantage points, it might be useful, as has been done by ODA for other agricultural enterprises, to institute a formal [mandated] practice of having a **pre-application conference**.

This conference would be a meeting between the ODA aquaculture service and the

²² An example of existing methods: <http://www.oregon.gov/ODA/shared/Documents/Publications/FoodSafety/CommercialShellfishHarvesterGrower.pdf>

²³ The ultimate authority, if a decision is queried, falling upon the Land Use Board of Appeals (LUBA).

²⁴ Referring to Annex I, it is seen that ODA is not always engaged in all steps of the processes although having the ultimate responsibility for the sub-sector.

parties wishing to undertake aqua farming. Representatives from other public or private agencies or stakeholder groups would be invited as appropriate. The reason for this meeting would be to go over the legal and regulatory requirements as well as discussing practical prerequisites (e.g., capability and suitability elements). This meeting could also include a requirement of a modest registration fee. This registration would assist in ensuring a complete census data set (e.g., farm size, water source, crops grown, techniques employed, etc.) covering the whole state program.

Most of the focus of these passages relates to farming for food for human consumption. However, aquaculture is much wider. As previously indicated it includes growing ornamental aquatic plants, invertebrates and fishes. It includes growing aquatic products for industrial or pharmaceutical use (e.g., algin, pearls, *Aphanizomenon flos aquae*²⁵, etc.). It also includes growing fish “seed” to stock public and private fisheries; the efforts of ODF&W in this area already highlighted. It is also worth underscoring that often hatchery aspects may seem to some observers as the major aspect of the finfish component of the overall state program (i.e., the across-the-board use of “propagation” permits reinforcing this perception). While non-food aqua farming systems are aquaculture and are important, the State needs to develop a critical mass in food production if the program is to fulfill its expectations. Three case studies are presented in Annex IV depicting a cross-section of current aqua farming operations in the State.

Key Issues

There are a number of key issues affecting the Oregon aqua farming program. The major crosscutting factor is that a cohesive state program does not truly exist at this time. A patchwork of public agencies has been providing some assurances with respect to compliance, but without a structured program within which to operate. There is effectively no formal extension/outreach program. Linkages to R&D programs are few and far between.

Private elements of the program are nearly as anomalous. Producer organizations are relatively unstructured. Civil society groups with strong views about aqua farming do not have, or have not chosen a medium through which to engage in constructive discussion.

With regard to shellfish farming, specific key issues include:

- ❖ prevailing regulations are divided among public entities and often archaic;
- ❖ expansion potential is poorly defined;
- ❖ intensification potential is complex as different technologies make operators subject to different controls/regulations;
- ❖ food safety oversight is over-stretched, needing bolstering if additional output is to be achieved;
- ❖ inputs, both production and technical, are limited;
- ❖ data collection/analysis is inadequate;
- ❖ diversification is generally not legally possible and when possible there is not the prerequisite infrastructure;
- ❖ market and/or business planning can be weak;

²⁵ http://www.swansonvitamins.com/klamath-blue-green-algae-superfood-130-tabs?SourceCode=INTL405&CAWE-LAID=1642437504&catargetid=530002460000108471&cadevice=c&mkwid=p4p34sje&pclid=67697600527&gclid=CjwKEAiAoo2mBRD20fvvlojj5jsSJABMSc7jrPc-8ITZAJNALTrnXa59VpvXP7Eoid-e9NVUDEQO-hoCoZvw_wcB

- ❖ on-going R&D is necessary to get the right technologies for the right place as well as to address key matters like ocean acidification;
- ❖ there is no investment in alternative shellfish crops [e.g., clams, mussels, abalone]; and,
- ❖ legislative and regulatory adjustments are needed to tackle the above concerns, these best framed in a comprehensive State Aquaculture Plan.

Some of these issues would be clearer if three practical field-level activities were undertaken: (a) an assessment of the estuaries where aqua farming is currently prohibited, determining if and how these could be utilized; (b) a more detailed and all-encompassing assessment of the overall shellfish potential of the State, including both the current crop (oysters) and candidates for diversification (clams, mussels, abalone) — this done in a format that could be used to encourage additional private sector investment in shellfish farming; and (c) pilot operations with selected public and private partners to demonstrate the feasibility of other methods of raising oysters as well as the culture of alternative crops.

Concerning the inland portion of the program, here the disarray is even more manifest as this segment has much less economic impact, hence lower visibility. The principal issue is to determine which farming systems are suited to Oregon’s bio-physical and socio-economic environments. It is likely this will be a mixture of crops carefully selected from the lengthy aquaculture menu.

For marine and inland systems (covering all the State’s ecosystems), THE KEY is the market²⁶; viable market and business plans²⁷ prerequisites to success. In some cases, operations may target markets jointly served by capture and culture suppliers. Such synergies could be foreseen in crops such as common carp, clams, sea urchins or freshwater algae.

The Oregon Way

In the preamble to *Forests and Fish: Protecting Aquatic Habitats in Oregon’s Forests*²⁸, the Governor writes: “...the people of this state: adaptive, responsive, inclusive, innovative – and committed to protecting our rich natural resources, for Oregonians and fish alike. That, I believe, is what is meant by “The Oregon Way.”

The Oregon Way has often been seen as being synonymous with a pioneering spirit that reflects the State’s history. High value is placed on the quality of life: a vigorous outdoors approach, putting a premium on independent thought and conservation of the exceptional natural endowments with which State was bequeathed.

This philosophy has evolved through the decades. In present terms, among the high priorities in addition to the conservation roots is harmonious development; public validation of new innovations, promotion of green technologies and production high quality healthful natural foods. Metropolitan areas have developed highly-rated food cultures targeting organic²⁹ products in internationally integrated fusion cuisines that include large quantities of seafoods.

²⁶ More on marketing for small-scale producers can be found at <https://www.extension.purdue.edu/ext-media/EC/EC-738-W.pdf>

²⁷ For example: <https://www.sfos.uaf.edu/fitc/teaching/courses/fish336/materials/FISH%20336%20Lect%2037%20AQ%20Business%20Plan.pdf>

²⁸ http://oregonforests.org/sites/default/files/publications/pdf/OregonWay_Fish_Habitat_singles.pdf

²⁹ Guidelines and regulations for organic aquatic products are a work in progress. Nonetheless, growers strive to produce high quality, sustainable products pending more formal designations.

The Oregon Way has been applied to land use planning for decades. A 1994 analysis³⁰ celebrating the twentieth anniversary of the State's innovative Oregon Senate Bill 100 (May 29, 1973) that: "*created an institutional structure for statewide planning. It required that every Oregon city and county prepare a comprehensive plan in accordance with a set of general state goals. While preserving the dearly held principle of local responsibility for land use decisions, it simultaneously established and defined a broader public interest at the state level.*"

The Oregon Way is very much in concert with increased investment in the State's aqua farming program. Indeed, today's operators are pioneers — few in number and innovative in practice. Aqua farming makes good use of the State's aquatic resources while providing high quality food and income. Aqua farming, which may be urban or peri-urban, often takes place in rural communities where stimuli to economic growth are badly needed. Aqua farming can be very energy efficient — both in terms of energy to provide the growing environment and the energy for growth³¹. Aqua farming requires a conditional use permit; this ensures public input and conformity with statewide priorities and principles. The aqua farming program described here-in also operates simultaneously at the state (macro) and farm (micro) levels as foreseen in the State's land use methodology.

In short, aqua farming is in consonance with the Oregon Way.

Synopsis

The processes affecting current and would-be aqua farmers are not unduly convoluted. These are chiefly aimed at safeguarding land and water resources, bio-diversity and the consumer. For the investor, it is not so much that the existing processes present a complex maze, but that they are neither comprehensive nor standardized. The generational crop of oysters and the long-established activity of salmonid hatchery operations are relatively well ensconced in prevailing processes that embrace local, state and federal legislation, rules and regulations. This is not to say these pathways are ideal or that they cannot be improved; but they do function without excessive impositions on established operators.

But, processes for the myriad of possible aquatic crops currently not grown in the State are far from well defined. This nebulous situation applies to most options for expanding and diversifying the Oregon program: other shellfish beyond oysters, other marine or freshwater invertebrate culture, aquatic plant and algae farming in any waters along with food finfish cultivation.

This lack of definition to the program, however, can be seen as an opportunity. New systems will require new investors and new operations. Accordingly, it is possible to craft new processes for these investments hand-in-hand with stakeholders to achieve products that are up-to-date and in concert with the demands and expectations of both the farmer and the consumer.

³⁰ Goals for the land conservation and development program included: 1. Citizen Involvement, 2. Land Use Planning, 3. Agricultural Land, 4. Forest Lands, 5. Open Spaces, Scenic and Historic Areas, and Natural Resources, 6. Air, Water, and Land Resources Quality, 7. Areas Subject to Natural Disaster and Hazards, 8. Recreational Needs, 9. Economy of the State, 10. Housing, 11. Public Facilities and Services, 12. Transportation, 13. Energy Conservation, 14. Urbanization, 15. Willamette River Greenway, 16. Estuarine Resources, 17. Coastal Shorelands, 18. Beaches and Dunes, and 19. Ocean Resources (http://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1049&context=usp_fac)

³¹ http://www.earth-policy.org/books/pb2/pb2ch9_ss4

3. Road Map

This section will attempt to tie all the previous points together, proposing a strategy for moving forward and achieving the ultimate goal of an expanded, dynamic and sustainable Oregonian aqua farming program. It will highlight the best opportunities while recalling constraints that affect these opportunities. It will then draw a set of succinct conclusion for which recommendations will be offered; implementing these recommendations being the Road Map leading to the previously underscored goal.

Way Forward: Opportunities & Constraints

The answer to the tacit question that underlies many discussions regarding Oregon's aqua farming program is: "Yes, Oregon does have the potential to have a significant state-wide program." The follow-up, equally important answer is: "Yes, this program can be implemented in an environmentally and socially sound and responsible way." Finally, in answer to the question "how do we get from here to there?", we can say: "maximize opportunities and minimize constraints through careful planning and implementation."

There are the natural and human resources with which to build a solid, diversified program in line with many other segments of the wider Oregon agricultural sector. There is a mixture of local and external [extra-state] markets, high demand for aqua products and good farm-to-market infrastructure through the I-5 corridor. There is a long and growing list of aquatic crops from which to choose the best commodities for the State's bio-chemical and socio-economical environments. In short, there are ample opportunities.

The technical constraints will vary system to system and will need to be addressed on an individual basis, shaping technologies to fit within local conditions through targeted research and development. Oregon is unlikely to compete with Washington State for top West Coast oyster producer nor with Idaho for the trout crown. Each state has a unique set of resources to devote to aqua farming and the key is to identify those where Oregon has a comparative advantage.

Non-technical constraints, however, are more challenging. There are two principal challenges:

- * **Knowledge/understanding** — there is a significant gap in knowledge/understanding for a notable section of the population as regards to realities of undertaking aqua farming. Many false impressions and over-expectations are based upon erroneous and/or outdated information. This misinformation can lead to political and social opposition as well as unwise investment in projects that are not technically viable.
- * **Public & private investment** — aqua farming, as a new and often untested venture, can be seen by the investor as a relatively high risk. When this risk is viewed through a lens resplendent with misinformation, many investors find it better to limit their buy-in or to go elsewhere. Public coffers support only limited aqua farming research and development while direct support services are even more curtailed. Similarly, few private investors are seeing opportunities in aqua farming beyond the perceived stalwarts of trout and oysters. Accordingly, low investment is a serious impediment that can, in part, be mitigated through improved flow of factual science-based information.

Regulation in and of itself is frequently not seen as a major constraint from the

point of view of current producers, albeit they would welcome more streamlined processes. While those newcomers wishing to enter any of the various aqua farming activities along the value chains are more likely to find the situation cumbersome and would be happy with fewer regulations. Nonetheless, to the extent these are understood, they are often not seen as deal-breaking obstacles — the most onerous, in fact, not being of State origin. Yet for new investors, simply penetrating the bureaucratic wall can be difficult enough dissuade all but the most steadfast.

The way forward is through an expanded state program guided and overseen by a **Plan for Sustainable and Responsible Aqua Farming Development in Oregon**. This plan is a priority objective³². It is best crafted through a single, common entry point — an aquaculture unit within ODA. The new program, implemented through its accompanying plan, will address constraints and optimize opportunities; these in turn deriving a variety of benefits to the public and private sectors (e.g., <ftp://ftp.fao.org/docrep/fao/009/a0874e/a0874e07.pdf>). Macro level and micro level processes need be concurrent and coordinated. Through concerted efforts to mitigate constraints and optimize opportunities, the goal of a new, expanded, diversified and intensified program can be achieved; a program that exceeds critical mass, approaching optimal levels of production.

Conclusions & Recommendations

It may appear as though the major conclusions are inherent in the opening paragraphs of this section. These answers, however, form the foundation for more specific conclusions that are intended to provide the bases for implementable action on the part of the public sector in general and ODA in particular.

In the following paragraphs, key conclusions will be highlighted [in **green**] with their corresponding recommendations [in normal text]:

- **A significantly larger Oregon aquaculture program is possible; a program very much in concert with the Oregon Way.** The program is currently tied to traditional practices with a monolithic shellfish industry, oysters the only crop, the driver of the state program. Inland aquaculture as a producer of food for the table is a nascent enterprise in the State which has yet to achieve any critical mass whereby operators can influence policies and processes. Achieving the aim of a larger program would require expansion, intensification and diversification along with an infusion of new ideas. This enlarged program should focus on rural and coastal communities where economic development has been stagnating and where meaningful benefits can be reaped. A target total value of \$22.8M (current estimated value \$12.1M) is proposed for a strengthened program. To achieve this target, the state must optimize her natural endowments.
- **There is no single magic bullet to achieve this larger program.** A number of reasons for the program seemingly being stuck in the doldrums should be examined — many are encapsulated in the present conclusions and recommendations. There are a number of options for new crops to diversify the program while increasing the economic impact of the sub-sector. From this growing array of options, systems must be chosen that fit well within the State's bio-chemical and socio-economic environments. Moreover, the tech-

³² The *National Aquaculture Act of 1980* outlines the contents of a national Aquaculture Development Plan (<http://nifa.usda.gov/sites/default/files/resource/naa80.pdf>) ; this may serve as a useful guide.

nologies inherent in these systems must be such that they can be employed using best practices that mitigate any negative footprint.

● **There are more commonalities than differences among core issues regarding aquatic crops statewide, regardless of the ecosystem.**

The overall approach should be a single, unified state-wide program with one agency serving as the focal point and coordinating unit — this being ODA. There are no clear designations; marine organisms may be farmed in inland areas while upland crops are grown in coastal regions. Moreover, the requirements for support and services are crosscutting (box).

● **Critical mass principle applies.**

The productivity of the state program should be significantly increased to ensure critical mass — i.e., benefit from the use of public funds exceeds the value of the funds themselves. It is likely suitable estimates of minimum thresholds for different systems can be calculated with better data and more harmonized effort. The nucleus of the needed new production should be seafood — i.e., aquatic products marketed for, and consumed by humans.

● **Private investment must be actively encouraged.** Public agencies need to adopt a strategy that attracts aqua farming investment, overcoming the impression by some outside the State that such investments are not welcome. A proactive campaign should be launched to stimulate investment while simultaneously pilot activities demonstrate new crops and farming methods that could be profitably employed in the State.

● **Several large-scale operations will benefit the stability and economic viability of the program.** Although a large portion of the State's program will likely be small operations catering for niche markets, larger opera-

The Oregon aqua farming program has three major components:

● **MARINE** — encompassing saltwater and brackish water ecosystems;

● **INLAND** — covering freshwater ecosystems, including those in coastal areas;

● **CROSSCUTTING** — issues and technologies involving both marine and inland sub-programs, including, among others, the need to: (a) safeguard the quality of state waters, (b) ensure the supply/production of safe foods, (c) protect natural bio-diversity, (d) promote bio-safety and bio-security, (e) support research and development, (f) facilitate capacity development, (g) maintain statistical records and monitoring measures, and (h) provide technical assistance.

tions that can pull down services and attract market share will greatly strengthen the program and should be encouraged.

- **Market and business plans are critical tools for the investor and manager.** The Community College Network should be mobilized to transform existing farm management programs into speciality classes focusing on aqua farming. Competent market and business plans should be part of an ODA-organized **pre-application conference**.
- **Misinformation leads to exaggerated fear of unfounded dangers provoked by aqua farming as well as to poor investments founded on unrealistic and ill-founded hopes.** The specter of past failed efforts seems to have left a pall that, when combined with sensational reporting on aqua farming errors, has left many of the public with an inaccurate and incomplete view of aqua farming. This should be redressed through a multifaceted educational campaign.
- **Collaborative action is needed with one agency [ODA] serving as the focal point.** This action should be interagency, regrouping the local, state and federal institutions engaged in aqua farming. This action should also include formal partnerships with groups such as PCSGA as well as environmental and other civic NGOs. State agencies with roles in the program (Figure 14) should nominate an aquaculture contact point. These contacts should network with the ODA focal point. A leading role by ODA would require some adjustments to the current structure of the Department. Given the newness of aqua farming and the modest size of the program, it is suggested initially the ODA focal point is designed as more of a developmental function, situated in the Marketing and Promotion Program. When the program is on solid footing and has reached its initial expansion target, it may be more effective to mainstream aqua farming into the Animals, Plans and Food Program. Annex V presents a possible organogram for the immediate future.
- **A centralized and coordinated effort is needed .** A single state agency or office should be designated as the coordinator for the State Aqua Farming Program. This unit should be within ODA. The centralization processes should adopt the **pre-application conference** as the entry point for all aqua farming operations; establishing a common entry point to build upon and ultimately create a one-stop-shop process that will facilitate entry for new investors. This is founded on the existing requirement of **conditional use approval** for all aqua farming operations; a requirement that may be seen as biased against aqua farming, but which in fact can be an effective mechanisms to coalesce all operators into a cohesive program. A pre-application conference should a formal part of the investment process with the first stop being ODA as shown in the proposed modifications diagrammed in Annex I.
- **Education is necessary.** Aqua farming education, training and publicity campaigns should be prepared to improve the skills of those along the entire value chain, including their ability to understand and comply with prevailing

regulations³³, along with using these tools to recast aquaculture in a truer more science-based light. The significant body of misinformation that abounds underscores why one should aggressively educate the public at large about today's realities: the fact-based pro's and con's of aquaculture. As part of these processes, ODA should build **The Oregon Aqua Farming Page** on their website (<http://www.oregon.gov/oda/Pages/default.aspx>) with links to other relevant state and federal agencies, colleges and universities, private firms, industry supporters as well as conservationists and the Green Community where processes and partnerships are explained along with up-to-date standards and best practices. Educational activities can also be designed to educate primary and/or secondary students about aqua farming, conservation and nutrition. The EU has a good model: https://ec.europa.eu/fisheries/inseparable/sites/inseparable/files/AquaC_schoolpj_EN_final2.pdf.

- **Better records and statistics are needed.** Given the weaknesses in current data sets, new methodologies should be put in place that cut across different institutions. One option that should be considered to achieve more centralized and accurate data is the instigation of a small (e.g., \$25-100) aqua farming registration fee managed by the ODA office that oversees the program. This registration and the initiation of improved record keeping should be addressed through the adoption of the new policies that put in place pre-approval meetings.
- **Research needs support.** Financial and staff support should be given to tertiary institutions with whom operators should link to establish farmer-led research programs pertinent to tailoring existing technologies and methodologies to the specifics of aqua farming in Oregon. The Agricultural Experiment Station at OSU, as the State's land grant facility, should be the lead research group. Sea Grant should also be a partner in these activities.
- **Extension/outreach services are required.** Well qualified technical support for operators should be provided on various levels. To the extent possible, efforts should be taken to field a minimum of two full-time extension agents [i.e., one for marine and one for inland systems]. Concurrently, efforts should be taken to see how information technology, perhaps linked to producer association(s), can facilitate knowledge transfer. As above, in line with land grant functions, the OSU Agricultural Experiment Station would be the focal point for aqua farming extension. Given the scope of these operations, it would be most effective if the OSU group linked closely with aqua farming thematic groups at various community colleges where specialist outreach activities could be offered; often dovetailing into existing farm-related curricula.
- **Producers must be engaged.** Ultimately, one or more cohesive and well-structured producer groups or associations should be formally established. These groups should take an active role in forging the state program. Virginia offers an innovative option of a producers' network to strengthen the role of

³³ One of many resources may be the *Western Regional Aquaculture Center* of NIFA/USDA that covers Oregon in its region (<http://depts.washington.edu/wracuw/publications/reports.html>). WRAC has the mission to "To support aquaculture research, development, demonstration, and education to enhance viable and profitable U.S. aquaculture production for the benefit of consumers, producers, service industries, and the American economy".

smallholder producers (http://www.matsonconsult.com/pdf/RdRuralCoop_Sep-Oct13Vr_Web%20for%20website.pdf). Associations should mobilize to help fill the education gap, maintaining their own comprehensive websites that cover investment and regulations from the producers' perspective. These sites should also have interactive templates for market and business plans for aqua businesses.

- **OSIAAG is a good starting point.** OSIAAG should be seen as the principal intermediary, forum and guide for the expansion of the state program. It is suggested this multi-stakeholder, interdisciplinary group form focal teams to examine in depth important aspects of the overall integrated state program. These teams would be *ad hoc* and flexible. Initially there should be four teams examining regulations, shellfish, algae and aquatic plants as well as farming inland waters.
- **A state aqua farming plan is needed.** Actions addressing all the issues raised above should be seen as steps ultimately leading to the crafting and approval of a much-needed comprehensive state aqua farming plan. Efforts currently being planned under the rubric of a “*shellfish initiative*” should be viewed as integral parts of wider efforts to elaborate a comprehensive state aquaculture plan. Accordingly, these initial activities should be designed and undertaken in such a way as to form a springboard for the subsequent elaboration of other elements of the plan — all elements being carefully merged into the final product: **Plan for Sustainable and Responsible Aqua Farming Development in Oregon.**

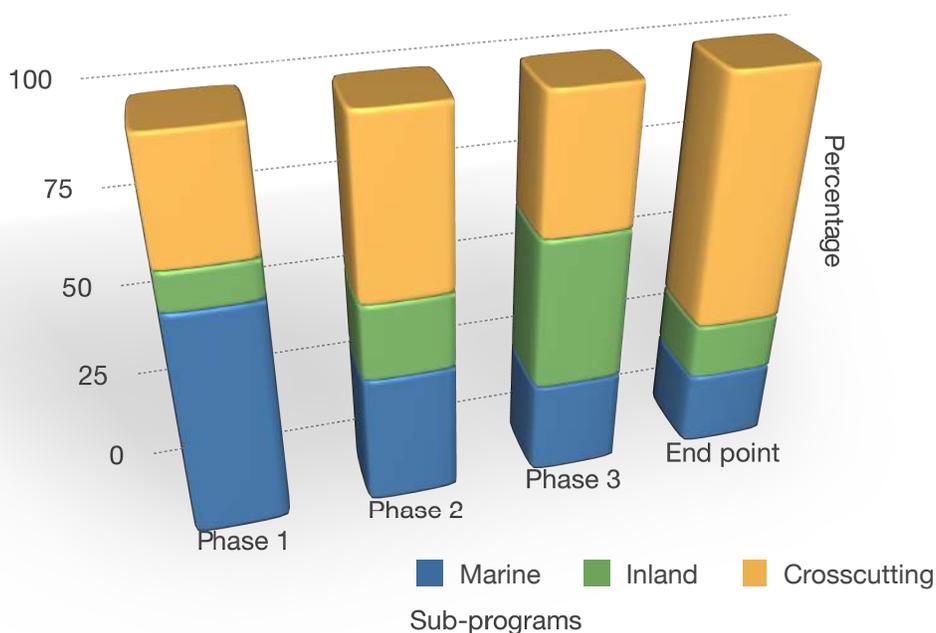


Figure 14: Possible allocation of effort: assuming methodologies that progressively lead to an end point [e.g., expanded program] through three phases, resources would be allocated between the three major components of the program — the marine, inland and crosscutting sub-programs.

- **An initial focus on the marine segment of the program may be effective.** Given shellfish³⁴ currently account for approximately 80% of the state harvest, and that there are multiple pressing issues requiring attention if the shellfish industry is to expand, a primary focus on the marine sub-program should be considered as a centerpiece of immediate action (Figure 14). Partners such as PCSGA should be engaged to undertake a thorough assessment of this sub-program including the capacity for expansion, intensification and diversification, accompanied by the impacts of these activities.
- **Pilot projects will accelerate progress.** With adequate resources, in both marine and inland systems, pilot activities involving public-private partnerships should serve as excellent examples of both institutional cooperation and investment opportunity. These projects would highlight new crops to integrate into the Oregon program.
- **Human and financial resources are needed to accomplish all of the above.** In regard to agencies that have responsibilities in the aqua farming arena, a staff member in each such agency should be formally designated as the lead individual. As the focal point, ODA should establish a better defined structure to oversee the aqua farming program, complete with full-time or part-time staff. State coffers should allocate funds to the program, as necessary supplementing these with appropriate extra-budgetary sources. This ODA effort should be undertaken in partnership with Land Grant and Sea Grant Colleges/Universities and community colleges in Oregon to provide extension, educational and research support.

Next Steps

As stated at the onset, the aim of this paper is to examine if Oregon can metamorphose from being a spectator to becoming a noteworthy player in the field of aqua farming. This evolution requires expansion, diversification and intensification — all of which are feasible. To successfully grow the program, considerable work in education is required, as well as investment by both the public and private sectors. In this light, what are the next steps?

Momentum has been achieved with important instruments like OSIAAG, already in place. The global market for aquatic products is growing as are the technologies to farm marine and inland waters. The Oregon program is at an important juncture that requires immediate political and financial support. Specific aqua-farming-flagged funding is necessary in 2015 if these assets are not to be lost. This funding can be from regular state fiscal resources, be extra-budgetary or a combination of the two. It is urgently needed.

OSIAAG needs to be the lens through which a new program is viewed and the filter through which this program is formed. Careful assessment and planning, through OSIAAG, is critical before any major new legislation³⁵ is introduced: there are simply too

³⁴ “Shellfish” *sensu stricto* refers specifically to molluscs. As oysters are the major crop, in the immediate term this is a suitable descriptor of the marine sub-program. However, as this sub-program matures and metamorphoses into a more diversified set of farming activities, it is likely a wider group of organisms will be cultured including, among others, other mollusks, algae/seaweeds, echinoderms and crustaceans.

³⁵ In this context, legislation is referring to new laws, rules or regulations. It is not referring to bills that might be introduced into the legislative process to increase funding and/or the availability of other resources.

many outstanding questions at this stage to know how best this legislation should be formulated and what actions should be planned. Thus, funds should be used to design and implement in the short-term a new venture: *Support to Oregon Aqua Farmers*. This measure will, in collaboration with OSIAAG: (i) undertake a comprehensive review of the *status quo* [building on the present document]; (ii) actively promote investment in aqua farming; (iii) elaborate a State Aqua Farming Plan; and, (iv) identify legislation (i.e., laws/regulations) required for the implementation of this Plan.

For the above to be accomplished, ODA must allocate staff time to the aqua farming program for the next 2-4 years. It will also be necessary to work in the immediate-term with community colleges to develop tools to use for aqua farming education and filling the information gap; this while simultaneously efforts are put in place to see what roles OSU, NOAA, PCSGA and other mainstream institutions may play.

Post Script: THE Plan

Through the course of the present discussion, the need for a state aqua farming plan has been emphasized. It may be helpful to fill in a few blanks to appreciate more fully the value of such a plan. The plan would answer the questions: who, where and how: who is responsible, where can specific actions be undertaken and how these must be done.

There are many permutations for planning. Some choose to have two processes; craft a strategy and from this draft the plan. In this two-step approach, the strategy will answer the “who” and “how” while the plan covers the “where” and “when” [and sometimes “how much”]. These can be merged into one process — a strategic plan or development plan or a strategic development plan.

Plans are the vehicles for achieving policy objectives. Plans are temporal: tied to a designated period of time, after which a new plan will be drafted to replace the existing document. Implementation of plans follows prevailing legislation and regulation. Thus, there is a need for synchrony and often legislative updating that corresponds to current planning.

Specifically in the case of Oregon, with no existing aqua farming plan, this groundbreaking effort would define the program’s institutional setting, describe the regulatory framework, specify quality control measures, identify suitable crops and farming areas while describing processes for new innovations to enter the program. The plan would cover outreach and capacity development including education needs and options, research and development, research-extension linkages and producer associations. The plan would incorporate all aqua farming value chains in the state.

There are a number of precedents to use as models or guides. Looking again to Indiana, the basics for their planning are found at <http://www.iisgcp.org/aqua/aqua-plan.html>. Not all states have aquaculture plans and what some states call a development plan is more an inventory or census of the *status quo*. A sample of plans is listed below:

United States³⁶: *National Aquaculture Development Plan* (1983) — <https://archive.org/stream/nationalaquacult01fede#page/n3/mode/2up>

Florida: file: http://www.freshfromflorida.com/content/download/33322/815077/Final_2014-15_Florida_Aquaculture_Plan.pdf

Illinois: http://www.ifishillinois.org/programs/aquaculture/aquaculture_development_act.pdf

³⁶ See also <https://www.law.cornell.edu/uscode/text/16/chapter-48> and http://www.nmfs.noaa.gov/aquaculture/docs/research/jsa_draft_aq_research_plan.pdf

Kansas: <http://www.kansasaquaculture.org/documents/ksaquaculturestrategydevelopment.pdf>
Kentucky: http://www.kyagr.com/marketing/documents/AQ_Aquacultureplan.pdf
Maryland: http://extension.umd.edu/sites/default/files/_docs/programs/aquaculture/ARG_110413.pdf
Michigan: http://michiganaquaculture.org/wp-content/uploads/2015/01/2014-MAA-Strategic-Plan_Final_141215.pdf
Massachusetts: <http://www.mass.gov/eea/docs/czm/publications/aquaculture-white-paper-and-plan.pdf>
New Jersey: <http://www.nj.gov/agriculture/pdf/aquacultureplanupdate.pdf>
Ohio: http://www.agri.ohio.gov/public_docs/forms/Aquaculture/Ohio%20Aquaculture%20Plan%20Final%2012.10.pdf
Tennessee: <http://fwf.ag.utk.edu/publications/aquastratplan.pdf>

“THE” Plan does not only refer to the State’s development plan. As has been the case throughout the discussion, actions take place at the macro and micro levels. New investors starting new aqua farms will also need to plan carefully. The publication *Beginning Farmers* cites six core considerations for new farmers: (i) **Vision and Values** — a farm has to be carefully planned to make sure that it fits within that vision as well as within the particular confines of the place where it is established; (ii) **Place Matters** — there are important subtleties to every market and every plot of land; (iii) **Planning** — new farms need to have a well designed business plan that takes into consideration individual infrastructure and financial needs, the viability of marketing strategies, and the farmer’s production capacity and knowledge; (iv) **Education and Experience** — preparation, knowledge, and training are essential. But so is being able to adapt quickly to the unexpected, to persevere when factors beyond one’s control conspire against you, and knowing how/when/what/where to expend time, energy, and resources; (v) **Managing risk** — it is helpful to plan carefully to manage risk through diversification, financial management, and the ability to withstand a couple of bad years; (vi) **Start small** — for most beginning farmers, we advise starting small to allow time for details to be worked out, for additional learning to occur, and to mitigate the size and scope of problems that will inevitably arise, <http://www.beginningfarmers.org/planning-a-new-farm/> .

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4. ANNEXES

Annex I Flowcharts: processes and procedures

The five flowcharts on following pages present an overview of the processes and procedures necessary to start-up and aqua-business in Oregon. These diagrams are not intended to be comprehensive, covering all possible business designs. They provide the general situation which must be adjusted for each individual case.

The first chart (Chart A) represents the major categories [baskets] of permits required to undertake aqua farming in Oregon. As stated above, these outline the general requirements but cannot take into consideration the particularities of each farm.

Charts B-E represent different scenarios in more detailing, following the general schema of Chart A. Chart B refers to aqua farming on state-owned lands and waters. This is generally referring to estuarial and water-based systems where the waters and lands are the property of the state. A dotted line after local approval indicates that for some sites the approval to use state property would come from DSL and in other cases from ODA. For shellfish farming on state lands, ODA is the authorizing authority.

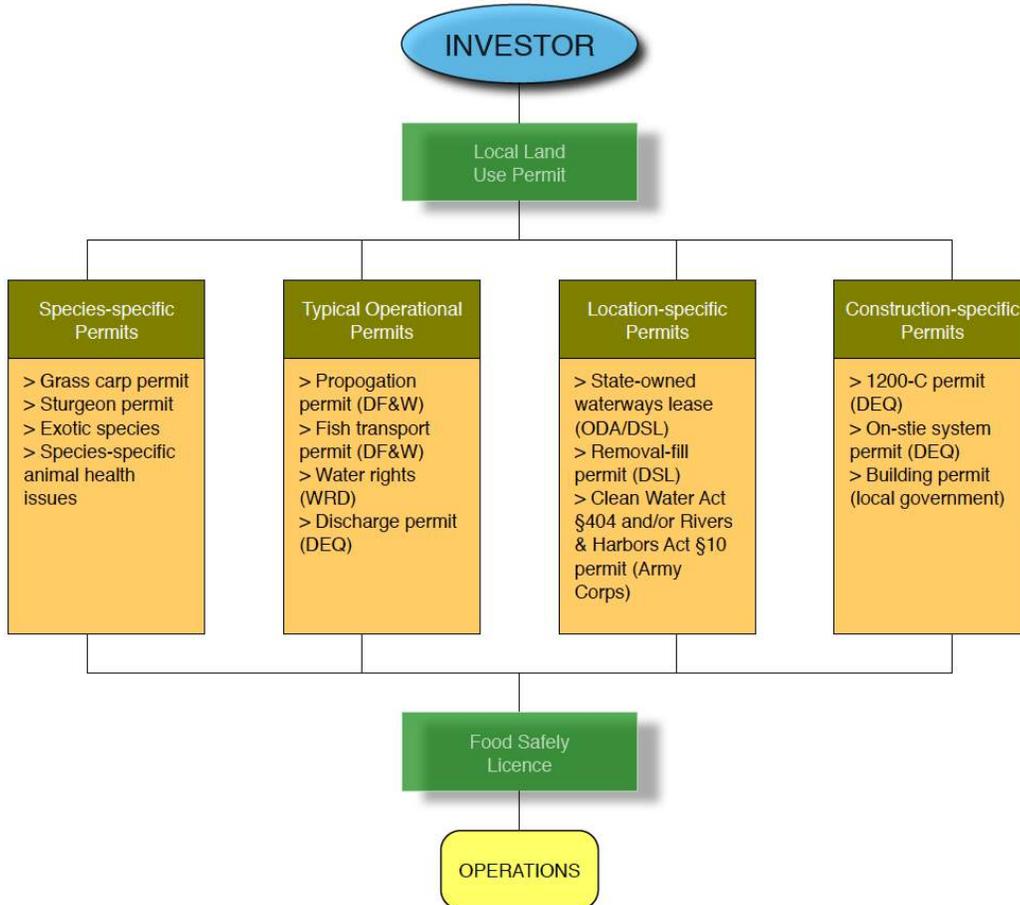
Chart C also refers to more water-based or tidal systems, diverging from Chart B in that the ownership for the property is **not** that of the state. Estuarial and other aquatic lands may be owned by port authorities, counties, municipalities or privately-owned.

Charts D and E refer to the upland or inland scenarios; generally referring, but not exclusively, to freshwater systems. Chart D deals with sites that are not involving major waterways, significant stream bed modification nor essential salmon habitat (ESH). Chart E deals with the situation when these factors do come into play.

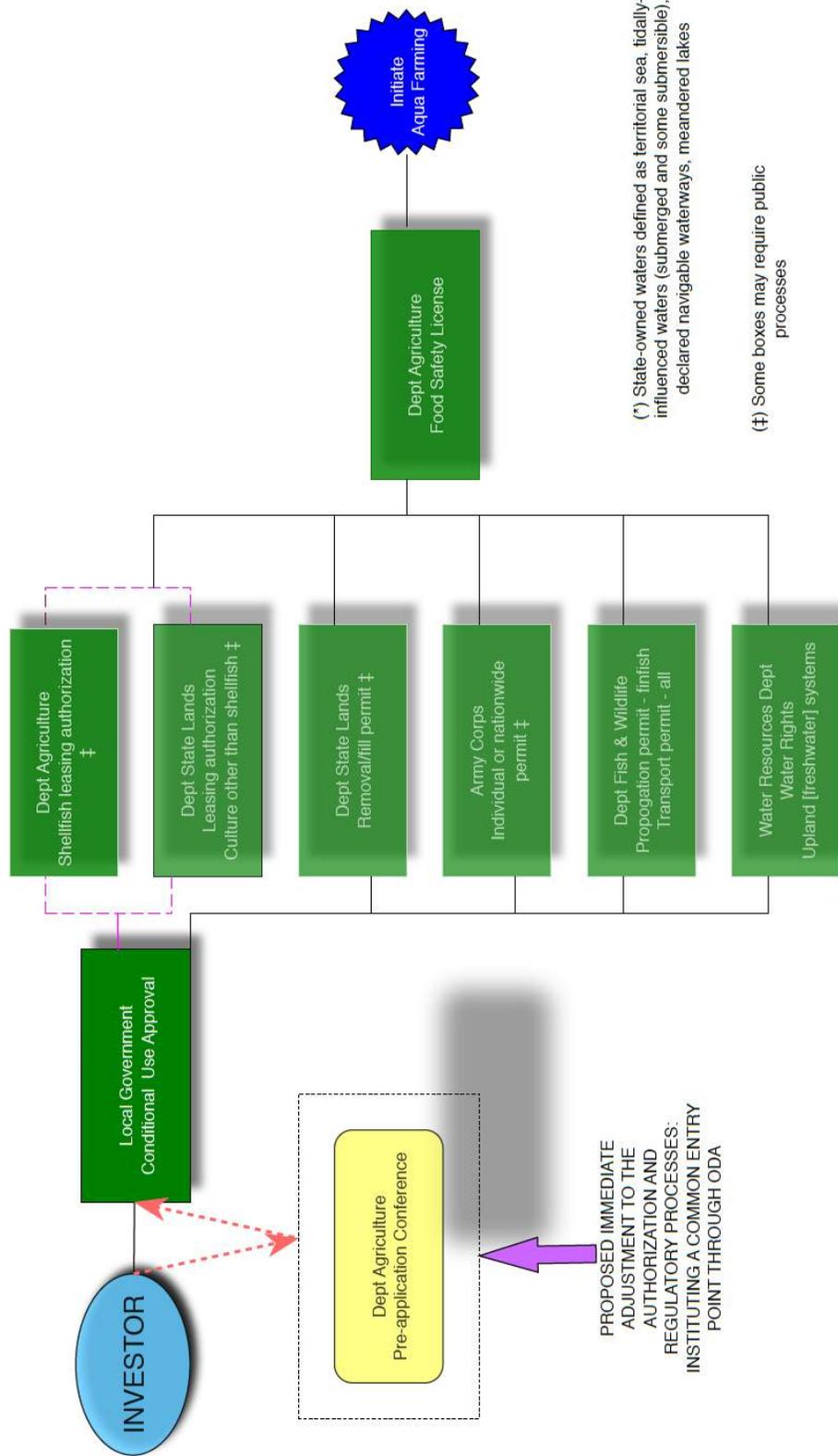
For Charts B through E, there is a yellow box indicating ODA, highlighted by a purple arrow. This step is currently **not** part of the processes. However, it is one of the recommendations of the present work that such a step be added; a universal pre-application conference with ODA for all aqua farmers.

(A) Aqua Farming Permitting

Major categories and indicative samples of permits requiring consideration by the new aqua farmer



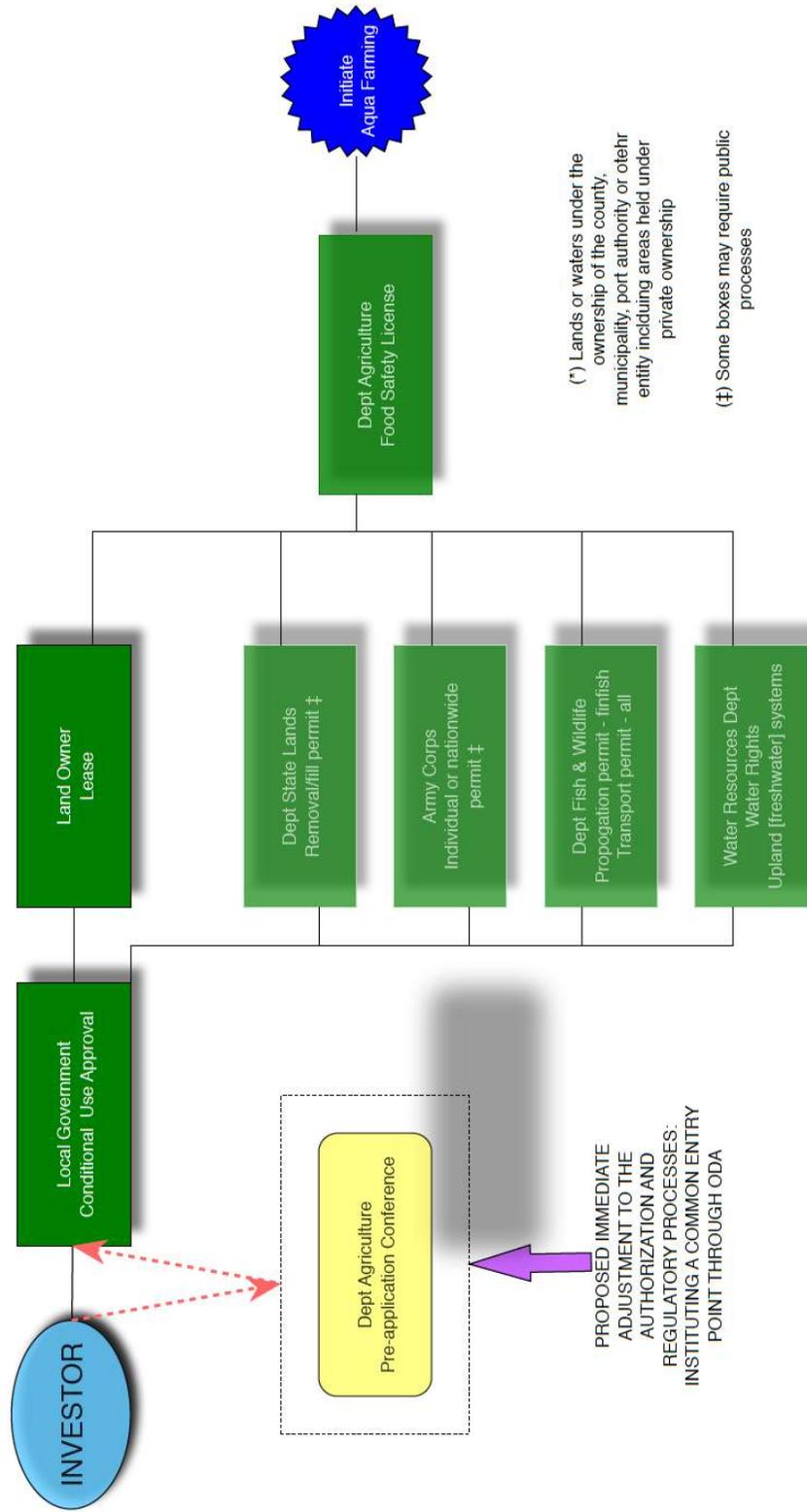
(B) Aqua Farming on State-owned Waters*



(*) State-owned waters defined as territorial sea, tidally-influenced waters (submerged and some submersible), declared navigable waterways, meandered lakes

(†) Some boxes may require public processes

(C) Aqua Farming on Non State-Owned Waters(*)

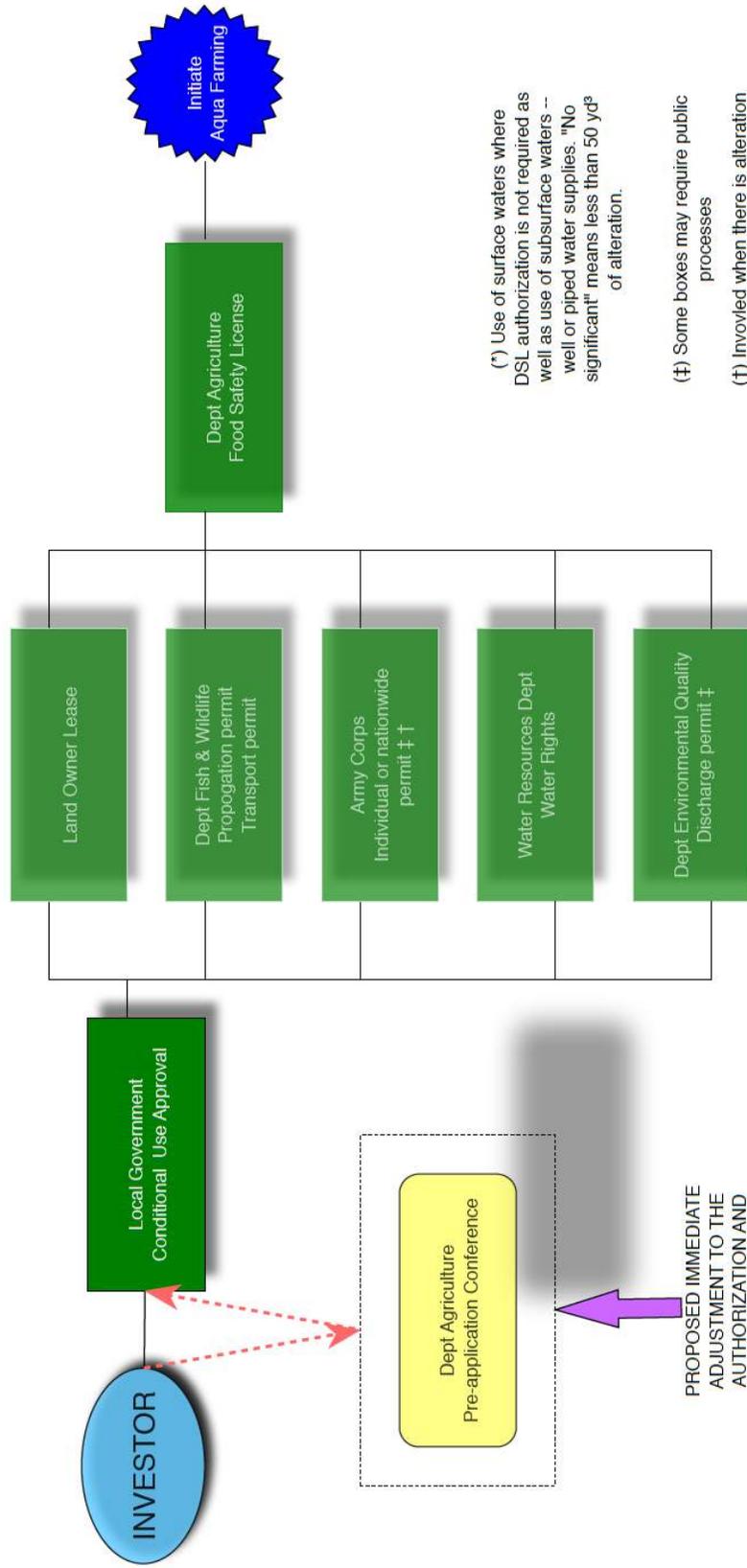


(*) Lands or waters under the ownership of the county, municipality, port authority or other entity including areas held under private ownership

(‡) Some boxes may require public processes

(D) Upland/Inland Aqua Farming

Land-based systems
 Not in wetlands or ESH and no significant alteration of beds or banks of state waters*



(*) Use of surface waters where DSL authorization is not required as well as use of subsurface waters -- well or piped water supplies. "No significant" means less than 50 yd³ of alteration.

(†) Some boxes may require public processes

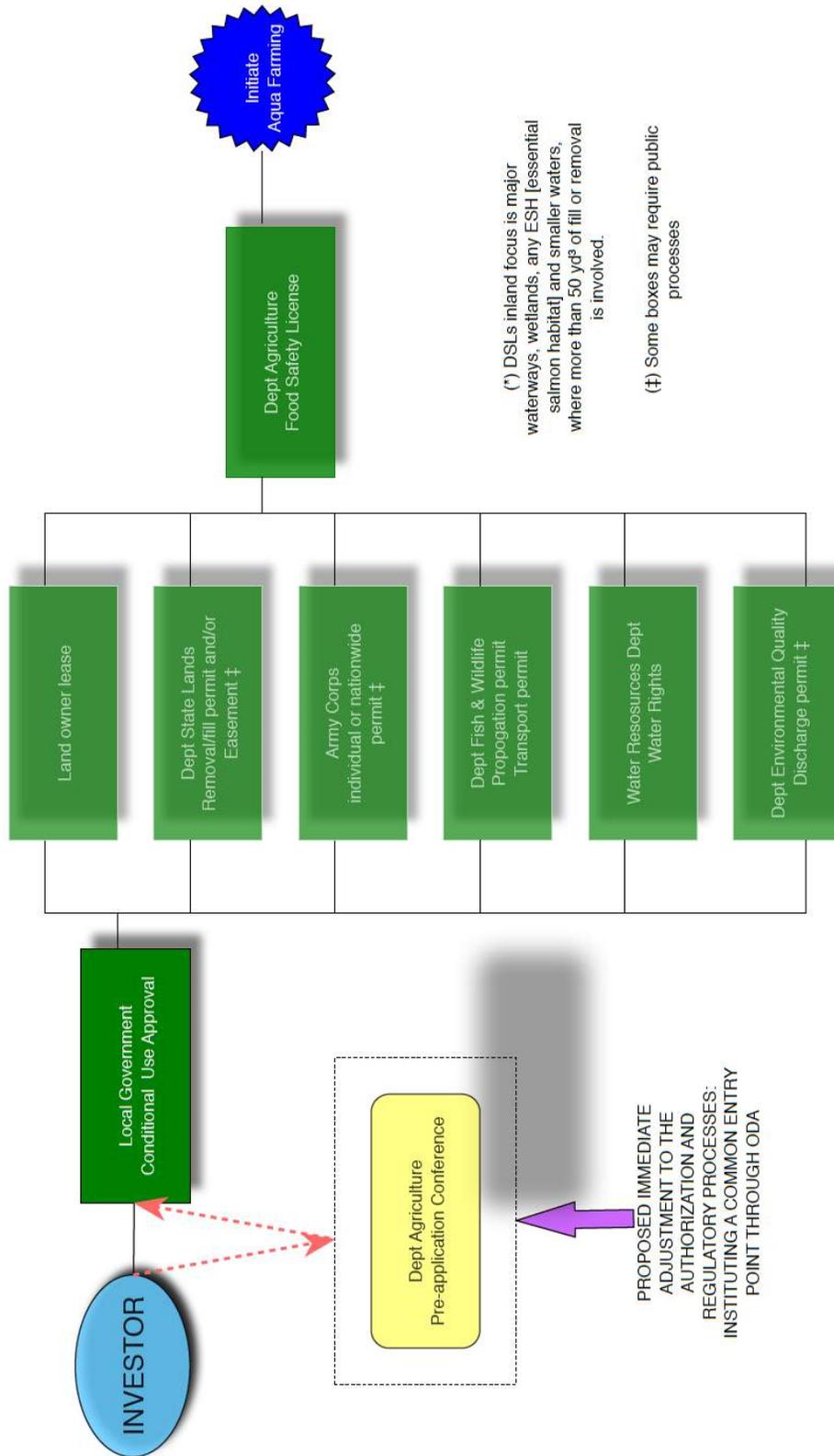
(†) Involved when there is alteration in the waterway

PROPOSED IMMEDIATE ADJUSTMENT TO THE AUTHORIZATION AND REGULATORY PROCESSES: INSTITUTING A COMMON ENTRY POINT THROUGH ODA

(E) Upland/Inland Aqua Farming

Land-based systems

Major waterways, wetlands, ESH and/or significant alteration of beds or banks (*)

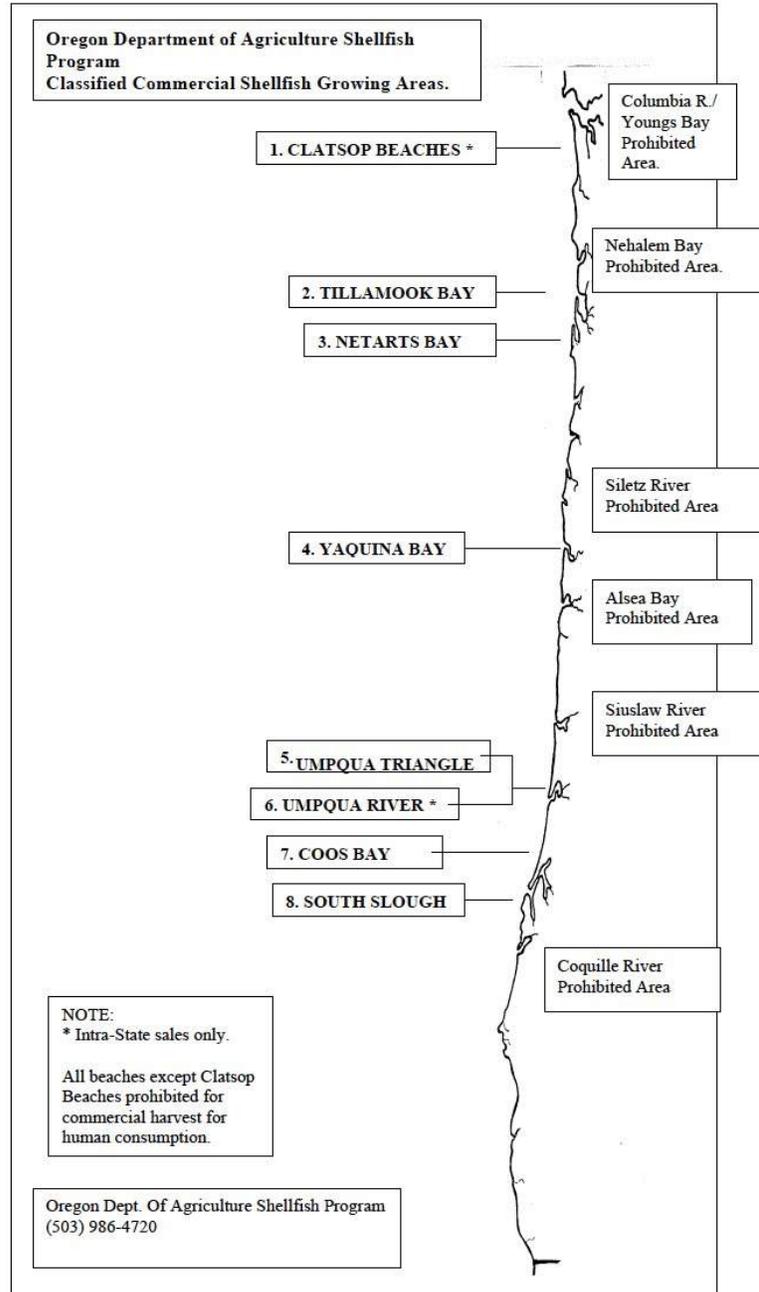


(*) DSLs inland focus is major waterways, wetlands, any ESH (essential salmon habitat) and smaller waters, where more than 50 yd³ of fill or removal is involved.

(‡) Some boxes may require public processes

PROPOSED IMMEDIATE ADJUSTMENT TO THE AUTHORIZATION AND REGULATORY PROCESSES: INSTITUTING A COMMON ENTRY POINT THROUGH ODA

Annex II: Map of ODA shellfish program



Annex III: Shellfish Industry

In May, 2014, the Army Corps of Engineers issued a document proposing the authorization of existing and new/expanded commercial shellfish aquaculture operations in Oregon. As part of the review process, the Corps prepared a detailed description of the current status of the Oregon Shellfish Industry in the six estuaries where they determined there were existing commercial shellfish farms — their designation applying to enterprises that had been granted a permit, license or lease from a state or local agency specifically authorizing commercial aquaculture activities prior to February 2012. The two tables below, extracted from this document, present many of the key details concerning the State’s shellfish industry.

Table 1. Location, acreage, species harvested, culture methods, and harvest methods for existing Oregon commercial shellfish aquaculture areas.

Name of Waterbody	County	Location of Shellfish Culture	Total Acreage* (Number of Growers)	Species Harvested	Culture and Harvest Methods
Tillamook Bay ^x	Tillamook	Throughout bay	2,606 (5)	Pacific and Kumamoto oysters (includes 9.47 acres of littleneck clams with bottom or bag culture and hand harvest only)	Bottom culture and variety of off bottom techniques including bag, rack-and-bag, rack-and-tray, long-line, and culture Hand and mechanical harvest
Netarts Bay	Tillamook	Mid and upper bay	531 (13)	Pacific and Kumamoto oysters	Bottom and off bottom culture (e.g. rack-and-bag) Hand harvest
Yaquina River ^y	Lincoln	Mid-bay	519 (3)	Oysters	Suspended raft culture** and bottom culture Hand harvest Mechanical harvest ^z
Siuslaw River	Lane	RM 4-5	9 (1)	Oysters	Off bottom rack-and-tray culture Hand harvest
Winchester Bay (Umpqua River)	Douglas	RM 0 (mouth); RM 2-5	120 (2) [†]	Oysters	Off bottom rack-and-tray culture, off bottom rack culture, and long-line [†] culture Hand harvest
Coos Bay	Coos	South Slough Upper bay (RM 10-12)	240 (4) 1,062 (3) [†]	Pacific and Kumamoto oysters	Bottom culture; bag culture, stake culture, [†] and long-line culture Hand and mechanical harvest; harrowing [†]
TOTAL			5,087 (31)		

*Total acreage represents a summation of all ODA acreages provided in the ODA ‘Oyster Growers and Plats Table’ and applicant acreages provided in the NWP 48 Forms. There may be some variation from the true acreage since minor discrepancies were noted between the ODA grower table, ODA plat boundary shapefile, and information collected by the Corps.
^xNMFS estimates that approximately 250 lease acres, as reported by the Corps, in Tillamook Bay are classified as ‘prohibited’ by ODA. There is also an area of overlap (acres unknown) between leases and prohibited area in Yaquina River upstream of Flesher Slough.
[†]Updated to include additional growers and culture method provided in PCNs received by Corps in 2010.
^zUpdated based on ODFW observations in Yaquina River and NMFS site visit².

Table 2. Acreage estimates by waterbody for new/expanded project areas (i.e., areas which require an additional lease or permit) that are likely to occur over the next five years.

Estuarine Areas	Estimated Acreage for Expansion/New Areas
Alsea Bay	5 acres.
Tillamook Bay	100 acres. <i>Estimates may be reduced pending completion of Oregon Department of Agriculture (ODA) GIS updating of existing plat locations.</i>
Netarts Bay	20 acres. <i>Estimates may be reduced pending completion of ODA's GIS updating of existing plat locations.</i>
Coos Bay Coos Estuary South Slough/Joe Ney Slough	50 acres 0 acres (No expansion currently anticipated.)
Siuslaw River (RM 4 to 5)	15 acres
Umpqua River (RM 2 to 5)	0 acres (No information available.)
Yaquina Bay	0 acres (No expansion anticipated.)

Annex IV: Case studies

Following are three case studies of aqua farming enterprises in production or gearing-up to produce. These are based on an open-ended questionnaire administered to operator or contact person at each farm³⁷.

Case I: Interstate production of trout stockers

This farm, consisting of a hatchery and a series of gravity-flow raceways, has high volume artisanal and spring water available at a constant 60° F. The current operators purchased the farm. It deals principally with live rainbow trout delivery throughout Oregon and California for state agencies, municipalities and private customers. It has a smaller food fish component, marketing currently in the San Francisco area with plans to expand to Portland.

The farm's market strategy is to produce high quality products including trophy-size fish to stock recreational facilities. Similarly, the food products are marketed as high quality fish-meal-free products.

Annual production is estimated at 300,000 pound. To achieve this crop, operating costs include over \$20,000 for eyed trout eggs, over \$200,000 for labor and nearly \$300,000 for feed. Fish prices can over \$5 per pound for food fish and over \$10/lb for large trophy fish. Farm staff include a management team of four [with technical and administrative responsibilities] and a workforce of up to seven.

On the regulatory side, the farm maintains an annual Fish Propagation License (ODF&W) and a NPDES 300J from DEQ; the latter incurring the highest fees and considered as being the most encumbering, both financially and in terms of time requirements. Annual AIS and salmonid health testing is required by ODF&W. Transport permits are also required by this agency for each movement of fish (corresponding import permits required for movement into California).

Production inputs are available but require considerable planning as they (feed and seed) come from out of state. Qualified labor is a challenge.

Technical assistance is spotty, most provides by private industry and fellow producers. OSU fish health services have occasionally helped as have staff of ODF&W. Portland State University has assisted with AIS.

A major challenge is the remote location of the farm. This particularly affects the ability of arranging for officials to collect and labs to analyze required samples for fish health and AIS as well as water samples required through the 300J permit.

Research needs focus on ways and means to make more efficient use of the available resources: additional crops (plant or animal), use of flow for micro-hydro and/or innovative ways to manage water, sediments and fishes.

Case II: Intrastate production of salmonid stockers

The fish farm occupies 23 acres (5%) of a larger ranch that includes livestock and hay production. Fish represent approximately 50% of farm revenues. The fish farm in-

³⁷ The questionnaire addressed the following: (i) Farm details: major crops, systems and size of operations, inputs (seed, feed, labor, other); (ii) Products and markets; (iii) Climate, water supply and quality; (iv) Land and water use issues; (v) Permitting requirements and entry requirements, rules and regulations and how they are applied; (vi) Availability of inputs (culture organism(s), feed, skilled labor, materials/supplies); (vii) Technical assistance — extension/outreach; (viii) Special challenges; and, (ix) Research/information needs.

cludes a hatchery and 30 concrete raceways supplied by artesian springs located on the property — roughly 165 gallon per minute of 64° F water with a pH of 7.4. The current operator inherited the farm from his Father who was the original builder. The farm produces rainbow trout and steelhead for sale to private customers with ponds and lakes for stocking for recreational purposes, supplying a three-county area. Fish, reared from fertilized eggs purchased off-farm, are available at sizes ranging from 4 to 16 inches.

The farm is in a designated agricultural zone, the waters permitted and certified by WRD for aquacultural use. In addition to land use and water rights requirements, the fish farm must purchase an annual fish propagation license from ODF&W for \$127 which specifies the species of fish that may be raised. In addition, the farm must supply 60 fish over 6 months old to ODF&W annually for testing. Finally a transport permit must be obtained for every fish shipment, regardless of quantity or previous sale, from ODF&W for \$12. These permits are valid for one month. It is proposed repeat sales to same customer/destination should be exempt while any quantity under 10 pounds or 100 fish should also be exempt and permit validity should be for 12 months.)

Inputs come from out of state but are available. Equipment is often ordered online.

Labor is available but unaffordable given the volume of business.

Technical assistance is not available but greatly needed. Specific needs include fish health and nutrition, fish biology as well as best practices.

A special challenge is water availability. The farm currently utilizes available water and similar sites are limited. Given the labor challenge, it is hoped some arrangements could be made to accommodate seasonal or intermittent farm labor.

Research needs include disease management (lab support with disease diagnosis and treatment), sources for funding or grants, alternative fish feeds (without fish meal), alternative species (e.g., freshwater mussels, shrimp, perch, walleye, bass) and market expansion.

Case Study III Inland farming of marine shrimp

This enclosed pilot farm uses a recirculating aquaculture system (RAS) and super intensive culture of (*Lito*) *Penaeus vannamei* (Oregon white-leg prawn) in four 24-foot diameter tanks incorporated into a system that uses recirculating “artificial” seawater (~ 12 ppt) at 84° F. The farm, with one full-time employee/technician, produces a product that is approximately 20 g (21-25 count), head-on product for sale to up-scale restaurants and markets in the Portland-metro area.

The farm is situated in converted poultry sheds where there is climate control to maintain the needed temperature and illumination. Well water is adjusted to the proper chemistry and then recalculated through the tanks. The shrimp post-larvae (PLs) are shipped from Florida and the feed, fed at roughly 8 pounds a day, is shipped from Pennsylvania. Needed equipment is available locally.

From the regulatory perspective, the farm has an ODF&W propagation license and HACCP licensing (no processing on site).

The farm receives no technical assistance. Moreover, as this operation is still piloting much of the technology, it is difficult to be able to clearly identify specific challenges, extension needs or research support.

Annex V: ODA Organogram

Possible adjustments to the current ODA stricter (<http://www.oregon.gov/oda/Pages/default.aspx>) to accommodate a coordinated aqua farming program, establishing an office “Support to Aqua Farming”, linking to the public and private networks that constitute the sub-sector.

