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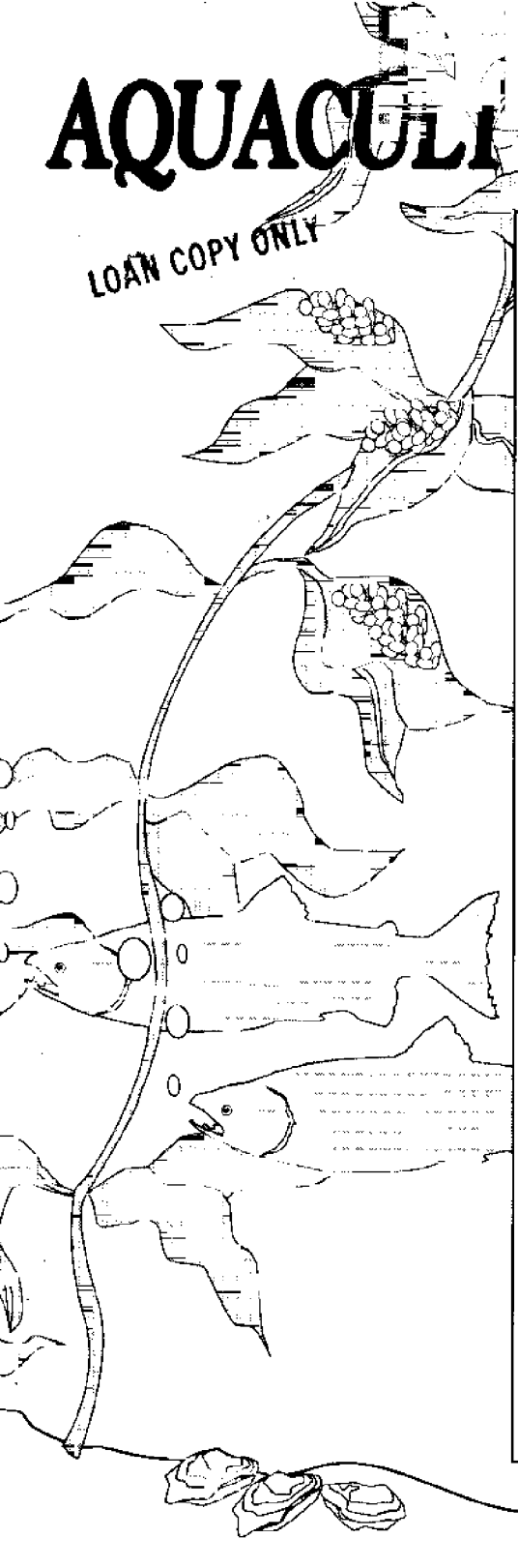

Guidelines for Shellfish Farming in Alaska

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Introduction

Shellfish aquaculture in Alaska can be a perilous career choice for the new entrepreneur. It can also be exciting and profitable for the person willing to work hard and deal with the issues and risks.

This manual has practical guidelines, strategies, and warnings about entry into shellfish farming business in Alaska and other cold-water regions. The information was collected by extension workers who have worked closely with Alaska shellfish farmers over the past two decades. It can be adapted to farming several bivalve species in the North in many parts of the world.

The book addresses the culture of the Pacific oyster *(Crassostrea gigas)* in Alaska. In Alaska, shellfish aquaculture methods include suspended culture, such as lantern nets hung from surface longlines, and to a lesser extent intertidal zone methods, such as rack-and-bag culture which can be used in areas where winter freezing is not a problem. Suspended culture methods are most frequently used to culture single oysters for the half-shell market, but can also be applied to the production of shucked oysters.

Even though Alaska shellfish farmers have experienced constraints ranging from biological concerns to complex sociopolitical difficulties, the Alaska shellfish farming industry is making significant progress. Most of the growth in shellfish culture in Alaska came only a few years ago, after the Alaska State Legislature passed the Aquatic Farm Act of 1988. This single initiative enabled the expansion of aquatic farms in several Alaska regions. During 1990-1994, Alaska went from a few aquatic farms to sixty-four. With farms permitted to culture shellfish on nearly 200 acres of state tidelands, the industry has grown from production totaling a few thousand dollars in 1988, to several times this amount at the end of 1994. This growth has taken Alaska beyond experimental shellfish culture industry. The Alaska industry is now poised for a period of significant growth.

In spite of progress made to date, shellfish farming remains a risky business. An important function of this manual is to decrease the rate of business failure associated with the industry.

The Road to Successful Shellfish Farming

As in any new industry, information may not be readily available on how to plan and start a business. But with a little digging, you will find a wealth of practical information. Veteran farmers are frequently willing to share information. Key to your success as a new aquatic farmer is a close working relationship with resource managers, consultants, farmers, support industry members, and university extension workers.

Get a copy of ***Developing a Mariculture Business in Alaska*** (RaLonde and Paust 1993), available at the University of Alaska Marine Advisory Program and local libraries. It has lists of resources and contacts necessary for the business planning process. Also, consider membership in an aquaculture association to gain industry support. The essential organizations include the Alaskan Shellfish Growers Association, (907) 288-3667; and the Pacific Coast Oyster Growers Association, (206) 459-2828.

Whenever considering entry into a new business venture, it is best to develop a clear plan of action and be thoroughly objective. **The tasks can be accomplished by the average individual.** Many people entering this field with little to no experience in aquatic farming have gone on to develop profitable businesses.

Before launching into business, the prospective farmer should examine personal goals, and technical, financial, emotional, and physical assets. The ability to do heavy work in a harsh environment is required. The currents are strong, the water is cold, and the hours are long. Self-preservation is an essential skill in this field.

The Alaska aquatic farming industry needs a large number of well-informed recruits equipped with the stamina and practical knowledge to overcome the challenges. We hope you will become a long-term member of the industry.

The following caveats should be seriously considered by prospective farmers and investors. They provide a realistic appraisal of problems encountered in the aquatic farming industry. (Statements are not listed in order of importance.)

Starting the Business

Follow These Steps

According to Needham (1988), most businesses do not run into difficulties—the difficulties were present from the beginning. The reduction of business risks can be accomplished by following a well researched business plan. A business plan coupled with careful research and a good pilot project should provide an early indication of problems and give ample time for mid-course corrections.

The easiest way to get into the aquaculture business is to buy an existing **viable** operation, an option not available in Alaska. For starting the business from scratch, the following sequence is suggested (Milne 1979, Paust 1987):

- Complete a market analysis, including factors influencing demand for the product.
- Consider available capital and sources of borrowed capital, and calculate the maximum permissible scale of the project.
- Select species or species mix based on market demand, available capital, and capabilities of site.
- Select appropriate culture methods based on species, product form, and site characteristics.
- Start site selection process, involving a search for several suitable sites within region.
- Select and test the best sites.
- Choose best site or group of closely associated sites.
- Make a formal business plan.
- Start pilot project to verify viability of the site, and the production and management assumptions in the business plan (significant modifications may need to be made).
- Progress to full-scale production.

No Precise Instructions Available

There is no detailed recipe for successful farming, for several reasons:

- No two shellfish growing sites are identical. Each site requires different technical solutions and culturing methods.
- No two farmers are identical. An approach that will work well for one farmer could result in failure for another. Experience, information, finance, and access to supporting infrastructure are different for each farmer.
- Farming techniques change with new technology. Careful research and application of current methods will be required.

The development of your definitive farm "recipe" will require a review of information, a feasibility study and business plan, and diligent trial-and-error work during and after the pilot phase.

The development of efficient farming methods requires patience. One rule is to find methods that work well and stay with them long enough to test their worth before you make changes. Any changes should be in small adjustments along with careful monitoring. Minor adjustments of a culture technique may be all that is necessary to bring the farm to peak production. Sudden shifts are to be avoided in favor of slower, more thoughtful action.

Aquaculture Business on a Small Scale

The extension service in Alaska caters to the needs of small-scale business clientele. This manual is of greatest value to prospective farmers interested in a few acres of intertidal and subtidal lands using limited yet adequate mechanization, and a small crew. The farm crew, in most cases, will be limited to family members and an occasional seasonal worker. The Alaska shellfish farming industry has attracted a number of entrepreneurs seeking rural lifestyles—people able to cope with hard manual labor, and able to resolve production and marketing challenges with innovative solutions geared to their small-scale operation.

Picture Yourself as an Aquatic Farmer

The Need to Be Optimistic and Innovative

The shellfish farming business is best suited for individuals with an optimistic outlook. The work is hard and the rewards are relatively modest. Small-scale shellfish farming is best suited for hard-working individuals interested in developing a valued lifestyle, not just a lot of money.

Successful farmers tend to be the ones who are innovative and capable of work-reducing thinking. The success of a small farm is largely cerebral in nature. One of the most important character attributes an oyster farmer can have is the ability to be persistently innovative. Sole reliance on heavy labor will slowly exhaust the good intentions and aspirations of those incapable of innovative thinking.

What Niche Do You Want to Fill in Aquatic Farming?

People enter the aquaculture business for many reasons.

Full-time farmers gain their entire income from farming.

Retirement farmers often consider farming as a source of supplemental income.

Part-time farmers want to produce supplemental income.

Diversified farmers want to add aquatic farming to their current business. An example is a commercial fisherman who fishes during commercial openings and farms at other times.

Lifestyle farmers may wish to live in an area removed from population centers and enjoy the hard work associated with aquatic farming.

Corporate farmers may never get their hands wet, but rather invest in a farming effort and supply other talents to the enterprise, such as marketing skills.

Infrastructure providers offer many services to farmers. An aquatic farmer may add equipment sales to the farming operation. Several other opportunities are available including transportation services, market consulting, accounting, and shellfish brokering.

Practical Experience Is Necessary

Although helpful manuals abound, in addition to reading you must get "down and dirty," that is, be willing to gain field experience. A common complaint, even among people experienced with hard labor is: "I have never worked so hard in my life as I do on this farm." Several farms have failed because labor requirements were beyond the capacities of the workers. Newcomers wanting to gain experience should find a shellfish farmer who is willing to take on temporary workers. At a minimum, visit several farms during peak activity. A list of Alaska aquatic farms is available from the Alaska Department of Fish and Game and the Marine Advisory Program.

Be Sure Information Is Accurate

You should read a variety of materials and maintain a healthy amount of skepticism. In addition, you will need to review information on business development, market conditions, legal issues, coastal zone management plans including state and local land-use plans, current farm directories, equipment catalogs, and many other documents pertaining to your area.

Printed documents can provide information, but not necessarily the final answers. It is a good idea to verify the information. Some ways to do this are:

- Double-check with people knowledgeable in the field. Recognized authorities can be found at universities, extension programs, state agencies, and consulting firms (see RaLonde and Paust 1993).
- Join an aquaculture association and take advantage of the expertise available to you among the members.
- Determine if the information has been applied in successful aquaculture operations or has otherwise been verified.

Be Cautious of Claims of High Profits

The public has been exposed to statements about high profits from aquaculture investments. These claims should be looked upon with suspicion. Be cautious about proposals that suggest immediate high profits. Huge profits are seldom found in any industry, and promoters touting major financial gains should be challenged to produce business and marketing plans.

Be cautious about computer-generated financial reports. Computer analysis of business performance is a powerful tool to assess feasibility, but the computer modeled operation is only as good as the raw data and assumptions used in the analysis. If you are presented with such a program, or any other financial analysis, follow these basic rules.

- Do not relinquish your judgment to the computer. All inputs should be verified as accurate.
- Question the formulas that are used to generate the numbers. What assumptions are behind the formulas?
- Don't rely on a single outcome. Changes in the market price, mortality, processing costs, permitting fees, etc., all affect the profitability of a farm. You should test the profitability of a proposed farm against a range of values.
- Any financial analysis must contain a cash flow analysis. You will need to know how much cash is needed during the development stages.
- Be alert to how the operation is scaled up through time. Does the project start with immediate high level investment or does it grow gradually through time? What assurance is there for adequate sources of capital investment?
- Is the promoter willing to provide complete information?

Investors entering this industry should be most concerned about the long-term continuity of their business.

Beware of the Gold Rush Mentality

Many industries have evolved from an initial phase during which the supply of product was limited and the market price, as a consequence, was high. The high profits generated during the initial phase of development were not necessarily the result of high demand and efficient operational procedures, but rather were the result of low supplies or a unique product type that generated high market prices.

High profits from new fisheries can produce inappropriate responses on the part of some investors. The stimulation of a gold rush causes investors to incautiously move into a developing industry and encourages them to take a number of shortcuts in developing business ventures. The large gap between cost of production and farm gate price is seductive. While prices remain high, operators are able to reap considerable profits. However, an expanding industry produces more product and this increased production frequently leads to reduction in market prices. Marginal and inefficient farmers not able to quickly modify production methods are then forced out of the industry.

Clear thinking is the best strategy to avoid calamity when profits seem guaranteed. It is risky to assume that an enterprise will be successful when the analysis of financial viability is based on short-term phenomena. A carefully drafted business plan will help avoid problems associated with the gold rush mentality.

Checklist—Before You Invest

Long before an investor makes the decision to develop a farm or become a part of the infrastructure supporting an aquaculture industry, a crucial assessment must be made concerning the strength of the industry. Several criteria should be satisfied before the decision to invest is made.

- The market for the cultured species should be expanding. There is little reason to enter an industry facing a static market. Increased production in a market where demand is either static or declining will lead to price declines and fading profit margins.

- A "premium" species should be involved, one for which relatively high prices are paid. Aquaculture is an expensive undertaking with narrow profit margins. Most successful farmers have been forced to reduce production costs through adjustment in gear and production strategies.
- The price paid for the species should be stable, and not based solely on a short-term shortage of product.
- Proven technology for the cultivation of the species is readily available and the needed equipment can be purchased off-the-shelf. Avoid unproved technology.
- The investor and farmer must position themselves in the industry based on personal skills and financial resources.
- You must prepare for a long-term business. Do not expect immediate profits. New aquaculture ventures often require a number of years of operation before the first sale of product. Oyster culture may take as long as three years before income is generated. You must be adequately capitalized to support the business during the start-up years.
- Enough information should be gathered to evaluate the risks and estimate the effort needed to make the business succeed.

Financing

The best strategy for funding a new aquaculture enterprise is to maximize equity financing in whatever form possible. Equity financing refers to funds you have control over, usually your own money. Some general rules about equity financing are:

Rule #1. The use of commercial sources for capital (money for which interest must be paid) should be considered only when the enterprise has moved out of its early developmental phases.

Rule #2. Low- to no-interest funds for initial investment can come from the owner, partners, contract growers, employees, public agency grants, and financial institutions willing to defer interest payments for several years.

Rule #3. New farmers are advised to dilute personal ownership rather than to rely on loans, by bringing in partners or stockholders. This strategy is easy to justify—if the business is successful, the founder of the company can generate sufficient discretionary capital to repurchase ownership rights at a later date.

How Much Money Is Needed for Investment?

Initiating a shellfish aquaculture business requires a significant financial investment. In some cases the availability of vessels and equipment used in other businesses or fisheries can cut down on initial costs. For example, a commercial fisherman who owns a boat with hydraulic operated equipment would find it a very valuable asset in a farming business.

Starting a culture operation even on a small pilot scale basis will require several thousands of dollars in initial investment. Larger operations with an annual production of 100,000-150,000 half shell oysters can cost $40,000 in initial cash investment for culture equipment alone. Additional costs can easily bring the total to $70,000-80,000 before the first sale of product. This estimate does not include purchase of a service vessel or work raft (another $5,000-$50,000 investment).

Obtaining investment capital is a difficult problem in Alaska. Most aquatic farmers use personal assets and private investment capital. Financial institutions are hesitant to back aquaculture in Alaska because of failure rates and because loan officers are not well informed about the aquaculture industry and its potential. This situation is improving.

If you hope to borrow money for investment capital from any source, a carefully crafted business plan will be required. The plan should provide clear indications of project organization and profitability. The business plan should also have a sensitivity analysis, to assess the "what ifs" within the business operation. For example, what will happen to project profitability if the price for oysters drops by 10%? What could you do to compensate for the problem? Financial institutions will look at your understanding of the business, including the sensitivity of the operation to various risks.

Why Some Shellfish Operations Have Failed

Nationwide studies have shown unusually high rates of failure for newly established small businesses. Most of these failures are due to poor management practices. Shellfish aquaculture, like any small business, has a high failure rate because of a lack of background information available to the investor. Iverson (1976) and Paust (1987) have information with accurate data on the management, finances, operation, and performance of operational farms in Alaska and other

northern regions (see Further Reading section). This type of information is difficult to obtain because of its proprietary nature and, in Alaska, because the industry is new.

In the recent past, many aspects of aquaculture development such as site selection, species selection, and project management were based on trial-and-error. The high rate of business failure, encountered by those who pioneered the oyster industry ten to twenty years ago, persists today.

The oyster industry's business problems are exacerbated by local conditions such as the lack of supportive infrastructure, equipment suppliers, veterinary services, competent consulting services, market coordination, transportation services, and communication networks. Other contributing problems include friction between farmers and the government agencies responsible for the regulation of the industry, and friction between farmers and competing users of estuarine waters.

Shellfish farmers themselves have been responsible for some of their business problems. The lack of comprehensive feasibility studies, the absence of business plans, and general ignorance of biological requirements of the species being cultured contribute to the demise of an aquaculture business. Other causes of business failure are more subtle—an imbalance in the relationship between personal capital and long- and short-term debt, the inability to work through a systematic development process, and miscalculating the amount of personal time that can be devoted to the project. Problems can become even more acute when inadequate planning is linked with impetuousness and impatience.

Major Constraints Facing the Industry

The potential for aquaculture development in the Gulf of Alaska is great. Major advantages include expanses of nutrient-rich waters and many undeveloped areas with pristine water quality. Many estuaries along the Gulf of Alaska coast are suitable.

Despite the advantages, there are several major constraints facing the industry. Most of the constraints exist because shellfish aquaculture in Alaska is a relatively new enterprise and problems are still being addressed by the industry. Some of the problems are serious, while others are just a nuisance. However, all of them will affect your business and you will need to find ways to deal with them. Some of the important constraints in development of aquaculture businesses are:

- Chronic absence of suitable marketing plans.
- Limited availability of investment capital.
- Overregulation by government inspectors and resource managers.
- Logistical complexities.
- Inadequate commercial and service infrastructure to support the developing industry.
- Many participants in the industry, including both farmers and regulators, still have much to learn about the industry. The development of expertise can require years of practical experience.
- Lack of dedicated seed sources.

The first three items are considered major obstacles facing the overall U.S. aquaculture industry.

Tips on Reducing Business Risk

The complexity of the aquaculture industry is often underestimated by the newcomer. Aquaculture sounds easy, but the cultivation of organisms such as the Pacific oyster is a complex arrangement of biophysical and sociopolitical conditions that need careful manipulation if the venture is to be successful.

Even with proper management strategies, there are still many risks that can place an independent operation in jeopardy. Methods of risk reduction should focus on the following:

- Developing proper management skills.
- Remaining acquainted with traditional methods of cultivation.
- Being informed about the availability and proper use of technological innovations.
- Maintaining relationships with industry workers who have long years of experience in the industry.

The Market for Alaska Shellfish

A frequently asked question is whether Alaska, at the outer limits of the natural distribution of the Pacific oyster, can effectively compete with farms closer to the center of the oyster's range. The answer is,

while Alaska oysters are high priced, they are recognized nationwide as high quality and are enthusiastically received in seafood markets.

Pacific oysters grow very well in Alaska, with some farms marketing half-shell oysters in about 18 months. Alaska oysters can be marketed in summer, when oysters from most warmer regions have become spawny and unmarketable. At ideal growing sites in Alaska, the colder water temperatures prevent oysters from becoming spawny in summer. The spawny condition is caused by the development of reproductive tissue (gonads). While summer marketing is a plus, the advantage is challenged by the high price of Alaska oysters. Expenses are higher because of higher production and transportation costs.

Accessing the market is not simple. Many Alaska farmers try to market their oysters locally or in other parts of the state. The Alaska markets become saturated during peak production, causing the price to drop. Because of the in-state price volatility, many operating farms are now devoting resources to developing markets outside the state.

Unfortunately, Alaska oysters do not enter the market on a regular basis. Production is not dependable because of a lack of secure seed sources, poor marketing plans, unavailable capital sources, and no unified industry organization. Fortunately, progress is being made in all of these areas.

Shellfish Aquaculture Techniques

Juvenile shellfish, called spat, are purchased from a shellfish hatchery, stocked in rearing trays, and allowed to grow for one to three years before being harvested and sold. This is a deceptively simple procedure. However, as novice farmers quickly learn, the aquaculture business requires a sophisticated level of understanding and a mastery of technical details. This is especially true in Alaska, where nearly every technical application is a modification of techniques used in other parts of the world. Alaska farmers need to work out the details of stocking densities, growth projections, design modifications, sorting procedures, and several other specifics to conform with the unique characteristics of their farms.

Other technical details of farm operation include identifying the "how-to" of shellfish processing, sanitation procedures, shell stock holding, seed holding, and shipping requirements, all of which are needed to optimize product quality. Finding technical information about oyster culture is not difficult. The difficulty arises in assimilating the information to make appropriate modifications and assemble a working farm. If you learn through research and practical experience, you can acquire the necessary technical skills needed to run your farm at a profitable level.

Need for Reliable Seed Sources

Most Alaska farmers currently must import spat from commercial hatcheries in Washington and California. Alaska statutes require that imported seed be less than 20 mm in length as a means to control diseases associated with larger seed. Because of these restrictions, Alaska farmers often do not get high quality seed and the seed may be delivered late in the growing season. As a result, the Alaska farmer has less control over production schedules. In addition, the brood stock (parent oysters) used in the southern hatcheries to produce seed for Alaska are not always acclimated to northern growing conditions. Thus survival and growth of the oysters is inconsistent. A solution to these problems would be the successful operation of a shellfish hatchery in Alaska. The first seed production facility was constructed near Seward in 1996. This facility will become involved with aquaculture research and development involving other bivalve species, including littleneck clams and scallops.

Growing Safe Shellfish

Alaska's pristine cold waters are able to produce shellfish to satisfy the highest quality standards. In this case, quality means product safety with regard to consumer health.

Two indicators of product safety are monitored—total tissue bacteria count and tissue fecal coliform count. Total tissue bacteria measures the total of all types of bacteria contained in the shellfish tissue and is an indicator of the general quality of the tissue. High numbers of bacteria indicate a potentially shortened shelf-life and a greater level of product deterioration. Fecal coliform, on the other hand, indicates the degree of contamination by bacteria of fecal origin primarily from mammal or bird wastes. The presence of fecal coliforms is an important indicator of food safety.

Alaska shellfish have consistently exceeded the Food and Drug Administration (FDA) standards in terms of both of these quality indicators. While the FDA limit in total bacteria is 500,000 bacteria per gram of tissue, Alaska shellfish typically register counts around 30,000. For fecal coliform bacteria the FDA limit is 230 bacteria per 100 grams. Alaska shellfish average about 33 bacteria per 100 grams. These bacteria levels are impressively low and indicate to the consumer that Alaska cultured oysters are safe and wholesome.

Avoid Water Pollution Problems

Marine bivalves are a valuable international food commodity. In recent years, market prices have increased in part because of decreased production in traditional farming regions. Reduced U.S. production of shellfish was caused by increased pollution and growing area closures in several major production regions (Pollnac et al. 1982). Unexpected water pollution is probably the most serious risk facing a shellfish farmer. It is difficult to find a simple solution to pollution problems.

An important point to remember is that even a small source of fecal contamination (sewage) in a bay of considerable size can damage a shellfish farm. Even minor levels of pollution will complicate the operation. Increased use of the area by recreationists, commercial fishing vessels, and residential expansion can place the farm in jeopardy. Aquatic farms in remote areas are not isolated from the pollution problems found elsewhere in the world. Pollution incidents and product recalls occurring in one growing region can have a nasty impact on the marketability of oysters grown in distant areas. In the seafood business bad news travels fast. Evil tidings concerning illness and area closures due to water pollution can quickly generalize and depress the consumption of product regardless of origin. In the seafood industry, **consumer perception is as important as fact.**

Culture Site

Start Planning a Year in Advance of Applying for a Culture Site

Under current regulations, which are subject to change, the Alaska Aquatic Farming Permit application must be received by the Alaska Department of Natural Resources (DNR) during March-April of a given year. Site productivity must be evaluated from spring to fall, along with a winter assessment. For this reason, planning should start in the winter or early spring of the year **before** the application is submitted. This will require a lot of field work.

Site Selection Process

The site selection process is an important part of your project. Several biological, physical, social, and economic factors must be examined to determine the short- and long-term viability of your farm. Avoid locating a farm for convenience only. **Do** consider a set of site selection criteria. One major site selection criterion that is frequently overlooked is a review of the local sociopolitical climate. Are the neighbors willing to accept your project? You might have an ideal site

in terms of biological and economic feasibility, but if you lack social acceptance, you may not get your site.

An important thought to keep in mind is that an aquatic farming venture is dynamic. The dynamic nature of the typical farm will require careful long-term planning to determine where you want your farm to be five, ten, twenty years down the road. Developing long-term plans will also help you narrow down your choices for a site.

The need for site selection criteria implies that an aquaculture venture cannot be randomly placed in any coastal location. The list of criteria covers a broad spectrum of environmental variables ranging from the required biophysical conditions needed to sustain the cultured organism, to more subtle sociopolitical and economic considerations. The following section has a brief list of criteria to consider. Please note that this list is not meant to encompass all the problems you may come across in your search for a farm site.

Key Site Selection Criteria

Pay attention to land use patterns in your area. The site's appearance today may be different from what it will look like ten years from now. Be sure you won't lose quality, particularly water quality, at your location. Is the area developing? What types of development already exist in the area?

Avoid too much isolation. You will need adequate transportation to and from your site, so stay near transportation corridors. Air freight is expensive, and transporting yourself, your crew, and your supplies and product to and from the site is time consuming and expensive. Can your site be accessed in rough weather? For many farm sites, the realistic approach is to make a compromise between your urge for a wilderness farm and locating a farm close to a population center.

Explore the prospects of locating near existing farms. Many farms, because of their small size or management style can be operated as a cooperative venture with other farms. We strongly suggest you look at becoming part of a cluster of farms if you expect to keep your farmed production to less than 300,000 marketable oysters per year or expect to pursue another profession while farming. One advantage of clustering farms is the ability to share resources. The most obvious shared resources in cooperative farming are:

- ***Personnel.*** You can share the work force. Multiple farms may be able to employ a few full-time employees.
- ***Sharing equipment.*** Farm equipment can be expensive. Equipment expenses are not easily met by the individual farm,

but cooperative purchase or leasing can make these acquisitions feasible.

- ***Supervision of the site.*** If you do not intend to live at the farm and maintain a constant vigil, you will probably need to provide a caretaker to prevent vandalism and loss of product through theft. Splitting the cost of a caretaker with neighboring farmers will help with this expense. Insurance companies will also expect a reasonable degree of farm security.
- ***Marketing product.*** Clustering of farms also allows for the coordinated delivery of product. Joint marketing can provide contributing farms with more market stability and higher prices for their product. To maximize this benefit, cooperating farms should have uniform quality standards.

Avoid sites that are highly confined. It is a serious mistake to select a site that is confined in a small cove and has reduced water circulation. Backwater areas may have warmer water temperatures that can lead to increased growth, but problems commonly far outweigh this advantage. Low circulation decreases nutrient import which, in turn, leads to reduced phytoplankton productivity and eventually reduced shellfish growth. High water temperatures can also result in spawny oysters that are not marketable during the summer.

Check for paralytic shellfish poison toxin. When you apply for an aquatic farming permit, you will notice that there is no requirement for the site to be tested for the presence of paralytic shellfish poison (PSP). The state instead tests for PSP each time you harvest shellfish for market. It would be a disaster to obtain a permit to operate, spend two years developing the site, and then learn, upon your first harvest, that your shellfish are not able to pass a standard PSP test. For this reason, you should conduct a preliminary PSP survey during the site selection process. A simple strategy is to collect at least 200 grams of drained blue mussel and butter clam tissue during the late spring or summer. Sampling these two species will provide information on the short- and long-term occurrence of PSP toxicity at your site. Blue mussels can quickly accumulate very high levels of PSP with no long-term retention of the toxin. Butter clams, on the other hand, retain the toxins over a long period, as long as two years in some regions. The Alaska Department of Environmental Conservation (DEC) is willing to help you take this sample. Contact the DEC laboratory in Palmer for further information, (907) 745-3236.

Watch current velocities. Knowledge of the physical oceanography of the site is necessary to develop farm construction specifications. It is

easy to underestimate the power of moving water, particularly if the force is applied against shellfish culture gear covered with heavy fouling. Excess current can also tangle the culture gear and damage the shellfish.

Check for evidence of fouling. Fouling is an unavoidable part of life for the oyster farmer. Fouling is caused by other marine plants and animals growing on the farm equipment and lines. If extreme, it can progress from being a mere nuisance to a disaster. Locations plagued with repeated sets of barnacles, colonial tunicates, and blue mussels should be avoided. The best way to determine the potential for fouling is to place culture gear into the water and allow it to foul over a period of months. Repeated settings of fouling organisms can become a real problem because of the labor required to continually clean the gear. An examination of the shoreline next to your site will provide some indication of the probable extent of fouling. Look for extensive beds of barnacles, mussels, sponges, tunicates, and seaweeds.

Get an estimate of plankton productivity. Phytoplankton abundance coupled with currents will control the growth rate of your shellfish. Clear water is **not** what you want when selecting a site. In areas not overly influenced by turbidity caused by suspended silt, the productivity assessment can be made using an inexpensive sampling device known as a secchi disk. The secchi disk is a 20 cm diameter white disk that is weighted to sink. Attached to the center of the disk is a rope that is marked at one meter intervals. A reading is made by lowering the disk into the water to a depth where it can no longer be seen. The more shallow the depth of disappearance, the more productive the site. At times of high plankton abundance, secchi depths of less than 3 meters are not unusual for productive sites. As a general rule, sites with secchi depths consistently greater than 5 meters during the warm water period (late spring through fall) should be avoided as being too low in productivity.

Test water quality. A water quality problem can produce serious consequences ranging from temporary harvest restrictions to the complete closure of a farm operation. To prevent water quality problems, all potential sites must be extensively examined for sources of pollutants and adulterants. This includes the inspection of adjacent watersheds and all developments therein. Marine mammals can also be a source of water contamination.

The contents of the seawater are the oyster's diet. Of great concern is the organism's ability to collect and concentrate pathogens and toxins produced by pollution. For this reason, estuaries in populated and developed regions should be avoided because of potential

pollution sources. A relatively insignificant source of sewage or fecal pollution is sufficient to contaminate even a fairly large bay.

Site requirements have been established by the National Shellfish Sanitation Program (NSSP). Alaska regulations require that the site pass the water quality test before the first product can be sold. The water quality testing conducted by the state of Alaska is reputed to be the most exhaustive in the nation. Unfortunately, water quality testing is not required until **after** the Aquatic Farm Permit is issued. By this time you may have already spent considerable time and expense developing the site, only to find out that your site does not pass the requirements and you cannot sell your product.

To avoid such a problem, we suggest that you contact the DEC laboratory in Palmer early in the process, (907) 745-3236. DEC will assist you in having your site tested for fecal coliform bacteria before you make any substantial investment.

When DEC officially comes to certify your site, they will collect water samples under the worst possible conditions—when the risk of water pollution is highest. This water sampling strategy includes taking samples immediately following a dry period. Your site will be tested during the first part of a rainy period when the farm site receives a significant amount of fresh water flow from nearby streams. Under these conditions, water quality problems, if present, will become apparent. You should also follow this procedure to get preliminary water quality samples. Independent samples can be sent to local water laboratories.

Competitive use of growing areas. The best sites for aquaculture operations are frequently also good sites for other types of commercial activities. As stated by Clime and Hamill (1979), aquaculture does not enjoy any heavenly blessing that would favor it over other competing uses. Competitors for estuarine sites range from tourists seeking solace on quiet waters to mining companies seeking use of the site for the construction of docks and transfer facilities. Also, keep in mind that people using upland areas may have the power to deny you access to a site that might otherwise be ideal for shellfish production. Coastal property and estuarine acreage are among the most valuable real estate in the country.

Aquatic farming competes for tidelands used for two traditional land uses: development and preservation. Aquaculture occupies the middle ground between these extremes. This position has led to some interesting problems. Aquaculture has the most stringent water quality requirements of any marine activity. As a consequence, opposition to the siting of a farm has come from land development interests that are seldom willing to comply with discharge requirements necessary to

preserve the high water quality standards upon which the farming industry relies. The opposition stems from Alaska state policies that imply that once a farm is sited in an area, the farm water quality standard is fixed for the area. On the other end of the scale are preservation organizations that see aquatic farm buoys as unsightly and contend that farms adversely affect the scenic quality of the area.

Very little field research has been done in Alaska to identify areas suitable for aquaculture. There is a basic lack of biophysical and other environmental information on which decisions of this kind can be based (ADNR 1987). Coastal zone management plans provide some help in assessing sites. Unfortunately, some management plans contain little useful information other than precautionary statements that mariculture should not interfere with current uses. Consequently, in addition to sampling sites for their biophysical characteristics, prospective investors will also need to complete a thorough review of competitive uses as part of the site selection process. If potential conflicts surface, the farmer must determine if there is potential for coexistence or if it will be necessary to give up on the site completely. A fact to be remembered is that two very important skills a prospective farmer can have are patience and diplomacy.

In Summary, Enter with Caution

There is a certain allure that attracts individuals to the aquaculture industry. As Secretan says (1988), aquaculture has an "almost magical ability to attract the innocent and to lure them into its web and ruin them." The seemingly simple task of culturing scarce and valuable aquatic creatures, and then selling them at a good profit, is an irresistible attraction to many people. Any rational investor, after completing an aquaculture farm feasibility study, will probably shy away from most aquaculture investment opportunities and instead place money in a local fast food franchise (Secretan 1988)!

On the other hand, the oyster culture industry has been in operation for many centuries in estuarine areas of the world. The oyster has an old and well-established market that is ingrained in the traditions and lifestyles of many consumer groups throughout the world (Lavoie 1989). Moreover, the oyster has a shelf life superior to that of most other shellfish currently being marketed. Many prospective farmers and investors have recognized the opportunities provided by the shellfish industry and have used standard business development strategies to capitalize on them. Among these necessary steps is close attention to a feasibility study and a business plan, including a major section on product marketing. With proper planning, it is quite possible that you will be able to build a profitable aquatic farm.

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