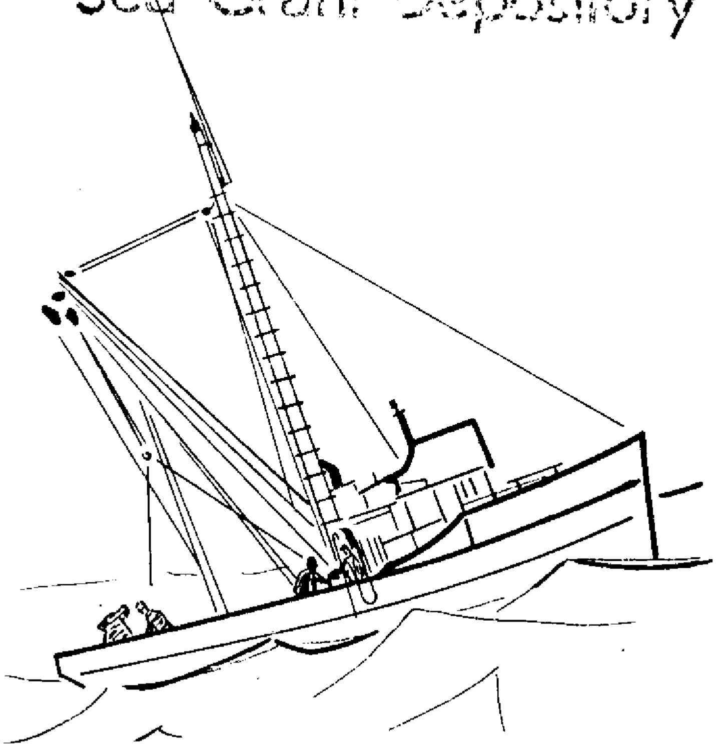
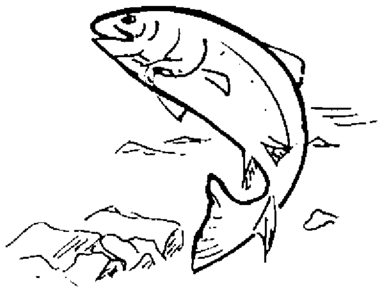


PROCEEDINGS of the SECOND ALASKA AQUACULTURE CONFERENCE

January 7, 8, and 9, 1977
Wrangell, Alaska



Sea Grant Report 77-7
July 1977

ALASKA
SEA GRANT PROGRAM

Alaska
Aquaculture
Foundation Inc.

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ABOUT THE PUBLICATION

In 1974, the Alaska State Legislature passed an Act (AS 16.10-400-470) authorizing the operation of private nonprofit salmon hatcheries. Additional modification in 1975 allowed for loans from the state's commercial fisherman's loan program to be used by these new aquaculture efforts. Again the legislation was modified in 1976 providing for a regional approach to the private hatchery program and allowing for loans of up to $3 million per hatchery.

Interest in this program has been high among different groups and individuals within the state. One such group, Prince William Sound Aquaculture Corporation, recognized the need of bringing together those persons with interest in salmon aquaculture development. Taking the initiative and leadership, this group held a conference in Cordova, Alaska in January 1976.

In order to follow up on the interest generated from the Cordova Aquaculture Conference, the Alaska Aquaculture Foundation, Inc. planned and executed a second conference in Wrangell, Alaska. Held January 7 through 9, the Wrangell Aquaculture Conference discussed questions not covered at the Cordova conference. This publication represents the formal presentations from that conference.

Donald H. Rosenberg
Director
Alaska Sea Grant Program

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ACKNOWLEDGEMENTS

Support for the conference was provided by the Alaska Aquaculture Foundation Inc., the National Endowment for Humanities, the Alaska Humanities Forum, and the people of the City of Wrangell. We wish to acknowledge the support and efforts of all those who attended and participated in the conference. A special thanks goes to Mr. Jay "Leo" Bladwin who carried the burden as conference co-ordinator.

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KEYNOTE ADDRESS
WRANGELL AQUACULTURE CONFERENCE

Howard W. Pollock
Deputy Administrator
National Oceanic and Atmospheric Administration
Washington, D. C.

It is a privilege indeed and a warm personal pleasure to return to Wrangell, to see so many old friends, and to have the honor of giving the keynote address for this 1977 Alaska Aquaculture Conference. Within the few minutes I've been allotted of your busy day I want to touch briefly upon three topics: (1) the United Nations Law of the Sea Conference, (2) implementation of the Fishery Conservation and Management Act of 1976, which unilaterally extended our fisheries jurisdiction out to 200 miles, and (3) federal efforts in aquaculture, including development of a NOAA aquaculture plan and introduction of a bill in congress known as the National Aquaculture Organic Act. Each is a major topic standing alone and each is of substantial interest to Alaskans.

Internationally, fisheries conservation and management and the whole range of Law of the Sea negotiations, are in a most critical stage. I won't review for you the long and tortuous work of the Law of the Sea Conference. However, from June of 1974, through meetings at Caracas, Geneva, and New York, a great deal of progress was made. Although many basic issues remained to be settled, the signs were hopeful that they would be suitably resolved. But this past summer session in New York was sadly unproductive, possibly even counter-productive. Perhaps this is because the Conference has now reached its most crucial stage. The less-contentious issues have been resolved and the remaining major issues are so basic that fundamental shifts in position will be required to avoid a breakdown in negotiations or a failure of the Conference.

My friends, it is difficult to imagine the size and complexity of this historic endeavor. Participating in the LOS Conference are several thousand delegates representing 157 nations. In addition, there are the views of accredited observers. All of these organizations influence the resolution of many issues which will shape the new international law for the oceans. These observers are, for example, specialized agencies of the United Nations, a number of intergovernmental organizations (such as the Organization of American States, the League of Arab States, the European Economic Community, and others), two dozen non-governmental organizations, the United Nations Council for Namimbia, other trust territories, and a number of revolutionary national liberation movements.

Developing nations are competing with and demanding assistance from technologically-advanced nations. Socialist and communist economies and political institutions are competing with democracies and private enterprise. The marine transportation needs of maritime nations are in conflict with the sovereignty and security requirements of archipelagic nations or nations having straits within their territorial seas which are used for international navigation. With the ever-expanding amount of ocean shipping, coastal nations are fearful of massive oil spills or other pollution of the waters off their shores. The marine scientist has need to conduct research in the waters of the economic zone without interference from the coastal nation, while the coastal nation fears exploitation or danger to its security from the researcher off its shores. Developing nations lack the technology and the finances to compete with a handful of advanced nations capable of exploiting the mineral resources of the deep seabed in areas beyond national jurisdiction. The interests of distant-water fishing nations are in conflict with coastal nations trying to protect the living resources off their shores. National interests are often in conflict with international needs for the benefit of mankind as a whole. Clearly, there is a wide spectrum of historical, religious, ethnic, social, economic, political, security, and other interests which must somehow be reconciled if the LOS treaty is ever to come into force. Nothing so broad, complex, and far-reaching has ever before been attempted in the long history of man's relationship with man. It is a monumental and epic challenge.

Notwithstanding the unproductive session last summer, a basic framework for the future legal structure of the oceans is beginning to emerge, including the following:

- coastal state sovereignty over a 12-mile territorial sea subject to a right of innocent passage;

- continued freedom of navigation on the high seas, coupled with a right of unimpeded passage for all vessels and aircraft through, over, and under straits used for international navigation;

- a 200-mile economic zone establishing coastal nation control over living and non-living resources but with freedom of navigation, overflight, communications, and other rights for all other states;

- coastal nation regulatory authority over resident or coastal species of fishes subject to international conservation and full-utilization obligations for harvestable stocks and coupled with special management regimes for anadromous species, such as salmon, and for highly migratory species, such as the tunas;

- coastal nation control over continental shelf resources even beyond 200 miles with provisions for modest revenue-sharing for the benefit of developing countries in the event of hydrocarbon production beyond 200 miles;

- protection of the marine environment from pollution or other degradation through creation of international pollution control standards with limited coastal state enforcement rights;

- specified rights and duties for both the flag nations of research vessels and coastal nations governing marine scientific research in the economic zones and freedom of scientific research on the high seas;

- creation of an archipelagic regime for island nations subject to unimpeded passage for ships and aircraft of all other nations through archipelagic sea and air lanes;

- creation of an international authority to deal with exploitation of deep seabed minerals beyond the limits of national jurisdiction; and

- a system for peaceful but mandatory settlement of disputes, involving probable creation of an LOS tribunal.

One of the principal obstacles to the conclusion of a treaty is the negotiations concerning creation of the seabed regime and machinery to supervise the exploitation of deep seabed minerals.

The attention of all countries is centered upon manganese nodules. These lie on the floor of the deep seabed at abyssal depths of 12,000 to 20,000 feet, and contain commercially-significant quantities of nickel, copper, cobalt and manganese, as well as less commercially important quantities of as many as 27 other minerals. The critical need for a secure supply of the principal minerals is readily apparent. Nickel is used in stainless steel alloys and in other steel alloys having high temperature applications, including components of jet engines and turbines. It is also used in petroleum refinement, electroplating, and manufacturing of electrical equipment and chemicals. Copper is used largely as an electrical conductor, but also has numerous other applications. Manganese is primarily employed in steel production purification processes and may be alloyed with steel for certain specialized purposes. Cobalt is principally used as an alloy to achieve resistance to high temperatures and is a necessary element in the production of "space age" alloys. The strategic implications are obvious, particularly in light of our bitter OPEC experience.

The most important remaining unsettled issues in the LOS Conference include the following five: the management regime for deep seabed mineral exploitation (which I've just mentioned), the legal status of the waters in the economic zone, defining the outer edge of the continental margin (which is the commencement of the international deep seabed area beyond national jurisdiction), the rights of landlocked and other geographically-disadvantaged nations, the degree of freedom to conduct marine scientific research in the economic zone, and the binding settlement of disputes inside and beyond the economic zone. With your concurrence, I will forego a fuller discussion of these subjects at this juncture, but will be happy to respond to your questions later.

Unfortunately, the pace of the conference on these issues has been much slower than originally anticipated. It was precisely for this reason that the United States Congress, led by such intrepid and determined leaders as our own Ted Stevens, moved decisively to protect the living resources off our shores by enactment of the Fishery Conservation and Management Act of 1976. It becomes effective on March 1st, less than two months from now.

The Fishery Conservation and Management Act of 1976 is dedicated to the proposition that renewable resources can endure forever with wise management. The influence of the Act is just beginning to make itself felt. Fishermen (both commercial and recreational), user-group representatives, scientists, processors, and the public at large all share with state and federal representatives in fishery policy decision-making. The North Pacific Fishery Management Council, which has jurisdiction over the Alaska region, has met a number of times and is well on its way to developing organizational and operational procedures, and appropriate fishery management plans.

In a historic reversal of the trend toward centralized government control, and in a most significant effort to make the key management decisions regionally, I'm happy to say that each of the eight regional councils has the responsibility for developing plans for the fisheries in its region, and the option of preparing appropriate government regulations. The plans are then submitted to the Secretary of Commerce for review and approval.

The Secretary looks to each council to recognize and accept its responsibility for balanced action. The Secretary further expects the National Marine Fisheries Service and other segments of NOAA, as the instruments of the federal government, to assist the councils in many useful ways.

As you unquestionably realize, before foreign fishing can continue after 28 February 1977 within our 200-mile limit and beyond that distance in the case of our anadromous or salmon fisheries, preliminary or final management plans governing such fishing activities must be adopted. We have very little time to put these management plans in place. The law provides that if a council is not able to have its management plan approved and implemented by 1 March 1977, the Secretary of Commerce must prepare a preliminary management plan. So that we in NOAA may be prepared to respond to the councils quickly, the National Marine Fisheries Service is preparing preliminary plans for a number of fishery units.

This action will in no way reduce or minimize the options of the regional councils in preparing their final management plans. Councils will have reviewed and commented on these preliminary management plans. Alaska's North Pacific Council is moving ahead with development of final management plans that will soon replace the preliminary ones. Preliminary management plans have been prepared for salmon, king and tanner crabs, shrimp and sablefish, as well as for the trawl fisheries of the Gulf of Alaska and the Bering Sea-Aleutian Island area. These drafts have gone through a public review period and the comments are being incorporated into the final environmental impact statements, which serve concomitantly as the preliminary management plans.

Many fisheries in the 200-mile conservation zone off Alaska have long histories of exploitation by foreign fishing fleets. Of course some of these fisheries have been exploited by domestic commercial and recreational fishermen as well as by the foreign fleets. Frankly, we are not certain how long foreign or even domestic fishing will continue in many of these fisheries. In particular, preliminary management plans prepared by the NMFS Northwest Center have recommended that foreign fishing be prohibited in fisheries such as shrimp, king crab and halibut.

The management of salmon fisheries presents certain unique challenges. For example, Canadian fishermen operating entirely within their own 200-mile exclusive fisheries zone can intercept substantial numbers of salmon returning to their U.S. spawning grounds. In like manner, the U.S. can intercept salmon returning to Canadian streams. Thus, the two countries have undertaken to negotiate a new treaty establishing equitable controls on salmon interceptions. The preliminary management plan on the troll salmon fisheries of the Pacific coast proposes that no decision on the level of Canadian fishing for salmon be made until the new salmon interception agreement is concluded.

The existing North Pacific Fisheries Treaty with Japan and Canada helps prevent, but does not entirely eliminate, Japanese interception of salmon of U.S. origin. Thus, consultations with Japan and Canada about possible new arrangements to protect salmon of American origin on the high seas are contemplated in the near future.

In my view, passage of the Fishery Conservation and Management Act of 1976 is an unparalleled event in the history of Alaskan fisheries. Henceforth, foreigners fishing in our economic zone will do so at our discretion. They will be allowed to fish only for species or stocks of species not fully utilized by our domestic fishermen. The foreign fishermen will be required to pay fees and to comply with conservation measures and other terms and conditions established in the United States regulations. There are vast fisheries resources in the conservation zone waiting to be tapped by U.S. industry. As I see it, this Act should be the catalyst to stimulate the flow of investment capital into development of these rich resources. I find it quite exciting and I foresee a bright and prosperous era of fishing in Alaskan waters for our own domestic fishermen.

Now, with the means to control foreign exploitation in our extended fisheries zone, there should be renewed incentive to rebuild the fish stocks in Alaskan waters to unprecedented levels. This will be done in anticipation of vastly increased catches by our Alaskan fishermen. Of course, it must be done by prudent and determined management of our several fisheries, but the objective can be materially enhanced by planting additional stocks, that is, by fish farming or ocean ranching to increase our potential for future harvests.

My distinguished friends, I am very impressed with, and applaud, the combined mariculture efforts of the Alaska Department of Fish and Game, cooperative community actions, and the federal government to increase the production of Pacific salmon in Alaska.

One of the in-words these days is "aquaculture". Articles on aquaculture or mariculture, its marine aspect, are frequently carried in magazines and newspapers, extolling the benefits to be derived. We read about protein production, increased employment, balance-of-trade and year-round availability of products in *The Wall Street Journal*, *Barron's Magazine*, and the *Reader's Digest*, to name just a few. This indicates that aquaculture has come of age. But how far advanced are we really? Is the climate right for investment? Is needed research and technology readily available? What is the government's involvement, commitment, and role? The latter questions I would like to address in particular, since the answers to them are of great importance to you.

In some countries aquaculture or fish farming accounts for over 40 percent of the total fisheries supply. In the U.S., aquaculture accounts for only two to three percent. Aquaculture in this country is in its infancy and progress has been slow and sometimes disappointing. The reasons for this are high risks due to the lack of research and development; the inability, and sometimes reluctance, of industry to expend large sums of money for research; insufficient coordination among involved governmental units, particularly federal agencies; and economics, the cost of fish food and labor.

Nevertheless, the situation is gradually changing for the better. NOAA is striving to meet the problems head on and is focussing its efforts through the National Marine Fisheries Service and the Office of Sea Grant. We are also promoting coordination among all federal agencies involved in aquaculture.

In November 1975 NOAA held an interagency workshop in aquaculture, attended by representatives of agencies having responsibilities and programs in aquaculture. In May 1976 the Interagency Committee on Marine Science and Engineering (ICMSE), part of the Federal Council on Science and Technology, formally established this workshop group as a Subcommittee on Aquaculture. We had two ICMSE subcommittee meetings last year, and a third will be held later this month. The scope of responsibility under the charter of the subcommittee includes information exchange, encouragement of joint programs, coordination of agency efforts, and review of national requirements.

This is a major step forward since no single agency has the authorizations, funds, personnel, and facilities to conduct the comprehensive programs needed to provide an adequate technical base for full development of private or public aquaculture in the U.S. Furthermore, no single agency has the responsibility for coordination of federal efforts in aquaculture. Interagency coordination of federal aquaculture programs will make our efforts much more effective.

Perhaps you have heard about the development of the NOAA Aquaculture Plan. This plan was developed to identify objectives or goals which must be attained to encourage the development of aquaculture, and to describe needed actions. The development of an economically-sound aquaculture industry will help to ensure a continuing abundance of varied fishery products at acceptable prices for the U.S. consumer. This development deserves the concerted efforts not only of federal agencies, but of state and university researchers. The application of this research by industry is the next important step.

Under this plan NOAA will conduct or fund research and development on selected species, take national action to reduce institutional barriers, and assist the established aquaculture industry to solve long-range problems or meet emergencies beyond their capability. It will encourage other federal agencies, the state, local governments, the academic community, and the private sector to cooperate and participate in this development, and to assume responsibility for services and programs more appropriately theirs. The plan has been approved by the Administrator of NOAA, and we are anticipating that copies will be available within the very near future.

Before I discuss some of the provisions of this Plan, I will mention another major document that has recently been published entitled "A Marine Fisheries Program for the Nation." It is a comprehensive outline of actions considered necessary to assure the growth and vitality of the nation's marine fisheries resources. Part 5 of the program is to "Encourage the Development of Public and Private Aquaculture for Selected Species of Fish." Included as an Appendix is The National Plan for Marine Fisheries, which outlines the method for accomplishing the program. It contains an introduction, background, recommendations, and implementation sections. It is no accident that Part 5 of the program on aquaculture appeared at about the same time that The NOAA Aquaculture Plan was being promulgated. The two were devised in coordination with frequent communications between the drafters and reviewers in both areas and with a very real understanding on the part of everyone concerned that combined efforts are necessary to restore and increase America's production of fish.

The NOAA Aquaculture Plan is a joint effort of the Sea Grant Program and the National Marine Fisheries Service. It states a national policy for encouraging aquaculture and defines the respective roles of the federal government, the states, universities, and private industry.

You may be particularly interested in its recognition that, and I quote, "Private companies are often unwilling or unable to conduct research or development because of the uncertainty of results, the need for specialized facilities and capabilities, and the lack of potential for patentable discoveries. Even so, estimates of industry expenditures during the past five years for research and development include over $22 million for marine shrimp and freshwater prawns, over $4 million for salmon, and over $6 million for oysters and clams. Further efforts by industry are needed to develop cost-effective production methods, assure high quality and consistent supply of products, and to expand markets."

The plan names high-priority species--that is, those that deserve special attention and funding in the near future because the promise of results is very high--but the plan also covers medium- and low-priority species. It will perhaps come as no surprise that the first high-priority species discussed is salmon.

While pointing out that more than seven percent of the seafood consumed in the United States is Pacific salmon, and that large quantities are exported, The NOAA Aquaculture Plan notes that U.S. fishermen, in times past, landed up to 600-million pounds annually--about triple the current landings. The maximum sustainable yield from wild stocks has for some time been exceeded. This provides a need for mariculture, with both American and worldwide demand for salmon continuing to grow.

Counteracting in part the overexploitation by foreign fishermen, and to meet the expanding markets, we have developed nearly 100 public salmon hatcheries on the west coast of the United States, employing more than 600 workers, with operating costs of more than $9 million annually. They are apparently paying off very well. A recent analysis of hatchery operations in the Columbia River drainage basin indicated benefit-to-cost ratios of 3.5 to 1 for fall chinook salmon and 7 to 1 for coho.

Ocean ranching of Pacific salmon has, of course, attracted considerable attention recently. Developed originally by a NOAA-sponsored Sea Grant Project at Oregon State University, it is envisioned as a system for private salmon culture. It has been further developed by the University of Washington, with both Sea Grant and private industry funding, and in Alaska by NMFS and the Alaska Department of Fish and Game. Oregon and Alaska have amended their laws to permit ocean ranching. Here in Alaska the law permits only nonprofit hatcheries, as you know, which presumably anticipates operations by cooperatives, fishermen's associations, processors, or Native corporations.

Pink salmon and chum salmon, the aquaculture report notes, are especially attractive for ocean ranching since they migrate to salt water soon after hatching, thus requiring minimal feeding while in fresh water and minimal hatchery facilities. However, they are less valuable than coho, chinook, or sockeye, and fewer will survive at sea and return to the parent stream. The first private chum salmon hatchery began operations in 1971 in Oregon, and there are now nine such ventures in Oregon and two in Washington. Several nonprofit private hatcheries capable of producing 10 to 20 million juveniles annually are planned in Alaska.

The other high priority species discussed in the aquaculture report--probably of only academic interest to Alaskans but very important to others of you at this conference--are marine shrimp, freshwater prawns, American lobster, oysters, and marine plants.

In closing, I would like to comment briefly on the National Aquaculture Organic Act of 1976, a bill introduced in the 94th congress by Congressman Bob Leggett, of California, and Senator Lloyd Bentsen, of Texas. If reintroduced in the 95th congress, as I anticipate, and passed, this legislation would represent a significant milestone in the development of aquaculture in the U.S. The legislation would authorize critically-needed funding support for federal, state, university, and private sectors for carrying on research and development programs.

In summary, my friends, we in NOAA and the Department of Commerce are heavily committed to the development and expansion of aquaculture. We believe that our efforts can provide an improved biological and technological base, help to solve long-range problems, and in many cases assist in the development of a satisfactory legal and institutional climate for aquaculture. Increased efforts of other federal and state agencies, universities, and industry are also needed. We are hopeful that these will also be forthcoming.

Thank you for being such an attentive audience. In closing, I want to say how wonderful it is to be back home! I'm sure all of you know I've had a deep and abiding love affair with Alaska for more than a quarter of a century. To those of you who made it possible for me to be here today, I give my heartfelt thanks and appreciation.

AQUACULTURE - AN IMPORTANT PART OF MULTIPLE USE MANAGEMENT ON THE NATIONAL FORESTS OF ALASKA

John A. Sandor
Regional Forester
U. S. Forest Service
Juneau, Alaska

Dr. Sato's presentation was certainly a fine professional paper. We could all have benefited by spending the rest of the evening with Dr. Sato and a discussion of his paper. His paper also reminds us just how far we have actually come in this field. In preparing for this presentation I was reviewing a report on Alaska investigations of the various fisheries in 1914. E. Lester Jones, at that time Deputy Commissioner of Fisheries for the Department of Commerce, had written this report after a lengthy study in Alaska. It is very fascinating looking back. I think sometimes when we do look back and can see what was happening at different points in time, we can gain a better perspective of how far we have come and where we should go. In this very fine paper, Mr. Jones outlines some of the many problems noted in the declination of fisheries at that time. This 1914 report includes an entire section on fish depredation by brown bear, eagles, and seagulls. People at that time were looking for various reasons for the declination of fisheries. Wildlife use of fisheries was regarded as a significant problem. In fact, one of the recommendations of the Deputy Commissioner was that there be a bounty on eagles and indeed, for those that are old enough to remember, such a bounty was imposed. I couldn't help but think how far we have come in not too many years from actually looking at the eagle as a significant cause of the declination of fisheries. Today we are honoring this majestic bird. This illustrates the futility of looking for scapegoats because we have finally discovered that the enemy is us!

I appreciate the opportunity to represent the Secretary of Agriculture and would like to share some specific thoughts with you on aquaculture and the management of Alaska's National Forests. I am deeply concerned with the bureaucratic maze many of you have faced. The reason I say this is because I have been looking through the regulations of what you who hope to go into the aquaculture business have to go through in order to actually get from point A to point B, C, D, and E, etc. Although I have only returned to Alaska this past March, I have learned how difficult it is to have your requests and permit applications processed. I've just got to say it must be a really frustrating experience to follow this process. I do want to let you know that I am well aware of the various hurdles, steps, and hoops that we've got to go through. This process must be simplified and we are going to try to do just that.

I would first of all like to outline the charter of the Forest Service and what we hope to be doing. Then, I'd like to spend 15 minutes or so listening to what you would suggest that I as the Regional Forester might do to make your job simpler and your aspirations just a little bit easier to attain.

The Forest Service itself is an agency operated within certain frameworks. One of the principal laws under which we operate is the Multiple-Use Sustained Yield Act. The Multiple-Use and Sustained Yield Act of 1960 directs that the Forest Service manage the lands that it has in trust for the American people for multiple use and sustained yield. The Multiple-Use Sustained Yield Act is just one page in length. It is a beautiful act briefly summarizing the objective of managing the national forests. In short, we are directed to manage the surface renewable resources of the forests in that combination of uses which will best benefit the American people. This very simple definition disturbs some people. People are bothered because the act is not specific enough, and some believe their particular special interest may not be fairly treated. But because ecosystems vary so much from place to place, and because the needs of American people themselves vary over time, I believe it is desirable to provide the American people with an opportunity to weigh, from time to time, what the objectives ought to be in a given location and then plan the resource management activities to meet those needs.

The other important part of that act is the definition of Sustained Yield which specifies that these variable resources be managed so that the sites and the productivity of the lands are not decreased. The Congress reaffirmed their commitment to Multiple Use and Sustained Yield in passing a similar act for the Bureau of Land Management. This concept has been reaffirmed again in the Resource Planning Act and in the National Forest Management Act which was just passed in 1976.

I know that most of you are interested in a variety of resources. This conference on aquaculture provides a means of determining how all of us might work together with the loggers, with the wilderness advocates and others in providing that mix of resource use that can best meet the needs of the American people. The process by which we define and achieve this definition of multiple-use management on the ground is in the land management planning process. I don't know how many of you have had the opportunity to see the draft of the Area Guide for southeast Alaska, but this guide will help define the management objectives and policies for southeast Alaska. There are sections on aquaculture, fish and wildlife habitat, timber management, wilderness, and other uses of the forests. Through the use of this guide, followed with a detailed forest management plan for the Tongass as a whole, we will jointly define what multiple use will actually mean in specific locations on your national forest. This guide is the broad policy direction for the national forests of southeast Alaska.

The forest management planning process is already underway and is to be completed by December of 1978. During this two-year process we will actually draw the lines on the map to indicate where particular activities will occur. Multiple-use management does not seek to manage every acre for every use. Multiple-use management includes designation of some lands for wilderness. Nationally, we have a target of roughly 15 percent of the national forest lands being dedicated to wilderness.

An important part of the land management process is the location of aquaculture sites. This will be a specific part of this land management planning process, and I think that this is one of the things that will be helpful in shortening the very difficult and troublesome steps that you have to go through. After approval of a permit application by the state the forest service reviews the specific site through the environmental analysis process prescribed by the National Environmental Policy Act. The forest service is required to prepare an environmental impact statement when the proposed site is in a "roadless area." The time to prepare an environmental impact statement itself would ordinarily run from three to six months, but where roadless areas are involved an additional opportunity for a 60 day review by Congress is also provided. I am suggesting that, if we at least work together in this land management planning process, the identification of aquaculture sites can be included, and thus help to reduce these long periods of study and review.

Another important part of the process, and why you need to be involved, is to resolve the issue of how much wilderness there should be in southeast Alaska, and how much wilderness there ought to be in the United States itself. We've had substantial discussions of how much wilderness there ought to be. These proposals, of course, vary greatly. One of them was a proposal for 43 wilderness study areas covering 7.5 million acres. This was one of the alternatives that was included in the draft area guide. These and other proposals will be debated and it is important that you be involved in the development of such proposals.

The forest service is trying to recommend a reasonable level (or acreage) of wilderness study areas. From a national standpoint, we have considered an average of 15 percent based on Resource Planning Act studies. Many of us in the forest service think that this percentage should be greater in Alaska because there are many unique lands that deserve special protection and could be preserved in perpetuity. Whether there ought to be 15 percent or 25 percent, I do not know. We want you to help develop our recommendation which will then be sent on to the Congress for their consideration and action. Thus far the forest service has proposed 1.9 million acres for wilderness study on the Tongass National Forest.

Of the 16 million acres on the Tongass National Forest in southeast Alaska, at least 10 million acres of that will re-remain wild for the foreseeable future. The reason it will remain so is because the commercial forest land acreage in southeast Alaska is just a little over 5.5 million acres and as far as timber harvesting is concerned, the forest service does not intend to harvest more than 50 percent of that within the next 100 years. Mining will take place on additional areas but the total area or areas suitable for economic development may not be great. The wilderness study process provides for a geological survey review that identifies the mineral potential of proposals for wilderness designation.

I want to acknowledge that wilderness ought to be represented in the commercial forest land stands, as well as in other areas. Again, I think this is one of the things that we want to work out jointly with the various publics in the planning process. The point I am making is that in this next two-year period, we will be working with local communities, the timber industry, the mining industry, the Sierra Club, the Southeast Alaska Conservation Council and other organizations and individuals. Every citizen has a basic right to help decide how "their" national forest is to be managed. I urge you to become involved in this process if you have not already done so. Some of you have, and I would ask that you continue in this effort.

Before opening this to questions, I would like to express my appreciation to those who have been working with us in the planning effort, especially to the state and to the Native groups who are also involved in this effort. Through this process, we can more effectively plan so that multiple-use management can work to the benefit of all Alaskans and all of the American people.

SALMON AND COMMUNITY IN SOUTHEAST ALASKA: REGIONAL AND HUMANISTIC PERSPECTIVES FOR AQUACULTURE PLANNING

George W. Rogers
Institute of Social and Economic Research
University of Alaska
Juneau, Alaska

The Alaska Aquaculture Foundation in its conference press release clearly stated my role on this program. "Dr. George Rogers, Professor of Economics at the University of Alaska ... is the designated humanist for the Conference, making the grant possible." What I say in the time allotted to me, therefore, might appear to be unimportant in relation to being the conduit of funding. But as the "official humanist" (and I will not attempt to say what that means) I also have a responsibility to the granting agency, the Alaska Humanities Forum, to address their theme -- <u>Land: Bridge to Community</u>. This involves us, unfortunately, in definition of terms before we start.

At the Cordova aquaculture conference last year I discussed the concept of the Alaska Fishing Community at some length.[1] In its most generalized sense this was based upon MacIver's definition of community as "a focus of social life, the common living of social beings; an organization of social life, definitely established for the pursuit of one or more common interests." The specific focus of community was activities related to the harvesting and processing of salmon. Today we will be discussing communities which have existed in this region (southeast Alaska) in varying forms during Alaska's history, and the evolution of changing forms of communities in response to changing resource uses and economic organization.

Economists consider "land" as one of three or four basic factors of production and it is therefore part of the Forum's theme. It is not a form of real estate, but represents all resources existing independently of man's activities that enter into or condition the economic process. In the present case the primary forms of "land" have been fisheries, minerals and forest resources and a unique

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1 George W. Rogers, "The Alaskan Fishing Community and the Socio-Economic History of the Alaska Salmon Fishery," <u>Proceedings of the Conference on Salmon Aquaculture and the Alaskan Fishing Community</u>, Donald Rosenberg, Editor, Sea Grant Report 76-2, February 1976, pp. 7-24.

forest-marine environment. "Bridge" is shorthand for the complexity of economic and humanistic processes by which "land" provides the economic support system for its social beings. It also determines the organization of "community" and influences the character and values of its members.

My approach will be that used in the first aquaculture conference at Cordova. The major part will deal with a historical survey of three key periods of economic and community development within the region, moving from the land-community unity of the aboriginal period to the community fragmenting processes of colonial-commercial exploitation and the present mixed-resource economy of the region. The final section will deal with the future of community based upon an extension of the present resource mix of fish and forest products and the possible role of aquaculture in that future.

ABORIGINAL PERIOD: LAND AS COMMUNITY

Long before the European discovery of southeast Alaska, this region supported one of the heaviest concentrations of aboriginal populations in the western hemisphere north of the larger populated areas in Mexico and Central America. This was known as the "territory of the Tlingit," one of the several "nation groups" among the coastal Indians of the northwest Pacific. At the time of the Russian fur trade, about 1,800 Haida had settled on the southern part of Prince of Wales Island, but this was only an invasion beachhead in a region occupied by an estimated 10,000 Tlingit. Not only did this region provide the means of support for a relatively heavy concentration of population, its natural resource base also provided the economic means for the elaboration of a primitive culture rich in art, oral literature, and social and legal organization. The land provided the timber for housing, canoes, and other artifacts as well as game, fruit, and vegetable foods, but marine resources were the principal source of wealth and well-being. The sea afforded rich harvests of salmon, halibut, cod, herring, olachen, and other fish. The sea also provided an abundance of edible mollusks, marine game (hair seal, sea lion, porpoise, whale, sea otter), and plant matter.

From early Russian sources and official census reports and supporting documents, Table 1 summarizes the geographic distribution of the region's Indian population from 1839-1910. The more familiar term "Native" is not used here as an attempt has been made to exclude all populations not indigenous to the region, such as the Aleut hunters of the Russian period. The Tlingit have been further divided into the thirteen main geographic divisions identified by the recorders of the original data. Each was located at one main village location around

Table 1. SOUTHEAST ALASKA - Indian Population by Major Geographic Divisions and Community Units, 1839-1910

Major Geographic Divisions and Population Units	1839[a]	1861[a]	1880[b]	1890[b]	1910[b]
Northern Division [c]	2,326	3,747	3,305	2,324	2,037
Tlingit:					
Yakutat	350	970	500	346	307
Chilkit (Klukwan, Haines)	498	1,616	988	818	694
Auk (Juneau)	203	118	640	326	269
Taku-Sumdurn (Douglas)	493	712	269	240	142
Huna (Hoonah)	782	331	908	504	625
Central Division[d]	3,532	3,348	2,552	1,759	1,687
Tlingit:					
Sitka	750	1,344	940	831	608
Hutshuw (Angoon)	729	600	666	420	536
Kake	393	445	568	237	325
Kuiu	150	262	60	-	29
Stikine (Wrangell)	1,510	697	318	271	189
Southern Division[e]	2,682	1,502	1,598	1,884	1,657
Tlingit:					
Henya (Klawock)	269	411	527	270	214
Tongass (Ft. Tongass and Ketchikan)	363)	333	273	266	184
Sanya (Saxman)	315)				
Haida:					
So. Prince Wales Island	1,735	758	798	395	530
Tsimshian:					
(Metlakatla)	-	-	-	953	729
Not Specified	-	-	-	-	336
TOTAL REGION	8,540	8,597	7,455	5,967	5,717

[a] Includes slaves with tribal (community) units. Unidentified creoles living at Sitka with Russians not included (350 in 1839 and 505 in 1861) as these were probably Aleut.

[b] Includes mixed blood or creole.

[c] Data arranged to represent same geographic area as combination of following 1970 Census Divisions: Juneau, Haines, Skagway-Yakutat.

[d] Data arranged to represent same geographic area as combination of following 1970 Census Divisions: Sitka, Angoon, Wrangell-Petersburg.

[e] Data arranged to represent same geographic area as combination of following 1970 Census Divisions: Ketchikan Gateway Borough, Outer Ketchikan, Prince of Wales Isl.

Table 1. (continued)

Source:	1910 data:	13th Census of the United States, Vol. III, Population, 1910, (USBC), P. 1137.
	1890 data:	11th Census of the United States, 1890: Report on Population and Resources of Alaska, p. 158.
	1880 data:	Ivan Petroff, Alaska: Its Population, Industries and Resources, U. S. Census Office, Tenth Census, Vol. VIII, pp. 31-32.
	1880-1910 data:	Indian Population of the United States and Alaska, (U.S. Bureau of the Census, 1915) pp. 111-115.
	1839 and 1861 data:	based on counts and estimates by Veniaminov (1835), Douglas (1839) and Wehrman (1861) as reported in Petroff, op. cit. pp. 33-41 and analyzed, re-computed and classified in G. W. Rogers, Alaska in Transition: the Southeast Region (The Johns Hopkins Press, 1960), pp. 336-358.

which several smaller places or "camps" might be oriented to accommodate the people during seasonal harvesting activities. Each name in the table can be identified on a map as a sub-territory embracing a block of fishing, hunting and berrying grounds and the population supported by that "land" unit. For purposes of conjunction with further tables, these sub-territories have been grouped into three divisions of the region.

The higher total population for the period 1839-1880 compared with 1890-1910 census enumerations may be due in part to over-count. These were either estimates or in the case of 1880 a census conducted over several months of seasonal movement. Contemporary accounts suggest the reality of actual population loss due to disease introduced by the newcomers and decline of the aboriginal subsistence systems. Redistribution of the people between village concentrations was in response to resource-base changes and made through operation of the clan system. Any attempt to describe these institutions within this talk would be grossly inadequate, but it can be stated that study of the heritage of the region's Native peoples demonstrates that with the resources at hand they created institutions and organizations which permitted a sound and rational relationship of man to his environment and a balanced utilization of the natural resource base to support something far greater than a bare subsistence existence.[2] At the heart was the world view I described at the last conference by referring to the society of the Yurok Indians of the Klamath River, the unity of all living things within a defined universe.

COLONIAL EXPLOITATION AND SETTLEMENT: FURS, GOLD, SALMON (circa 1800-1950)

Following the ill-fated attempts to establish settlements near Yakutat (1796) and Sitka (1799), the Russians, through force of arms, drove the Sitka Tlingit from their settlement site and there established Novo-Arkhangel'sk in 1804 as headquarters for their North American "empire." The only other Russian place established in the region was the D'ionisievsk Redoubt (1874), a fortified trading post near the mouth of the Stikine River, the present Wrangell. These were not true communities, merely small collections of operatives of a fur trading enterprise with a few Russian and Siberian managers and workers and Aleut and Creole hunters. They were engaged almost exclusively in the fur trade and this, in turn, was based primarily upon the harvesting of sea otter, the decline of which contributed importantly to the decision to sell Alaska in 1867. Exploitation of other marine resources was left to the whalers and sealers of

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2 George W. Rogers, Alaska in Transition: The Southeast Region, (Baltimore: The Johns Hopkins Press, 1960), pp. 174-219, 272-279.

Great Britain, the United States and Japan. Even the fur trade other than sea otter was surrendered by the leasing of most of southeast Alaska in 1836 to the Hudson's Bay Company. The HBC set up its operations at Wrangell (Fort Stikine) and the Taku River (Fort Durham, 1840). The Native population continued to live at their traditional village locations while the Sitka Tlingit resettled outside the fortified Russian "capitol" and, as the period drew to an end, used the palisade as a ready source of fire wood.

There were changes in the traditional ways of the Tlingit and Haida. The fur trade introduced a degree of specialization into Native activities as the use of trade goods modified their life style and new diseases reduced their numbers. The first two decades of American rule under army and then navy administration introduced Natives to the art of alcohol distillation ("Hootch") and the effectiveness of mountain howitzers and naval and gattling guns in the destruction of the Kuiu villages in 1869 and Angoon in 1882. Both forces were destructive to aboriginal unity and self-sufficiency.

The economics of this new United States district focused on the fur seal and the Bering Sea until two events in 1878 brought southeast Alaska back as the source of further economic trends. In that year the first salmon canneries in Alaska were erected at Klawock and Sitka. Within eight years canneries were operating in all areas of the region and by 1908 the annual pack passed one million cases of 48 one-pound cans. It reached the peak of 4.3 million cases in the 1941 season. The first gold mining camp in Alaska also appeared in 1878 at Windham Bay. Other discoveries extended throughout the region and production, principally in the Juneau-Douglas area, continued until World War II brought the closing of the last of the large operations in 1944. Gold production since that date has been primarily from old mill site cleanups.

Economic values were realized from other natural resources such as timber, fur, other minerals and fish but canned salmon and gold were the economic life-blood of southeast Alaska from the 1880's until the early 1950's.

From 1906 through 1957, the period of significant recorded production, a total of 6,489,480 fine ounces of gold were produced by the region's lode mines, and 107,543,175 standard cases (48 one-pound cans) of canned salmon came from the region's canneries. Converting these quantities to 1957 prices (average 1957 wholesale price in the case of canned salmon), the value of the products of the lode gold mines was $227,131,738 and the value of the salmon canneries was $2,446,600,000, more than ten times the value of gold produced for the same period.

The southeast was truly a salmon-based economy, very much as the Native economy had been, but there were very basic differences.

Production became highly specialized and was no longer for the subsistence of residents of the region, but for export to distant markets. Indian fishermen and women were involved in the new commercial fisheries, but most of the labor force was imported from outside on a seasonal basis. This had important implications for the "community" within the region.

Population trends and distribution are indicators of patterns of community change and development (Table 2). Sitka continued as a major, but inert, population center with levels fluctuating slightly above or below the 1839 figure. The regional expansion between 1880 and 1929 was primarily within the present areas of the boroughs of Ketchikan and Juneau, the first in response to fisheries expansion ("The Salmon Capital of the World") and the second to gold. All areas took a sharp upturn between 1929 and 1939 as commercial fisheries moved into their most productive and exploitive stage.

Because of their orientation to fishing, the indigenous villages of the region survived except for the Kuiu villages which were wiped out by the U.S. Navy in 1869. Five were absorbed into adjacent new settlements of the commercial-colonial period. These were: Sitka, Ketchikan (Tongass or Fox), Wrangell (Stikine), Juneau (Auk), and Douglas (Taku). The Indian population in the traditional villages not absorbed into the "urban" classification remained constant in size, declining by only about 100 persons between the 1890 and 1970 census reports (3,594 to 3,498 persons in total), while the increase in total Indian population appeared in the main "urban" places (Table 3). Since the 1960 census an increasing portion of the "surplus" population has migrated out of the region because of the decline in fish resources and fisheries employment, and shortening of seasons.[3] The continued survival of these villages at their earlier levels of population is also an indication of the survival of the culture, albeit modified by the shift of its support system from subsistence to commercial salmon fishing. It is also an indication that the local resource-environmental systems were and are close to their limits of human population support.

Among the new communities emerging in this period, Metlakatla appeared in 1887 when about 800 British Columbia Indians (Tsimshian) migrated to Annette Island under the leadership of William Duncan and re-established there a model community based upon adequate natural resources (the Annette Island Reserve created in 1891) and a mini-utopian society which combined a rigid Christian idealism with the full utilization of nineteenth century technological advance (use of fish traps, hydro-electric power, etc.). Like all utopias, however, it was not without its elements of tyranny. While Duncan lived

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3 On the basis of census and vital statistics data I had estimated this out-migration as 1,600 between 1950 and 1960 and 3,600 between 1960 and 1970. G. W. Rogers, "Alaska Native Population Trends and Vital Statistics, 1950-1985," <u>ISEGR Research Note</u>, Nov. 1, 1971. pp.5-8.

Table 2. SOUTHEAST ALASKA - Total Population by Census Divisions, 1938-1975[a]

Year	Total Southeast	Northern Division[b]		Central Division[b]		Southern Division[b]	
		City and Borough of Juneau	Haines and Skagway-Yakutat	Greater Sitka Borough	Angoon and Wrangell-Petersburg	Ketchikan Gateway Borough	Outer Ketchikan and Prince of Wales Island
		Subsistence		Fur	Subsistence	Subsistance	
1839	9,260	696	1,630	1,600	2,652	678	2,004
1861	9,648	830	2,917	2,365	1,772	333	1,431
1880	7,748	929	2,396	1,103	1,657	273	1,390
Census Date		Gold	Fishing	Fishing		Fishing	
6/1/90	8,038	2,047	1,778	1,194	1,145	509	1,365
6/1/00	14,350	4,094	4,807	1,580	1,699	770	1,400
12/31/09	15,213	5,384	2,828	1,459	2,022	1,767	1,753
1/1/20	17,402	5,458	1,884	1,735	2,655	3,025	2,645
10/1/29	19,304	5,500	2,115	1,565	3,343	4,429	2,352
10/1/39	25,241	7,647	2,795	2,551	4,022	5,742	2484
		Government, Fishing, Forest Products		Forest Products, Fishing		Forest Products, Fishing	
4/1/50	28,203	7,818	2,735	2,726	4,439	6,829	2,656
4/1/60	35,403	9,745	2,945	6,292	4,579	8,774	3,068
4/1/70	42,565	13,556	3,661	6,409	5,416	10,041	3,782
7/1/75	50,438	17,714	4,801	6,600	5,746	11,311	4,266

a Pre-1970 data adjusted to represent same geographic areas as 1970 Census Divisions.

b 1970 Census Division combined identified in column headings.

Source: 1939-1970 decennial U.S. Bureau of the Census reports for Alaska (1939 and 1961 from Russian sources cited in 1880 U.S. Census). Alaska Department of Labor, Current Population Estimates by Census Divisions, July 1, 1975.

Table 3. SOUTHEAST ALASKA - Indian[a] and non-Indian Population by Type of Place of Residence[b] 1890-1970

	1890		Oct. 1, 1939		April 1, 1950		April 1, 1970	
	No. Persons	%	No. Persons	%	No. Persons	%	No. Persons	%
Total Population	8,038	100.0	25,241	100.0	28,203	100.0	42,565	100.0
Indian	5,967	74.2	6,179	24.5	7,295	25.9	7,625	17.9
Non-Indian	2,071	25.8	19,062	75.5	20,908	74.1	34,940	82.1
Non-Indian	2,071	100.0	19,062	100.0	20,908	100.0	34,940	100.0
Main "urban" places	1,643	79.3	16,910	88.7	18,898	90.4	32,146	92.0
Other places	428	20.7	2,152	11.3	2,010	9.6	2,794	8.0
Indian	5,967	100.0	6,179	100.0	7,295	100.0	7,625	100.0
Main "urban" places	2,373	39.8	2,665	43.1	3,926	53.8	4,127	54.1
Other places	3,594	60.2	3,514	56.9	3,369	46.2	3,498	45.9

a "Indian" includes an undisclosed number of non-regional Indians (Athapaskan and other North American Indians). "Non-Indian" includes Aleuts and Eskimo, most located in Sitka (Sheldon Jackson), Mt. Edgecumbe and Wrangell.

b "Urban" places corresponds to population located within present corporate limits of Ketchikan Gateway Borough, Greater Sitka Borough, City and Borough of Juneau, Wrangell, Petersburg, Haines Borough and Skagway.

Source: U. S. Bureau of the Census reports and worksheets.

a closed society was maintained with regulation of visitors and control of marriage outside the community. In a sense, this was the most fully developed new community established within the region during this period. In spite of its obvious economic success, however, no serious attempt was made to copy it beyond two faltering starts by the Presbyterian missionaries.

From 1890 on, growth was in the new non-Native places. The majority of the new residents of the region, however, lived in fishing and mining outposts or the new "urban" places which were only incipient communities. General statistics indicating this were the census reports that males outnumbered females about two to one until after World War II, that young and old people were almost entirely missing (non-Native population was dominantly in the active working age bracket from 16 years to 65 years) and that population turn-over was high. A 1937 investigation of Alaska's economic, social and political development observed:

> "Mining and fishing are essentially masculine employments. A large portion of the workers engaged in the salmon canning industry are brought from outside the canning districts, and have been almost entirely males ... The working population consists almost entirely of adult males, engaged for the most part in occupations requiring considerable physical activity and mobility, and living in more or less temporary communities. This type of employment tends to discourage the building of normal family and communal life ... Mining in itself is not seasonal, but ... the operation of mines tends to be irregular, and ... again militate against the establishment of permanent communities with well-developed social activities."[4]

BASIC ECONOMIC CHANGE AND COMMUNITY: SALMON TO FOREST PRODUCTS (1954-1976)

Since mid-century, the region's economy has been undergoing basic changes. Following the closing of the last lode gold mining operation in 1944, except for a brief export of significant values of uranium in the late 1950's and production of drilling "mud" for petroleum development, the minerals industry of the region has been negligible. Fisheries have experienced continuous decline with the salmon harvest falling from the peak average annual harvest of 47 million fish in the seven year period from 1936-42 to 13 million fish for 1970-74 and 6 million and 7 million for 1975 and 1976, respectively (Table 4). Fisheries products declined from the 1941 high total output of 255,590,000 for all products prepared for market to

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4 National Resources Committee, Regional Planning, Part VII, Alaska -- Its Resources and Development. (Washington: USGPO, December 1937), pp. 40-41.

Table 4. SOUTHEAST ALASKA - Timber and Salmon Harvests, 1936 - 1976

Period	Southeast Alaska - Yakutat Salmon Harvest		Tongass National Forest Timber Harvest	
	Annual Average (thousands fish)	Trend	Annual Average (m.b.f.)	Trend
1936-42	46,908	1.000	33,363	1.000
1943-48	26,948	0.574	71,948	2.157
1949-54	23,799	0.507	64,723	1.940
1955-59	17,138	0.365	220,896	6.621
1960-64	16,937	0.361	375,710	11.261
1965-69	17,245	0.368	479,013	14.358
1970-74	13,087	0.279	553,563	16.592
1973	10,479	0.223	588,491	17.639
1974	8,884	0.189	544,025	16.306
1975	6,249	0.133	408,371	12.240
1976	7,499	0.160	441,335	13.228

Source: U. S. Forest service and Alaska Department of Fish and Game.

106,147,984 pounds in 1974. The cause of this decline has been simply over-exploitation and depletion of the salmon resources and, despite increased management and rehabilitation efforts since 1955, it should now be clear that production can never recover its past high levels. Other species of fish and shellfish have been increased in harvest, but in 1974 salmon products still accounted for 78 percent of the total value of all fisheries products.

The region is not, of course, limited exclusively to marine resources. Seventy-three percent of the region's land area is within the Tongass National Forest. It contains an estimated 146 billion board feet of commercial timber, 92 billion board feet of which is economically accessible under present conditions. Until 1954, however, these resources had been subjected only to a modest harvest to provide special cuttings of high-grade spruce logs for export during World War II, and small annual harvests primarily for local timber requirements. In 1954 a mill initially producing 300 tons daily of high alpha pulp for use in rayon and cellulose acetate production went into operation at Ketchikan and, late in 1959, a similar mill at Sitka started with an initial capacity of 390 tons per day for export to Japan. The average annual timber cut in the Tongass National Forest jumped dramatically from an average of 65 billion board feet for the five-year period 1949-1954 to 221 billion board feet for 1955-1959, to 554 billion board feet from 1970-1974 (Table 4.)

The economic effects of this basic shift in resource-based activities is illustrated in Table 5 which estimates the change in the composition of the total value of natural resource products during three stages in the critical transition period from 1949 through 1963. From the marine-based economy (86.7 percent) of the period 1949-53 the region's economy emerged in 1959-63 as one in which the values had shifted to land-based resource products.

In all three major geographic divisions of the region, population growth jumped ahead and then began to level off by 1975 (Table 2). In the central and southern divisions this growth was directly attributable to the new forest products industry and more than offset declines in fisheries and processing. In the northern division another force for growth was at work. Following transfer of Alaska to the United States, Sitka and then Juneau served as capitals of the District, Territory and State of Alaska. But it was not until statehood in 1959 that public administration and politics introduced an employment element into the regional economy far out of proportion to the number of residents in the region. It also became the diffusion conduit for economic benefits generated elsewhere in Alaska (national defense and energy developments).

This new government and resource base, in contrast to fishing, was only minimally seasonal and unlike mining it was assured

Table 5. SOUTHEAST ALASKA - Estimated Value[a] of Natural Resources Products, 1949 - 1964

Estimated Average Annual Values for: Calendar Years

Product	1949-53 (000's)	1949-53 (%)	1954-58 (000's)	1954-58 (%)	1959-63 (000's)	1959-63 (%)
Total - All Products	$46,516	100.0	$60,096	100.0	$85,297	100.0
Marine Resources -						
commercial fisheries (wholesale value)[b]	40,307	86.7	32,043	53.3	36,978	43.4
Land Resources	6,209	13.3	28,053	46.7	48,319	56.6
Forest products (value f.o.b. mill)	4,300	9.3	25,200	41.9	45,622	53.4
Wildlife (furs and est. subsistence values)[c]	1,400	3.0	1,300	2.2	1,100	1.3
Minerals (including sand, gravel and building stone)	209	0.4	1,245	2.1	1,277	1.5
Agriculture (wholesale, commercial and home use values)	300	0.6	308	0.5	320	0.4

a Value at highest level of processing or harvesting within the region, unadjusted current dollars.
b Commercial catch and production only. Does not include personal use or sport take.
c Raw fur value and minimum food value of estimated game take by resident hunters.

SOURCES

G. W. Rogers and R. A. Cooley, Alaska's Population and Economy. University of Alaska, 1963. Vol. II, pp. 196-221, for 1949 through 1960.

U.S. Bureau of Mines, Minerals Yearbook, Vol. III: Area Reports, Domestic, 1961 through 1963.

U.S. Fish and Wildlife Service, Fisheries Statistics of the United States, for 1960 through 1963.

of perpetuity, in theory at least, given current sustained-yield resource management policies, growing long-term national and world-wide demands for timber and fibre, and petroleum-stimulated state revenues. Furthermore, without the introduction of these new elements, the region's economic base and population would have declined drastically and the support system of the present and potential community would have erroded. The existing communities were modified or even transformed and began to assume more of the characteristics of a true community than had been evidenced prior to the 1950's. From 1950 - 1970, the census reported virtual numerical equality between males and females, and children and senior citizens began to move toward a more normal distribution. More of the non-Indian residents were beginning to view the region as a place to live as well as make a living. The systems upon which they depended for their living, however, still looked upon the region as a warehouse of valuable or potentially valuable commodities to be drawn out for satisfaction of distant market demands. Fragmentation was also inherent, not only in the specialization of activity, but in the diffusion of management responsibility among state and federal agencies with differing stated objectives and management philosophies.

ALTERNATIVE FUTURES: AQUACULTURE AND COMMUNITY

There have been heartening signs of a new regional unity and community development within the last few years. 1976 was a banner year for congressional restatement of federal resource management policy. There was a broadening of fisheries conservation, and Forest Service and Bureau of Land Management objectives to recognize that renewable resources not only produce national economic values, but also life support systems for communities. The new legislature also provides for more meaningful public participation than the largely sterile public hearings of the past. Progress is being made toward better coordination and integration of state and federal programs, all of which will promote a greater sense of community and regionalism.

But the outlook for fisheries as a continuing basic element in the community support systems is not encouraging. In spite of increased state management and resource rehabilitation efforts and the federal research programs, the trend of salmon harvest has continued downward. Looking at world-wide commercial fisheries, Jacques Yves Cousteau recently reviewed the discouraging record of "scientific" management, technological advance which increases the depletion without any reinvestment in stock, and the futility of political solutions such as the present 200-mile extension, which are merely manifestations of the Domino Theory of Fish Destruction. The international industry is not so much concerned "with the supply of fish for future generations as it is with amortizing the staggering costs of the elaborately equipped fleets of the post-World War II era." It does an insignificant job of even meeting current food needs.

Less than ten percent of the proteins consumed in the world and less than five percent of United States protein consumption is provided by the seas. This is not surprising in Cousteau's view and the proper management of the ocean's resources should be obvious.

> "In 10,000 B.C. man realized that, by gathering berries and killing wild animals, he would deplete his food resources on land. He ceased trying to pit his human wit against animal cunning and applied his intelligence and vast experience to farming selected plants and breeding animals rather than slaughtering them. He had learned that hunting was living off capital and that farming was living off revenue. One hundred and twenty centuries have passed, and we have yet to apply that same simple principle to our oceans. We are living off capital, each year flagrantly withdrawing more.
>
> ...Fish are extremely high on the food chain -- about 10,000 tons of sea vegetables produce one ton of tuna, whereas ten tons of fodder produce one ton of beef! It is as hopeless to count on fish as it would be to count on tiger meat to feed the world. ...How can we use the sea to relieve some of that desperate need we have for food? The answer is not so difficult -- it is the same one that man stumbled upon 12,000 years ago. If the fishing era is coming to a close, we will have to farm the sea."[5]

None of us present here can willingly accept Cousteau's depressing conclusion that the fishing era is indeed coming to an end as we all have some stake in its continuation. But the regional catch statistics are hard to ignore. Our present aquaculture proposals take on heightened importance in their context, but should not be taken as sure-fire answers to the problem of resource enhancement and replacement. They are experiments in the right direction of living off "revenue" rather than "capital." I will pass over the considerable area of debate present here and go on to ask what sort of role a successful aquaculture might play in emerging communities in our future.

Aquaculture is not a new idea. More than 1,000 years ago the Chinese began farming several varieties of fish, for example, and these practices can be found in other parts of the world. The most fascinating to come to my attention recently was through an article on prehistoric Hawaiian fishponds. In this

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5 Jacques-Yves Cousteau, "Catch as Catch Can," Saturday Review, August 7, 1976. pp. 48-49.

article, a Hawaiian archeologist, William K. Kikuchi, analyzes how this indigenous aquaculture influenced the development of social stratification in the pre-contact Hawaii.[6]

Tradition places the building of these complex systems in the period of the Hero-Gods or the Hawaiian dwarf-elves, but evidence suggests a date sometime just prior to the fourteenth century A.D. The system continued to flourish into the nineteenth century. A total of 360 sites of four main types have been identified and described ranging from inland ponds integrated with irrigated taro fields to man-made seawalls enclosing coastal bodies of water. The average size of the ponds was 18.44 acres and each was associated with distinctive architectonic features such as ditches, gates, shelters, or temples. Agriculture and aquaculture were simply two extreme ends of prehistoric Hawaiian resource management. They were represented in an interconnected continuum of units (e.g., non-irrigated fields, irrigated fields, fish ponds, etc.) the products of which were a function of emphasis upon vegetable, fruit and/or fish. In a real sense fish ponds were treated simply as extensions of taro plots. They were seeded (stocked with mullet fry), fertilized (mulched with cut grass and pieces of mussels, clams, seaweeds, etc.), weeded (cleaned of algae), and harvested.

The fish pond also had cultural significance as a symbol of status and power. "The universe of the native Hawaiian was a delicately balanced, tri-state system of the super-natural, the natural and the cultural. There were four 'national' gods--Ku, Kane, Kanaloa, and Lono--who, with a multitude of demi-gods and guardian spirits, manifested themselves in every form of nature, from rocks and plants to atmospheric phenomena and running water. These served as constant reminders of the sanctity of all forms of earthly matter." Complementing the gods were the chiefs whose status was determined by their genealogical relation to the gods and who possessed some of their divine powers. All of the land and its resources and produce were owned by the paramount chiefs and fish ponds became manifestation not only of these supreme rights but demonstrations of their ability to "call up fish" upon demand as the gods might do.

The supporting aquaculture bureaucracy of the four Hawaiian islands is estimated to have employed about 10,000 men ranging from the priest-architects to the local fish pond caretakers. In performing their tasks they were assisted by supernatural powers. "All bodies of water, from the smallest pool to the largest fish pond, were the domicile of guardian spirits, mo'o, which manifest themselves in lizardlike or mermaid form. Their role was to protect their watery domain from man-made pollution in order to ensure an

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6 W. A. Kikuchi, "Prehistoric Hawaiian Fishponds," Science, Vol. 193, July 23, 1976. pp. 295-299.

abundance and proliferation of aquatic foodstuffs. Disrespect, in the form of verbal insults, of polluting the pond water with sewage, offal, or corpses, or of the presence of women in their menses, was considered sufficient cause for the spirits to denude a territory of its resources. Since famine was greatly feared, gross violation of cultural mores was punishable by death or by plucking out the eyes of the offender." The Ketchikan and Sitka mills can consider themselves lucky to have had to contend only with an Environmental Protection Agency.

The end of the fish ponds coincided with the end of the political power of the island's chiefs. "As soon as the native aristocracy changed to a Western-style Kingdom, the fish pond's function changed until, by the 1930's, the majority were simply archeological remains -- mounds and walls of rock along a river or shore."

I am not implying that the successful establishment of aquaculture in southeast Alaska is contingent upon creation of a political and community system on the pre-historic Hawaiian model, but that 600 years of experience does outline the humanistic elements essential to aquaculture playing a full role in the community development of our region. The first lesson we can learn is recognition of the multiple benefits of broad community involvement in the program. Two of today's speakers touched on the potential value of involvement of youth in meeting labor demands. Aside from providing a period of employment and income and possible apprenticeship for future careers, it also could produce a new generation of citizens educated in man's relationship to nature and the essentials of sound stewardship.

The second major humanistic element must be the recognition of and a return to respect for what Kikuchi calls the "tri-state system of the supernatural, the natural and the cultural," what I referred to earlier as the unity of all things in the universe. We must always remember that in these experiments we are only working with nature, not attempting to replace nature. This dangerous alteration course is now too clearly seen in the heart of the resource and environmental crisis we face today. I was very impressed with the technological improvement demonstrated on film of the Foundation's egg planter, but somewhat disturbed by its name, the Bionic Mother. We must beware of the pretension that we can replace the mother through such devices. We can only provide assistance in improving the yield of processes initiated by the true Mother.

THE ALASKA SALMON PICTURE

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Nineteen seventy-six represented a significant improvement in the Alaska salmon picture over the preceding four seasons. Preliminary catch figures totaled 43.0 million salmon compared to an average of only 25.6 million salmon during the previous four years, an increase of 68 percent.

Highlighting this year's season were catches of over 10 million pink salmon in the Kodiak district, over 5.5 million sockeye and 1.7 million chum salmon in Bristol Bay, 2.4 million pink salmon on the south side of the Alaska Peninsula, and 1.1 million sockeye at Chignik.

Other rays of sunshine in the salmon picture include the third largest salmon harvest in the history of the A-Y-K region; an above average even-year pink salmon harvest in Bristol Bay; and the highest red salmon catches since 1960 on the north side of the Alaska Peninsula, since 1970 in Kodiak, since 1966 in Cook Inlet, and since 1970 on the Copper River. The Cook Inlet pink salmon harvest was also the largest since 1968.

Despite the improvement in the salmon fisheries in 1976, the state still faces several bleak seasons. The projected harvest for 1977 is 35 million fish, with a range of 23 to 46 million. The decline in catch in 1977 is due primarily to anticipated weak sockeye returns to Bristol Bay and moderate to severe declines in pink salmon returns in much of central and western Alaska.

Areas of particular stress include northern Southeastern Alaska and Prince William Sound. In 1976, returns of pink and chum salmon to Prince William Sound fell short of expectation, and the general season had to be closed early to provide escapement requirements. Not all of them were met. The 1977 returns are expected to show some slight improvement over the 1976 returns.

Returns of pink salmon to northern Southeastern Alaska were a disaster. Despite nearly total closure of the area to the taking of this species, only 740,000 pink salmon were estimated in the escapement figures compared to a goal of 4 million. The projected return in 1977 shows only a slight increase over the 1976 return.

Southern Southeastern fared somewhat better than northern Southeastern in the year just past. The total return of just over 9 million pink salmon was almost equally divided between catch and escapement. Projections for 1977 indicate continued improvements in these stocks to produce a total return of 12 million pink salmon to the southern part of the Panhandle.

In response to the lean years of 1973-75, the department recognized the need for a comprehensive plan to rebuild the state's salmon fishery to its previous high level. Intensive work on the plan began in the fall of 1975 and was finished last fall. The plan is currently being printed and should be available for public distribution next month.

In developing a salmon plan for the state, the department saw the need for a balanced approach. Our plan was therefore built on four different programs, which, taken together, are designed to provide an annual harvest of 56 million salmon in the short term and 115 million salmon in the long term. The short-term objective is based on an assessment of the biological potential of Alaska's salmon habitat and a substantial contribution by supplemental production facilities. The four programs which have been elaborated in the plan include management, habitat or environmental alteration, supplemental production, and habitat protection.

Sustained harvest objectives can be achieved only if enough fish are allowed to escape the fishery each year to perpetuate both natural runs and hatchery stocks. These escapement requirements vary between natural and hatchery systems. They also differ by species, run timing, and even sex composition for each system.

It is the responsibility of the state's salmon management program to achieve the proper ratio of catch and escapement. Errors in both directions have been made in the past. If we let too many fish into the streams one season, we are justifiably criticized for it. If we let too few fish into the streams we are criticized the next time around with even greater justification when the inadequate escapement produces an inadequate return.

Under the management program, the Alaska Salmon Fisheries Plan calls for improvement in pre-season forecast accuracy, identification of individual stocks of salmon as they pass through the fisheries, assessment of in-season abundance of returning fish, more precise regulation of commercial harvesting, definition of optimum escapement requirements for various systems and species, more precise and comprehensive enumeration of salmon once they enter the streams and rivers, and a better public information system among other projects.

But management alone may not be capable of bringing catches up to their historic levels, and that is why the supplemental production and habitat alteration programs are needed.

Supplemental incubation and rearing systems will be asked to eventually produce an average of 47 million adult salmon a year to help moderate fluctuations in the abundance of natural stocks. This goal will be best achieved through the combined efforts of public and private facilities which have been planned to complement each other.

Additional fish can be produced by habitat or environmental alteration. This program includes stream clearance projects and installation of fish ladders to make additional spawning and rearing areas available to salmon, other habitat improvements such as lake fertilization and stream flow control, and predation and competitor control projects.

The fourth program, habitat protection, is necessary in order to preserve existing salmon habitat against encroachment and degradation.

Specific goals and projects under these four major programs are described in the plan for each region of the state. Goals for Southeastern Alaska, for example, call for an average annual harvest of 17 million salmon in the short term, that is seven years, and 39 million salmon in the long term or 18 years. Projects include pink salmon migration studies, studies of estuarine survival of pink and chum salmon, and construction of 11 pink and chum production facilities by 1990, to name but a few of the projects. Although I have spoken only of commercial harvests, the plan also provides for the maintenance of adequate numbers of salmon for subsistence use and an increase in the harvest of salmon by sport fishermen.

This plan is not cheap, and each project has a price tag. Fortunately, public support was shown for the initial stages of the plan in November when voters passed the fisheries bond proposition which will provide $29 million for state supplemental production facilities and additional program support facilities. Additional funds to fulfill the plan on time may be more difficult to come by as the state tightens its budgetary belt in anticipation of a fiscal crunch during the next few years.

The plan provides an outline of objectives by area and methods for achieving those objectives. Obviously, the department cannot do the job alone. Regional aquaculture associations have already been given a role in working with the department in developing comprehensive salmon enhancement plans for each region of the state, and this plan will provide an important working document for that effort. In addition, I will be soliciting public input on the plan when it is finally published.

At long last, the state has a document which can provide a sound and orderly direction for the future of the Alaska salmon. The commitment to restore our salmon fisheries to much higher levels of production, even if successful, would not guarantee a healthy fishing industry without our limited entry program, which now finally seems secure. Thus, I believe the essential tools are now in hand to stop and reverse the longstanding erosion of our great salmon resource. The task however, will require time, investment, and determination. I know that we will win this one.

A SUMMARY OF FRED ACTIVITIES IN 1976

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The salmon enhancement program of ADF&G's FRED Division made significant progress in 1976. At the present time FRED facilities from Bristol Bay to Southeastern Alaska are incubating and rearing approximately 53.4 million salmon eggs. This figure includes 24.5 million sockeye eggs, 17.5 million pink eggs, 7.6 million chum eggs, 2.35 million coho eggs and 1.45 million king salmon eggs. Fish and Game's Hatchery Section also incubates and rears king salmon and coho fry at the Fire Lake complex in Anchorage and at the Crystal Lake complex in Petersburg where heated water is available for accelerated growth.

Alaskan voters passed a $29.2 million bond issue in November 1976. This bond issue will provide funding for the construction of eight new hatcheries. FRED's activities encompass four Alaskan regions:

CENTRAL REGION

The five facilities operated by FRED in the Central Region are: Kasilof, Big Lake, Tutka Lagoon, Halibut Cove Lagoon and Lake Nunavaugaluk.

The Kasilof facility located on Crooked Creek near Soldotna is among the first facilities built by FRED, and results obtained there have guided design of other substrate incubators in the State. In the fall of 1976 11.5 million sockeye eggs were taken at Tustumena and Hidden lakes. They will be incubated and reared for a short term at Kasilof and then returned to the lakes. Over one million sockeye fingerlings were returned to Tustumena lake in 1976 and another 100,000 were reared in saltwater at Halibut Cove Lagoon. About 85,000 Crooked Creek king salmon smolt reared in ADF&G's Hatchery Section's heated ponds in Anchorage were returned in May 1976 for tagging, fin clipping and release in Crooked Creek. The design of the Kasilof incubators had been modified to use unfiltered water drawn directly from the creek. Well water is now mixed with stream water to improve water quality and permit a trial rearing program for king and coho salmon fingerling.

Big Lake incubation facility was completed in the spring of 1976 and is located in Meadow Creek near Wasilla. A recent sockeye egg take filled it to a capacity of 10 million. Expansion to a 20 million egg capacity is expected with production aimed at restoring an annual run of 50,000 to 250,000 adult salmon to the Big Lake system. A temporary incubation unit operated on the site beginning in August 1975. One hundred thousand fry were incubated and released last spring. That small number of fry comprised about 30 percent of all fry migrating from Meadow Creek to rear in Big Lake.

Tutka Lagoon, another new incubation facility located on the lower Kenai Peninsula, went into full production this fall when 10 million pink salmon eggs were taken. It was completed in the spring of 1976 and will be expanded to hold 20 million pink salmon eggs. It will also serve as a center for the rehabilitation of several lower Kenai Peninsula pink and chum salmon stocks.

One estuarine rearing facility is presently operating in the Cook Inlet area at Halibut Cove. The primary objectives at Halibut Cove Lagoon have been to produce fish for the developing sport fishery and existing commercial fishery, and to build brood stocks at the lagoon where none originally existed. About 300,000 coho salmon and 100,000 sockeye salmon were reared at Halibut Cove Lagoon in 1976. Also, 25,000 Crooked Creek king salmon smolts and 5,000 coho smolts were delivered from heated water ponds at Anchorage for imprinting and release at Halibut Lagoon. Adult pinks amounting to 5.8 percent of the pink salmon fry released at Halibut Cove Lagoon rearing station returned in the fall of 1976. This is the highest artificially produced adult return of pink salmon recorded in Alaska. This return was from 50,000 pink fry which had been reared and released in August 1975. Returning adults provided a commercial fishery where none had previously existed.

The 1976 bond issue provided funds for two new facilities in the Cook Inlet and Kenai Peninsula areas that will accommodate about 51.5 million pink and chum eggs, 24 million sockeye eggs and 20 million coho and king salmon eggs.

In Prince William Sound an incubation facility will be located at Cannery Creek in Unakwik Inlet, and will be capable of producing and releasing 20 million pink, nine million chum fry and one million coho fry.

The new Lake Nunavaugaluk incubation facility, located about 25 miles from Dillingham will incubate 15 million sockeye eggs at full capacity. The hatchery will test water intake systems during the present winter and be placed in partial production in 1977.

At present, three million sockeye eggs are incubating in in-stream incubators in a natural spring area in East Creek, a tributary of the lake. The returning adults from this release and a release of 360,000 sockeye fry made in 1976 will provide hatchery brood stock.

WESTERN REGION

The western region includes facilities on or to be located at Kodiak and Afognak Islands, and the Alaska Peninsula.

The Kitoi Bay Hatchery (Afognak Island) has been in existence since the mid-1950's as a pink and sockeye salmon research station. In fall 1976 it was converted to a production facility with a capacity of 20 million pink eggs, and only 7.5 million pink eggs were taken because no more were available. Eight percent of the total 1976 run of pink salmon to Kitoi Bay were attributed to fry released from the Kitoi Bay Hatchery. A return of 12,975 pink salmon from a release of 1.3 million fry was counted over the weir this fall.

The 1976 bond issue funds the initial phase of a major rehabilitation effort at Karluk Lake, which was once the greatest producer of sockeye salmon in the world in relation to lake size. An incubation facility for 25 million sockeye eggs is proposed to re-establish sockeye stocks in underutilized spawning and rearing areas in this system. This proposal is presently being reviewed.

A 50-million egg pink and chum salmon incubation facility funded by the bond issue will be located at Russell Creek near Cold Bay. Construction should begin during the summer of 1977. The State Public Works Department has contracted with an engineering firm, and preliminary design work and well drilling are under way.

NORTHERN REGION

FRED opened an office in Fairbanks during fall 1976 to begin a king salmon program. Obvious methods of incubating and rearing salmon will be explored prior to development of entirely new concepts, which may be necessitated because of the Interior's climate. Heated water from diesel power plants is available at Fairbanks and on outlying military bases. Tentative plans are being developed to evaluate the use of this waste heat for rearing salmon.

Part of the research on king salmon will be conducted under a federal grant from the Alaska Energy Office for a feasibility study on the use of geothermal water sources in the Interior and on the Alaska Peninsula in rearing king salmon. The 1976 bond issue provides money for a research facility to produce sheefish, grayling, trout and king salmon, with emphasis on king salmon.

SOUTHEASTERN REGION

In the southeastern region there are three FRED facilities operating at George Inlet near Ketchikan, Starrigavan near Sitka and Fish Creek near Juneau.

The George Inlet facility, started in 1974, is the only FRED facility devoted totally to incubation and rearing of chum salmon. This fall 7.6 million eggs were taken at Disappearance Creek on Prince of Wales Island, and are being incubated in both the Deer Mountain and George Inlet facilities. Fry will emerge from substrate incubators next spring.

In early summer 1977, 4.5 million fry will be released at George Inlet, 750,000 at Disappearance Creek and the remainder in Ketchikan Creek. The egg takes of 1974 and 1975 resulted in .8 million and 2.3 million fry being released. The first returns to the George Inlet facility are expected in the fall of 1977.

In the spring of 1976 a new marking program was initiated at George Inlet, when coded wire tags were adapted for use on chum fry. FRED uses fish tagging and marking as a method to evaluate projects at all its facilities.

Fish Creek estuarine rearing pens near Juneau have been devoted to rearing coho fingerling since October 1974. Coho salmon eggs are taken at the Mendenhall ponds, incubated at Crystal Lake Hatchery in Petersburg, and returned as fry to the Mendenhall ponds where they are fed until they can adapt to the estuarine environment. Fish are then transferred to Fish Creek for wintering and released the following spring.

Estuarine rearing pens are also located at Starrigavan Bay, seven miles north of Sitka. These pens, in operation since 1972, were one of the original FRED projects. Incubation facilities were completed in 1975 and are in the second season of operation.

Both of these facilities are capable of rearing all five species of salmon, but the major emphasis has been on coho.

Preliminary catch and escapement data indicate that more than two percent of the coho smolts released in 1974 returned this fall. At present 125,000 coho are being fed in the rearing pens and 900,000 coho eggs are being incubated. King salmon fry from Crystal Lake Hatchery will be sent to Starrigavan this winter for rearing.

The recent bond issue provides for two new southeast facilities; one at Hidden Falls on Baranof Island with a production capacity of 47 million chum fry and three million coho fingerlings, and one still under consideration at Klawock Lake on Prince of Wales Island.

A cooperative feasibility study with the Alaska Power Administration is in progress at the Snettisham power project south of Juneau, to see if the constant 41 degree Fahrenheit water is suitable for production of chum salmon.

In summary, it is absolutely essential to integrate the disciplines of biology, pathology, genetics, fish culture, and engineering, if a successful program is to be conducted. That integration is being accomplished by FRED.

SHELDON JACKSON COLLEGE AQUACULTURE TRAINING PROGRAM

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Private nonprofit salmon hatcheries became a reality in Alaska in 1975. One year after the 1974 Alaska Private Nonprofit Salmon Hatchery Act was passed, the Alaska Department of Fish and Game (ADF&G) issued the first three permits to NERKA Inc. of Fairbanks, Prince William Sound Aquaculture Corporation of Cordova, and Sheldon Jackson College (SJC) in Sitka.

The 1974 law was enacted as an incentive to private individuals, particularly commercial fishermen, to become involved in the rehabilitation of the state's depleted fisheries. Under the law, prospective hatchery operations must be approved by ADF&G. The central feature of this legislation is the relegation of private salmon culture to the nonprofit domain. Benefits are to be shared by all Alaskans in the form of rehabilitated salmon fisheries which can then provide physical nourishment for the people, economic sustenance for the communities, and a continuation of a way of life for those who have traditionally harvested from the common property fishery. Among those benefiting from this new industry are Native groups with their traditional interests in renewable resources. The Native Land Claims Settlement Act provided them the opportunity for salmon enhancement programs.

Trained salmon culture personnel are not readily available in Alaska. The career opportunities that would arise for Alaska Natives and other residents, because of this need, encouraged SJC to initate the first applied aquaculture program in Alaska. Central to the program is a two million egg pink and chum gravel incubator on campus near Indian River. This incubator and additional hatchery facilities serve as a student training center as well as a demonstrational model for the economic and biological feasibility of salmon ranching in Alaska.

The SJC training program was formulated with the following four objectives:

1. To promote Native Alaskan education by providing an educational career ladder for Indians, Eskimos, and Aleuts so that what they learn can be applied to a practical and meaningful vocation.

2. To enhance salmon stocks by establishing a private hatchery on campus to produce fish for the common property fisheries and as a source of self-sustaining funds for the program.

3. To promote cooperation among public and private organizations involved in the development of salmon ranching.

4. To provide technical assistance and advice to Native and non-Native corporations and individuals by sharing our own experiences and the knowledge gained from others.

To help guide the program directions, a Technical Advisory Committee was formed. This committee meets each May and November to evaluate progress and offer suggestions for modifications. Members of the committee represent Alaska Department of Fish and Game, National Marine Fisheries Service, U.S. Fish and Wildlife Service, Alaska Fisheries Council, Tlingit and Haida Indians, SEALASKA, Alaska Native Brotherhood, Bristol Bay Native Association, Alaska Legislature, University of Alaska, Petersburg Fisheries, Inc., Alaska Trollers Association, U.S. Forest Service, Metlakatla Island Reserve, private fish culture industry, first- and second-year SJC fish husbandry students and SJC Administrators. The staff responsible for carrying out the program objectives are: Mel Seifert, Director; Dennis Lund, Production Manager; Dave Bright, Aquaculture Supervisor; Mack Cook, Instructor; Gabe George, Teaching Assistant; and Cathy Hanson, Secretary.

The program has been fortunate to receive private funding during its initial four years from the Northwest Area Foundation. The first two-year grant of $137,000 provided for a year of planning, obtaining the necessary permits, construction of the two-million-egg shallow-gravel incubation system and initial curriculum development. The Netarts-type plywood box incubators were constructed in the summer of 1975 on the Crescent Bay waterfront next to Sage Science Building on the SJC campus. Water supply came from Indian River. Additional rooms within Sage Building were utilized for class lectures and indoor wet labs.

The first pink, chum and coho salmon eggs were taken in August and September of 1975. No problems occurred during the egg and sac fry incubation process and, in the spring of 1976, approximately 1.6 million pink and 65,000 chum fry were released into Crescent Bay. The pink salmon were released as they were ready but the chums were fed Oregon Moist Pellet for 36 days at water temperatures of 4° to 6° Celsius and increased in size from 1079 per pound to 587 per pound. Survival from egg to release of these two species was about 90 percent.

Three groups of 10,000 pink salmon were single fin clipped to compare survival and return of Indian River progeny (which comprised 91 percent of brood stock source) to Katlian River, South Fork progeny (a nearly donor stream) and a cross between the two. Some 10,000 chum salmon fry were also single fin clipped for survival study. All but a few hundred chums originated from Katlian River, South Fork brood stock. Of approximately 12,000 Indian River coho eggs taken on a separate collector's permit, some 8,000 were fed for 65 days and released back into the upper reaches of Indian River at 424 per pound. They were single fin clipped and stocked on July 31 for a survival study which might yield some data on carrying capacity of the natural coho fry and yearling population. About 3,000 were retained to be fed to smolt size and released in the spring of 1977. At the time of this report in January they were about 40 per pound.

In 1976, the Northwest Area Foundation awarded SJC a second two year grant for $214,000. The increased funding was to expand incubation and rearing capacity from two million to ten million fry release.

In September of 1976, pink and chum runs were negligible. Pink salmon eggs were obtained from Starrigaven Creek, a stream emptying into the first bay north of Sitka and the water supply for a FRED Division coho egg incubation and salt water rearing facility. Because another hatchery stream was involved, all eggs transported to the SJC hatchery were treated with Wescodyne after water hardening and prior to incubation stocking. This extra handling and stress resulted in an expected lower hatch of about 83 percent compared to the previous year. About 1.5 million pink salmon fry will be released in the spring of 1977. Because of the very mild winter temperatures around Sitka, the fry release is expected to be earlier than usual, perhaps March and April. About 60,000 will again be single fin clipped for later survival identification.

Chum salmon were obtained in Nakwasina River, the third bay area north of Sitka, by beach seining brood stock and towing them back to the Sage Building holding area in floating pens. The seven mile trip took 14 hours and all chums swam along inside the pens with no problems or mortality encountered. Approximately 85 chums were spawned yielding some 200,000 eggs. Over 90 percent hatched and high survival to swim up is expected. A few thousand coho eggs from Indian River stock were again taken to provide long term rearing experience for the students.

During the past year, work continued on converting a 30 by 50 foot room in Sage Building into a freshwater - seawater wet lab. One half of the room has freshwater from Indian River which is used by the students to operate their individual egg incubation and fry rearing projects. The other half of the room contains large homemade aquaria and fibreglass tanks to maintain intertidal and open water sea life. Water is supplied by pump through a four inch PVC intake line into Crescent Bay. This room, as well as the rest of the hatchery facility, is often visited by students from local public schools as well as outlying villages.

The academic program stresses the concept of on-the-job training. Students are asked to arrive on campus one to two weeks before school starts in late August so that they are on hand when the pink salmon runs occur in the Sitka area. They gain experience in capturing, holding, and spawning salmon and stocking the incubators. This hands-on experience continues throughout the school year when, in addition to courses in fisheries and related subjects, they work in the hatchery gaining practical skills in daily operation and maintenance for which college credit is given. In addition, students are encouraged to develop their own individual lab or field projects and several earn money working in the hatchery through a federally supported work study program.

In 1976 the Alaska Sea Grant Program awarded SJC a $57,000 grant to support the academic program, basically supplying salary funds for several of the fisheries and biology staff. Field work was also begun on recording estuarine conditions at time of fry release each spring. Currently 15 first-year and second-year students are enrolled in the program. They come from all parts of Alaska and some from the Lower 48. They all have one thing in common--a love of the Alaskan environment and a desire to help rehabilitate her salmon.

SUMMARY OF GEOTHERMAL ENERGY APPLICATIONS TO AQUACULTURE*

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The author claims no substantial expertise in aquaculture, but is knowledgeable in the applications of geothermal energy.

Geothermal energy is the result of the slow leakage of the earth's heat from the inner sources of heat out toward the surface of the earth. The heat in general is produced by the radio-active decay of uranium and thorium in the earth. The energy is present under any spot on the earth's surface. It is usually useful, however, only in the region of geothermal anomolies where the heat approaches the surface of the earth due to some internal mechanism such as convective upward flow of hot water or irregulatities in magma contour. Such anomolies are very often expressed by the presence of hot springs. Those hot springs may, on occasion, be useful sources of energy in themselves, especially where the amount of energy needed is not great.

Recently, a number of people have begun to consider the use of Alaskan hot springs as sources of energy for salmon aquaculture. The State Division of Energy and Power Development of the Department of Commerce has presently a contract with the Federal Energy Research and Development Administration to investigate the possible use of Alaskan hot springs in salmon aquaculture. That work will be conducted through the State Department of Fish and Game.

As an introduction to the subject, some of the data obtained by an Iceland salmon hatchery using geothermal energy are given. The data are shown in Table 1. The conclusion of the Iceland experience is that the use of geothermal energy, when available, may reduce the cost of smolts by about 30 percent. Also, smolts raised under these conditions appear to have a higher probability of return from the sea as full-sized salmon than normal hatchery smolts. The Iceland experience indicates that the conversion from feed to smolt is appreciably more efficient when the smolts are raised in 55°F water than when they are raised in somewhat colder water.

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* The word "aquaculture", not in most dictionaries, seems to mean the raising of animal life in water, as contrasted to the word "aquiculture", in most dictionaries, meaning the raising of plant life in water.

TABLE 1

KOLLAFJORDUR FISH FARM - ICELAND - 1973

Output:	200,000 smolts/year.
Price:	35 cents to 50 cents each (with geothermal heat) (4" to 6" long)
	60 cents to 75 cents each (without geothermal heat)
Return:	Up to 10 percent with 6" smolts, as low as 2.3 percent with small ones.
Input flow:	90 gals/min. at 158°F* = 5,000 gallon degrees/minute above 55°F.
Conclusion:	<u>With geothermal</u> must get $3.50 to $15.00 for every returning salmon to break even.
	<u>Without geothermal</u> must get $6.00 to $30.00 for every returning salmon to break even.
Savings:	Geothermal saves 30 to 40 percent.

* Flow corresponds to 600 gallons/minute at 55°F.

In Iceland, the fish in the rivers belong to the surrounding farmers. The farmers buy smolts from the hatcheries to release in their rivers and obtain their financial return by renting the fishing privileges to sports fishermen, largely from Europe. There is no commercial salmon fishing in Iceland. The use of hatcheries there has rebuilt the salmon runs in many rivers and started new runs in other rivers that previously did not have salmon at all. While the cost of smolts is high compared to what is apparently needed in Alaska, the return is high to the country because of the money spent by the foreign sports fisherman during his trip to Iceland to catch salmon. The smolts may cost $.35 to $.60 a piece, but the return is quite high, sometimes approaching 10 percent. The fishermen spends $50 to $100 in Iceland for every salmon caught. So the national economy is strengthened appreciably by this practice.

A number of slides were shown illustrating the use of geothermal waters in Japan in the aquaculture of alligators and eels. These efforts are profitable there.

Table 2 gives a list of Alaskan hot springs that might be considered for salmon aquaculture use. The Iceland fish farm uses about 5,000 gallon degrees per minute above 55^{o}F in their operation, the output of which is 200,000 smolts per year. Table 2 gives the gallon degrees per minute for a number of the larger Alaskan springs. The following comments apply to the listed springs:

The Bailey Bay Hot Spring feeds into a lake which in turn flows via a formidable waterfall, into the ocean. It is suspected that returning salmon cannot get up the waterfall into the lake, and hence the Bailey Bay spring may not be useful for this purpose. However, perhaps trout could be raised there for release into the lake to produce a trout system. Or salmon could be raised at that point and released below the lake, if that were desirable.

The Bell Island Hot Springs are presently developed and the energy is being used efficiently so it does not seem that the transfer of that energy to a hatchery would be sensible.

The Chief Shakes Hot Springs on the Stikine River appear to be a little small for this application. The springs are on Bureau of Reclamation land.

Manley Hot Springs are used to a certain extent, both for house heating and for greenhouse agriculture. However, there is still appreciable waste energy there, which might be useful for aquaculture if the site were deemed appropriate.

TABLE 2

Spring	Temp. °(F)	Flow (gal/min.)	Product (above 55°F)	Lat.	Long.
Bailey Bay	190	81.3	11,000	55° 59'N	131° 39.5'W
Bell Island	160	23.6	2,500	55° 56'N	131° 34'W
Chief Shakes	123	53.4	3,600	56° 44'N	132° 03'W
Manley	125	186.0	13,020	65° 00'N	150° 38'W
Melozitna	128	160.0	11,680	65° 08'N	154° 40'W
Circle	134	294.0	23,000	65° 29'N	144° 38'W
Clear Creek (N)	140	96.0	8,160	64° 51'N	162° 18'W
Clear Creek (S)	148	115.0	10,695	64° 51'N	162° 18'W
Pilgrim	170	8.0	920	65° 06'N	164° 55'W
Serpentine	154	26.5	2,623	65° 51'N	164° 43'W
Geyser Bright	200	100.0	14,500	53° 20'N	168° 30'W
Ophir	140	240.0	20,400	61° 12'N	159° 51.5'W

The Melozitna Hot Springs are partly used for house heating at the moment. The stream alongside is a good source of grayling. Whether that stream would be an appropriate site for a salmon hatchery would have to be considered by those who are more knowledgeable on the habits of salmon.

Circle Hot Springs are not close to fresh water. while there is appreciable waste heat from the present utilization of Circle Hot Springs, it does not appear to be a reasonable site for a hatchery.

The Clear Creek Hot Springs are not presently developed and would appear to have plenty of heat available for hatchery operation. Clear Creek itself appears to be a quite adequate source of fresh water for hatchery operations, so that site might also be a serious contender for an aquaculture operation.

Pilgrim Springs, alongside the Pilgrim River, would appear to be a very desirable site for salmon aquaculture. However, clearly the springs themselves would have to be developed since the presently measured flow is too small. Such development would probably be feasible since it is clear that the Pilgrim Springs area really releases much more heat than is represented by the numbers in the table.

Serpentine Hot Springs would appear to be a little small. Although there is a stream alongside the springs, the springs are on BLM land and BLM is apparently not sympathetic to development in that region.

The Geyser Bright Hot Springs, on Umnak Island in the Aleutian chain are probably very appropriate candidates for salmon aquaculture. The Aleut Corporation is aware of this possibility.

The Ophir Hot Springs, some 70 miles north of Bethel, are now being considered by the Calista Corporation as a possible hatchery site. It would appear that the salmon young would have to be transported a few miles to be placed in an appropriate river.

Therefore, it appears that there are several sites in Alaska that might be candidates for geothermally-heated salmon aquaculture. Any large development, however, would probably require the development of geothermal resources by drilling and hence would be a much more costly operation than is contemplated for hot spring application. Such drilling, nevertheless, might well be sensible for intended large operations.

AGRICULTURAL CONCEPTS WITH PRACTICAL APPLICATIONS FOR SALMON ENHANCEMENT

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Time-tested agricultural concepts of intensive soil cultivation, genetics, fertilization and weed and pest controls have counterparts in water. These concepts can be applied to salmon aquaculture or enhancement. For the purpose of this presentation a discussion of genetics will be omitted but the other concepts, as applied to intensive salmon aquaculture, will be illustrated by numerous examples drawn largely from experience in Alaska.

The aquacultural analogy of intensive soil cultivation is the utilization of lakes combined with fertilization, predator, and competitor controls to obtain economical production of sockeye, coho, and maybe even chinook salmon. Coho salmon, normally inhabitants of smaller rivers and streams, can be successfully reared in ponds, as was demonstrated in Oregon 20 years ago, or in Alaskan lakes as shown in recent years. Target production criteria for Alaskan lakes, based on present levels of technology, should be directed toward the following: (1) lake stocking density of 1,000 fry per acre until research can indicate higher levels of stocking, (2) attempts to obtain a fry-to-smolt survival of 60 percent, (3) ocean survival of smolt-to-adult salmon to range from 2 to 10 percent and average 7.5 percent. Hence, from the initial planting of 1,000 fry, we would have 600 smolts migrating and 45 adults returning per surface acre, which averages out to approximately 450 pounds per acre. Environmental conditions are not constant and therefore annual variations must be expected and the most effective aquacultural procedures have not been determined to obtain maximum returns.

Sockeye salmon, with few exceptions, are creatures needing a minimum of one year's residency within a lake in their life cycle, and are therefore more naturally adapted for lake cultivation than coho salmon. Natural production, under optimum natural conditions, has resulted in astounding numbers of adult salmon per surface acre of lake. Karluk Lake, famed as among the most prolific sockeye salmon producers in the world, probably has one of the highest recorded returns per surface acre. The 1896 parent spawned escapement of 1,115,000 sockeye salmon returned 5,583,000 progeny, or 446 fish per surface acre of lake. Situk Lake, near Yakutat, had a 300 fish return per surface acre in the early 1930's. Stocking can begin at a minimum of 1,000 fry per acre and will vary from lake to lake, depending upon individual fertility. Ocean smolt survival, dependent directly upon smolt size, may be somewhat higher than for coho salmon smolts as indicated by known returns.

Chinook salmon reared in a 47-acre pond near Eugene, Oregon in 1951 to 1952 indicated outstanding growth compared to wild juveniles residing in the McKenzie River, the pond's water source. Hence, they too can be lake-reared.

An important factor in maximizing crop production in the soil is that of adequate fertilization. The concept of soil fertilization is well documented by decades of experimentation and the practice is well established as well as a must for successful farming. In salmon aquaculture, lake fertilization has been virtually overlooked in spite of its use in other areas of fish farming, particularly in Asia. In sockeye salmon lakes, the carcasses may form an important source of nutrients, particularly in those lakes with small watersheds lacking a supply of leaching nutrients. To increase effectiveness, Mother Nature concentrates the salmon carcasses at the mouths of the rivers or on the beach spawning areas right where the biodegrading carcass leaches out the nutrients and the emergent fry appears. Hence, at least for a critical time, the newly emerged fry remains in close proximity to the leached nutrients that feed the nutrient cycle and produce the subsequent food of the juvenile fish. Before large-scale fertilization can be included as a practice in salmon aquaculture, considerable research is needed to determine effects of fertilization, types of fertilization, application rates, and expected improvements in returns.

Agriculture's weeds, pests, and predators have aquacultural counterparts which have similar detrimental effects upon production. Competitors share in the available food supply, reducing amounts available to the salmonids, which in turn reduces juvenile salmon growth and later their ocean survival. However, overstocking salmon fry into a lake produces intraspecific competition, which can be as harmful, or even more harmful than, competition by other species of fish.

Predation can be a significant factor in determining survival of salmon fry or smolts. J. G. Hunter (1959) at Hooknose Creek, British Columbia, determined that juvenile coho and sculpin predation upon emergent pink and chum salmon fry was as high as 85.48 percent and averaged 45.42 percent. Predation on lake-rearing salmon is dependent upon their distribution in relation to their predators. Coho salmon would be particularly vulnerable to char predation due to constant intermingling in the same habitat. Sockeye salmon fry spend several months in the lake littoral zone, vulnerable to sculpins and other species resident to this area. After several months the juvenile sockeye seek the deeper waters of a lake and develop a diurnal vertical migration pattern of approaching the lake surface at night and submerging into the depths during daylight hours. Hence, the predation pattern and species change with time.

A new and unique salmon enhancement approach, the development of groundwater as a reliable and dependable water source and its use in conjunction with an incubation channel, is suggested as being particularly applicable to Alaska. Here we have numerous glacial alluvial fans present below active glaciers or previously glaciated areas in which an almost inexhaustible supply of water lies a few feet below the surface. Such a water source is filtered, dependable, and nonflooding and the possiblity of freezing is minimized. As an example, man inadvertently developed such water sources in the Valdez area during excavations for two gravel pits and one drainage ditch in the alluvial fans of the Valdez Glacier Stream and the Lowe River. Minimal flows in March 1977 ranged from 2.31 to 4.83 cubic feet per second. Pink and chum salmon have moved into the outlet streams and are reproducing effectively. The outlet streams contain a high percentage of glacial sand and silt, which effectively reduces egg-to-fry survival. Production of salmon fry could be increased considerably by converting the existing channels into incubation channels. Suitable locations for such combinations include the huge Copper River flats, the Yakutat Foreland, and Brady Glacer. Many more exist in less accessible locations.

The farming potential of our barren lakes in the low-lying coastal areas of Alaska is considerable and now awaits development. A great amount of research and development remains to be done before intensive cultivation of these lakes is possible but even at the present low level of lake-rearing technology the potentials are attractive. Every cubic meter of lake water, to the depths inhabited by salmon juveniles, has a smolt production potential that individually is low but collectively very large. The aquacultural concepts of lake fertilization and competitor and predation controls, although presently not well understood, have attractive potential. The combination of groundwater development and use of incubation channels has a definite advantage when other means of aquaculture are lacking. The need for high protein sea foods is increasing annually and Alaskan salmon aquaculturists are willing and ready to develop the potentials.

OYSTER CULTURE IN ALASKA

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It is not necessary to go into oyster culture in general--literature is available for that; the main purpose here is to review the rationale for species selection and culture method most appropriate to Alaskan conditions. It is essentially an affirmation of conclusions already reached and acted upon in some measure.

Growing oysters is only a part of an oyster industry. There are conflicts of land use, both subtidal and intertidal, as well as problems of sanitation and paralytic poison control. These involve governmental participation and regulation. Marketing is the major difficulty. In the foreseeable future any Alaskan production will surely be confined to local outlets because of inability to compete with the production of the State of Washington and with Asian imports.

It is technically possible to culture a given molluscan species almost anywhere in the world. Whether it can be cultured profitably and competitively is the question. The potential of any mollusc as a culturable species is based largely on the following factors:

1. Consistent availability of low cost seed

Consistent seed supply is a major problem in temperate waters, for species well within their geographical range may have breeding failures. These failures occur more frequently than is generally realized, for the breeding success of few species has been followed for extensive periods. However, at least with some species such as the Pacific oyster, there are techniques for stockpiling seed to compensate for years when breeding success is indifferent. Cost of producing seed is also a consideration, for mollusc culture is labor intensive and it seems that temperate water areas are associated with high labor costs.

2. Rapid growth rate

In general most temperate water molluscan species have a relatively slow growth rate. Most hardshell clams in British

Columbia require five or six years to attain the minimum legal size limit. With bottom culture the native oyster (*Ostrea lurida*) requires five years to reach market size, less than two inches in diameter, so its use as a culturable species is doubtful under present economic conditions.

3. High value

High labor costs and the intermittent nature of most shellfish operations leading to difficulties with conditions of labor make a high value for the product imperative. In other words, a cultured mollusc in temperate waters is a gourmet item or nearly so. Relative to the world's food problems, molluscan culture can only alleviate locally the lack of protein. Another factor with molluscan shellfish is the cost of government intervention with respect to sanitary and paralytic shellfish poison control. Add to this government-sponsored research and the cost benefit becomes questionable.

Consideration of these criteria as well as studies and experience indicates the only successful species for molluscan aquaculture under British Columbia conditions is the Pacific oyster (*Crassostrea gigas*). Oddly enough this is an introduced species. The blue or bay mussel (*Mytilus edulis*) has potential on the basis of seed availability and growth rate, but whether the market value will be sufficiently high is problematical at this time.

In light of the British Columbian experience, the Pacific oyster is also the logical molluscan species for culture in Alaska. Oceanographically the northern areas of the province are little different from those of southeastern Alaska, so results from northern British Columbia should be applicable. There has already been enough experience in Alaska to demonstrate potential (Yancy 1966).

CULTURE SYSTEM

There are relatively few methods of culturing oysters. The two basic systems may be termed "on bottom" and "off bottom" but there are infinite variations, particularly of the latter, and more are being developed.

Both methods have been attempted in northern British Columbia. Bottom culture produced excellent oysters but the five to six years required for market maturity is too long for a profitable operation. Raft culture as adapted for British Columbia conditions was also used and results showed the possibility of a profitable system, at least for local markets. It would seem a similar technique would be suitable for Alaskan conditions.

RAFT CULTURE

The basic raft culture method successfuly utilized in British Columbia consists of strings of shell cultch spatted with young oysters. The shells are spaced about 12 inches apart on galvanized wire (more recently vinyl-covered wire) to allow growth in all directions. The shells are separated on the wire by twists made with a simple tool. The strings are suspended from a raft or some other form of floating structure in water deep enough to prevent the strings from touching bottom at low tide and in an area reasonably well protected from excessive wave action.

Since one of the most costly items in the system is the floating structure, optimum use must be made of it, so every attempt should be made to produce a crop in the least time possible. Oyster growth occurs only during the summer in these waters. The desired market size is involved. In British Columbia fresh market oysters of a length of about five or six inches are required. It is nearly impossible to place one summer's seed on the raft next spring, and to harvest oysters of the necessary size after one summer of growth with the water temperatures as they exist, even in the Strait of Georgia. Therefore, the seed is held on the ground for one summer to allow it to reach a length of one to one-and-one-half inches. These will then require only one summer (March to November) on the raft for the majority to attain full market size in the Strait of Georgia. In the Queen Charlotte Islands and on the west coast of Vancouver Island an extra year is required. However, the possibility of using the smaller oysters after one summer on the raft should be investigated. Smaller oysters generally have greater market acceptability than large ones. The increased shucking costs may be partly compensated for by the reduced fouling, as this increases with the time the oysters spend on the raft.

Areas suitable for raft cultûre have the following characteristics:

1. Water quality
   - (a) Adequate temperature and salinity.
   - (b) Adequate food supply.
   - (c) Freedom from excessive fouling.
   - (d) Freedom from sewage and industrial pollution.

2. Physical factors
   - (a) Protection from excessive wave action.
   - (b) Sufficient water depth.
   - (c) Proximity to a small area of oyster ground.
   - (d) Freedom from ice.

3. Other requirements
   - (a) Compliance with navigable waters regulations.
   - (b) Proximity to markets.
   - (c) Proximity to a seed supply.
   - (d) Surveillance.

PRODUCTIVITY

A log raft 40 feet by 10 feet will float about 100 strings. Strings holding 15 shells with at least 25 spat per shell form a length suitable for a small operation and, in most instances, keeps the oysters above the thermocline. It is possible to obtain one gallon of oysters per string of this length, but there will always be a number of smaller oysters that may later be grown to a larger size on the beach or on trays. One acre can accommodate about 25 rafts so an estimated production per acre is about 2,500 gallons or about 20,000 pounds of meat. To repeat, in the Strait of Georgia this may be attained in one summer on the beach and one summer on the raft. Outside Georgia Strait one summer on the beach and two summers on the raft are required.

COSTS

Costs are difficult to determine for so much depends on the experience and on the size of the operation. Estimates are given in Quayle and Smith (1976) and show $3.50 per gallon from the raft. Shucking, packing, and freight costs are just over $3.00 per gallon and the present wholesale value in British Columbia for a shucked packed gallon is $11.00. However, capital costs such as boats and operating premises are not included.

CONCLUSION

There is little doubt the Pacific oyster is the obvious species, short of introducing another exotic, for culture in Alaskan waters. There is also little doubt that the raft culture technique with strings would be most suitable. Trays may also be used but the economics are doubtful. The salmon fisherman already has the boat and all of the skills associated with raft culture activities. The strings are placed on the raft in March and normally they need no further attention until harvest from November onward. Whether or not such a culture would be profitable for local markets may be answered only by trial and some data which may already exist. Seed is not a problem except for the additional transportation costs, for it is available from natural setting in Washington, British Columbia, Japan, and hatcheries in Washington State or California.

One of the most attractive features of the raft culture system, particularly in a salmon fishing milieu, is that it fits so well with the fishermen's year.

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JAPANESE AQUACULTURE

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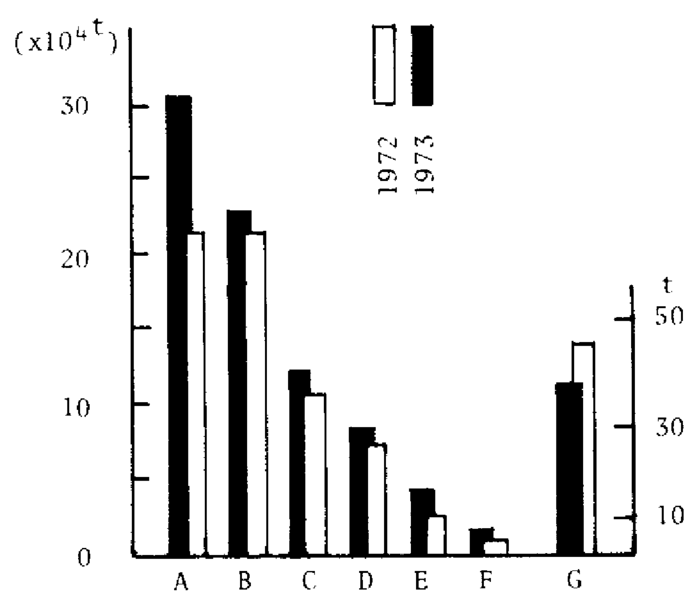
SUMMARY

Total production of Japanese aquaculture was 855,000 tons in 1973, and it was just 8 percent of 10,690,000 tons of total landings of Japan in 1973. Japanese aquaculture consists of cultures in shallow sea waters and inland waters and their productions are 791,000 and 64,000, respectively. Main animal species of Japanese aquaculture in shallow sea waters are oyster, yellowtail, scallop, prawn, and pearl oyster (Figure 1). Seed liberation of abalones is prevailing now and the chum salmon hatchery program is also being improved to increase their coastal return.



A: Laver
B: Oyster
C: Undaria
D: Yellow-tail
E: Scallop
F: Prawn
G: Pearl oyster

Figure 1. Production of Marine Cultures.

JAPANESE OYSTER
Classostrea gigas

Annual productions of cultured Japanese oyster with shell were 191,000 to 267,000 tons in the last ten years, and the productions are stable in these years. They spawn in early summer, in water over 25°C. Seed of Japanese oyster is mostly produced in natural waters though the production is possible by artificial tank breeding. Among methods of Japanese oyster culture, the raft culture method is used inside of the bay and the long-line culture method is used outside of the bay. The harvest of Japanese oyster culture is about 8 to 127 tons/k^2 in the raft culture method.

Mass mortality in culturing oyster was seen in the mid-summer. However, it has been possible to prevent it by controlling gonad formation in summer.

JAPANESE SCALLOP
Pecten yessoensis

Annual productions of cultured Japanese scallop were 6,000 to 41,000 tons in these four years. The production rapidly increased since the technique of collecting the natural scallop seed was developed several years ago. They spawn in spring, in water over 8.0°C. The seed of Japanese scallop is mostly produced in natural waters though production is possible by artificial tank breeding. As to the culture method of Japanese scallop, the ground culture method was common. The hanging culture method, however, has been spreading in northern Japan after establishing the technique of collecting the seed in natural waters. After a year and a half from the implantation of the seed to the hanging culture, the Japanese scallop is harvested. Mass mortality of cultured scallop is occurring in the southern limit of the culture, and it may be caused by earlier developing gonad in higher water temperature during winter and spring.

KURUMA-PRAWN
Penaeus japonicus

Annual productions of cultured Kuruma-prawn increased from 145 to 740 tons in the last ten years, and the production is steadily increasing year after year. They spawn in summer in bays and inlets. Juvenile Kuruma-prawn are being collected in natural waters and also can be produced by artificial breeding in tanks. Pond and net cages are being used for culturing Kuruma-prawn in southern Japan. The harvest of cultured Kuruma-prawn is about 100 g/m^2 in a pond. Seeds of Kuruma-prawn are being released to natural shallow sea waters too. Sandy beach, however, is necessary for their surviving predators. Therefore, artificial sandy beaches are being built experimentally.

JAPANESE YELLOWTAIL
Seriola quainqueradiata

Annual productions of cultured Japanese yellowtail range from 10,000 to 89,000 tons in the last ten years, and the production is increasing enormously year after year. They spawn along the coast of southern Japan in spring. Juveniles of Japanese yellowtail are being collected in natural waters for culturing. Tank breeding of them is being experimentally developed. Pond, pen and net cage are used for culturing Japanese yellowtail, and raw fish are being given to them as an artificial food. The harvest of cultured Japanese yellowtail, which is about 900 g., is about 80 kg/acre in a pond within one year. Red tide sometimes kills culturing Japanese yellowtail because they are being reared in bays and inlets.

YEZO-ABALONE
Haliotis discus hannai

Annual landings of ten species of abalone in Japan increased from 4,300 to 6,000 tons in the last ten years. Among them, Yezo-abalone are quite similar in appearance to Alaskan pinto abalone. However, Yezo-abalone seem to be slightly bigger than pinto abalone. Yezo-abalone spawn in fall. Natural recruitment, however, is not enough to sustain their stocks in the rocky coasts of northern Japan. Therefore, artificial tank production of Yezo-abalone seeds is prevalent to release them in natural waters in Japan.

Yezo-abalone grazes sea weeds on the coastal rocks. It grows to more than 90mm in shell length at the end of the third year after releasing and is then landed for market. Recapture of Yezo-abalone seeds, which were more than 30mm in shell length, is about 30 percent three years after releasing.

CHUM SALMON
Oncorhynchus keta

Annual coastal returns of chum salmon were 2,550,000 to 16,220,000 fish and 8,900 to 56,800 tons in the past ten years. The trend has been for annual return to increase every year. The highest return of chum salmon along the coast of Hokkaido and Honshu was 14,500,000 and 1,720,000 fish, respectively, in 1975. However, the return along the coast of Hokkaido and Honshu decreased to about 8,000,000 and 800,000 fish, respectively, in 1976. In 1975, coastal return rate of chum salmon was about 2 percent of released fry in Hokkaido. The results were considered good which is due to the release of fed fry. Coastal return rate of chum salmon in 1975 was less than 1 percent of released fry in Honshu. However, since the fry has been released after feeding to grow over 1.0 gram at Otsuchi River Salmon Hatchery, Honshu, Japan, the return rate of chum salmon stock increased to more than 1 percent in this particular hatchery.

SALMON RANCHERS DILEMMA -- THE IMPENDING FUNGICIDE CRISIS

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INTRODUCTION

The most commonly used fungicidal chemicals in salmon hatcheries are malachite green and formalin. Meyer and Schnick (1976) warned that more stringent control of these and other chemicals in the fish-culturist's medicine chest is imminent. These authors state that the U. S. Environmental Protection Agency was given authority to control fungicides and other toxicants by the Federal Insecticide, Fungicide, and Rodenticide Act of 1964, the National Environmental Policy Act of 1969, and the Federal Environmental Pesticide Control Act of 1972. The U. S. Food and Drug Administration authority to regulate chemicals was provided in the Federal Food, Drug, and Cosmetic Act passed in 1938 and amended in 1967, 1969, and 1972. Regulations of these two agencies require that all existing registrations be reviewed and re-registered by October, 1977.

Chemicals that do not qualify for registration cannot be used legally in the culture of fish for human consumption. Harmful chemicals used in hatcheries must be prevented from entering the natural aquatic environment. So-called "grandfather rights" to continue use of chemicals such as formalin and malachite green are to be superseded by more restrictive requirements. Federal and state agencies are not granted immunity and are urged to set the example of compliance with regulations. Penalties for non-compliance include fines up to $25,000 and jail terms up to one year.

Neither formalin nor malachite green are expected to qualify for registration by October 1977. To qualify chemicals for registration and legal use in fish hatcheries, certain prescribed laboratory tests must be passed. Apparently the expense, about $250,000 per chemical, has been a major factor but not the only factor delaying registration of some chemicals. A suspicion that malachite green might be carcinogenic has probably been a factor in discouraging efforts to register it. Drug clearance research may eventually provide fish culturists with a legal and practical fungicide but other alternatives should also be explored.

Experiments with pink salmon eggs in simulated intertidal environments at the Auke Bay Fisheries Laboratory indicated that seawater may have an inhibitory effect on fungus (Bailey and Heard, 1973). Many hatcheries proposed for Alaska will be situated near the coast where seawater is available. We began cooperative studies with the Alaska Department of Fish and Game on the use of seawater to control fungus by installing a seawater pumping system at the Auke Creek Hatchery in 1976. The results of the first exploratory test using pink salmon eggs are described in this report.

METHODS

The test incubator was a 30-by-30-by-30-cm polyethylene plastic box containing a 25-cm-deep mass of gravel on a perforated false bottom (Bailey and Heard, 1973). Upwelling flow was maintained at 4,645 ml/min which provided an apparent velocity of 300 $cm^3/hr/cm^2$. Apparent velocity is defined as flow-rate divided by cross-sectional area of the incubator.

A 1.5-horsepower electric jet pump with intake at the 5-foot tidal elevation provided the source of seawater. Whenever the pump was running, the head tank supplying water to the eggs received seawater. At all other times, the head tank received only fresh water. The 300-gallon head tank insured a gradual transition of salinity somewhat like a natural intertidal zone.

Eight incubators were seeded with about 4,600 water-hardened eggs each on the same day the eggs were fertilized, i.e., September 15, 1976. Four incubators received the seawater treatment and four received only fresh water. The eggs were enumerated by Burrows water displacement method. An estimated 15 to 20 percent of the eggs died and turned opaque white because of injuries suffered during the enumeration and seeding. This high initial mortality is not a normal operational situation but was advantageous for this experiment because the large number of dead eggs guaranteed a severe test of seawater as a control for fungus.

The seawater pumping system became operational on September 30, two weeks after the eggs were fertilized, and by that time, fungus mycelia about 1 mm long extended in all directions from individual eggs. After all the eggs hatched, dead eggs were removed from the gravel surface and hand counted.

The pump was operated for about three hours every workday but the periods of exposure were not precisely controlled and actually ranged from one to seven hours (average, three hours). In one instance, October 28-29, the pump was inadvertantly left running for 20 hours. Maximum salinity during treatments was about 23 0/00 when the exposures began September 30, but gradually increased to about 30 0/00 when the exposures were discontinued December 23.

RESULTS

The eggs hatched in December and hatching occurred at least a week earlier in the untreated incubators than in the treated incubators. A dense mat of fungus and dead eggs covered the gravel in the untreated incubators. Surviving alevins were trapped on top of this mat and they were not able to enter the gravel substrate. Growth of fungus was not extensive in the seawater-treated incubators. Although some clusters of fungused eggs were seen, all surviving alevins penetrated into the gravel substrate within a week after hatching.

After hatching, more dead eggs (7,232 eggs) were counted in the untreated incubators than in the treated incubators (4,283 eggs). The 0.39 fraction of eggs that were dead in the untreated incubators was significantly greater (P=0.014) than the 0.23 fraction of dead eggs in the treated incubators (Table 1).

DISCUSSION

In natural redds, accelerated hatching of eggs under stress from fungus may be a compensatory mechanism that would allow some of the alevins to seek a better environment. Alevins trapped above the dense mat of fungus and dead eggs in untreated incubators could not move to a better location. It is likely that many of the surviving alevins would have died or would have been weakened by continued residence in this environment. This prospect for continued high mortality along with the increased losses that occurred before hatching are compelling reasons for efforts to find a legal method for the control of fungus in hatcheries.

Daily seawater flushes of about three hours duration reduced losses due to fungus. Future studies should include taxonomic identification of fungus. Seawater tolerance probably differs among species of fungus, but probably does not differ greatly among species of salmon in the egg stage of life.

This exploratory test may provide a ray of hope for hatcheries situated on the sea coast but it does not give a definitive answer to the need for a fungicide in the fish-culturist's medicine chest. The quantities of artificial salts needed to control fungus at inland hatcheries would render single pass systems impractical. Recirculating salt water treatments might be feasible. Additional research is needed to relieve salmon ranchers from the fungicide dilemma. Efforts should be accelerated to obtain legal clearance for an effective fungicide, design incubators that minimize fungus problems, and define fungicidal properties of seawater.

Table 1.

Analysis of variance of fractions of dead eggs found in untreated and in seawater-treated incubators at time of hatching.

Source	Degrees of Freedom	Sum of Squares	Mean Squares	F
Treatment	1	.051376151	.051376151	11.92
Error	6	.025853918	.004308986	
Total	7	.077230069		

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TROUT FARMING POTENTIAL IN ALASKA

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Experience in farming trout on a commercial scale is practically non-existent in Alaska. The factors of climate, the high cost of doing business in Alaska, and the inherent risk of trout farming have discouraged private investors. Consider too the obstacles of market development, facility construction costs, transportation costs and it is apparent why serious consideration of trout farming has not been attempted.

Trout farming, however, is a serious and profitable business elsewhere. The current status of this industry within the continental United States is healthy. A review of the industry reveals some interesting facts. The trout market is somewhat concentrated in the northern states with people who are fish eaters by experience. It is restaurant-centered as a gourmet item; therefore it demands a lucrative price. It does not have ethnic patterns. With year-round production and freezing, the industry has substantially become less seasonal than in the past. The product is sold in 8, 10, or 12 ounce drawn form (gilled and eviscerated) but with head, tail, and fins attached. Shelf life, freezing techniques and modern packaging have all been improved to produce a quality product.

In contrast to most of the past 20 years, the last several years have brought a sellers market to United States trout farmers, mostly because Danish and Japanese products have virtually disappeared from the market. Accurate production data are not available. However, I did learn that the 1971 market was estimated to have been about 6.0 million pounds of processed farm-raised rainbow trout excluding live trout sold for private and public pond stocking which accounted for another 1.5 million pounds. The estimates for 1972 and 1973 were 9.4 and 11.8 million pounds respectively.

Researching through the commercial fish-farming journals it was noted that, with good promotion current, output probably could be increased as much as 25 percent without depressing price.

Trout farming industry spokesmen indicate that for the next ten years market outlook, market expansion will be on the basis of population growth rather than per-capita consumption growth. And again, with a good marketing program, the output of processed trout could reach 25 million pounds by 1980.

Trout farming appears to present a healthy economic opportunity for Lower 48 operators who can sell a processed product for consumption plus a live product to a large and expanding public for private and public pond stocking.

Better prepared nutritional fish feeds, federal fish disease laboratories, and expanded genetic research have also combined to improve quality of production for trout procedures to further create a viable industry. A statement often heard on the trout farming community is "We can do with trout what the turkey industry has done."

Concerning the potential possibilities of problems of creating a trout farming industry in Alaska, a number of geographical, biological and economic problems are present. Geographically, Alaska is not well suited to trout farming. Cold water and air temperature create special problems. Using natural surface or sub-surface water supplies would probably be unfeasible because of their less than optimum temperatures for year-round production. To be an economically viable operation dictates that rapid growth rate be attained in the shortest time span for lowest production cost. This means optimum water temperatures for efficient food conversion and growth rates. Some means, therefore, has to be devised to temper (warm) natural water supplies either through heating by conventional means or through geo-thermal hot springs, if you are fortunate enough to find one.

Commercially prepared fish feeds have come a long way in the last decade or two in improving their nutritional values. However, feed costs have risen rapidly in the most recent years with every expectation of continued increase. High feed costs possibly could be offset in part if Alaskan private enterprise was to develop its own facilities for production utilizing local herring, pollock, or hake. Given the right economic incentives, this could be an interesting venture as both public and private rearing facilities develop in Alaska to create a sufficiently attractive market demand.

On balance, utilizing fresh water supplies for trout farming presents formidable economic obstacles to investors and, in my opinion and others acquainted with Alaskan conditions, should not be encouraged at this time.

There may be a bright spot in the picture with the new technology developed in saltwater pen rearing. Experience gained the last two years from Department saltwater pen operations in Southeast Alaska indicates good food conversion and growth rates can be obtained. This is new technology and many questions remain unanswered. I hasten to add that a cautious approach should be taken.

This past October the Department experimentally stocked 8,500 resident rainbow trout fingerlings in the Fish Creek saltwater rearing pens at Juneau. We wanted to learn what problems would arise in adaptation from fresh to salt water, what kind of food conversion and growth rates would be obtained, and lastly, if we could successfully produce a six inch fish in eight months under the natural temperature conditions.

The rainbow were stocked as feeding fingerlings at about 2.5 inches in length and made the conversion to salt water with no difficulty or mortality. These fish will be carefully monitored until the experiment is concluded this May. The next phase of this experiment will concentrate on determining optimum density loads on pounds of fish per cubic foot of water.

Certain disease risks are greatly increased with increased densities and these too must be determined. The factors of disease are probably the most limiting to successful production.

Saltwater rearing poses unique hazards to fish farming compared to freshwater operations. These hazards include items such as floating debris tearing the pens, storms and predacious fishes that just love to gnaw holes in the enclosed mesh. Good fish husbandry and modern materials have largely overcome most of these problems. New fish vaccines have been and are under development to combat infectious diseases so easily transmitted in high density situations.

It appears that sufficient technology is at hand to warrant a pilot project using saltwater rearing pens for the commercial production of salmonids. This would be a high risk venture at the least, but probably no greater than the development of other new technologies in the past. Initially, this pilot project should probably be undertaken by a government agency to establish some preliminary criteria for the private sector.

In summary, economic factors to consider and resolve for successful trout farming are:

1. Cost of the product produced which includes:
    a. labor to feed and care for the fish
    b. authorization of the capital outlay for facility construction
    c. feed and drugs for disease control
    d. egg costs.
2. Marketing promotion and logistics.
3. Uniform quality of product.

The biological factors, as previously discussed, include disease control, genetic improvement, and water temperature control.

Because of the total lack of experience with trout farming in Alaska and the subtleties inherent in the industry, I highly recommend that the next Conference on Aquaculture invite officials from Idaho, for example, who can advise of the marketing and production logistics and baseline biological criteria that can then be applied to Alaskan conditions.

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