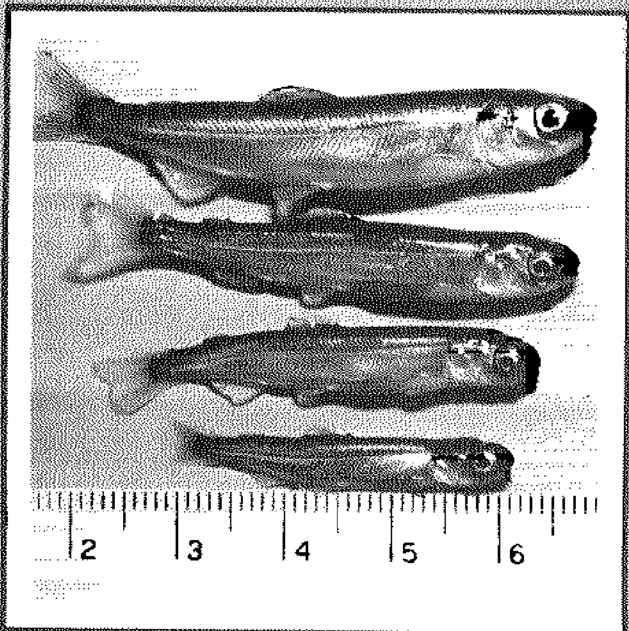


Proceedings of the

Third Alaska Aquaculture Conference

Cordova, Alaska
April 27-28, 1982

December 1982
Alaska Sea Grant Report 82-8
University of Alaska

Alaska Sea Grant College Program
University of Alaska
Fairbanks, Alaska 99701

Proceedings of the

THIRD ALASKA AQUACULTURE CONFERENCE

Cordova, Alaska
April 27-28, 1982

Edited by T. Frady

Sea Grant Report 82-8
December 1982

ACKNOWLEDGMENTS

The Third Alaska Aquaculture Conference was co-sponsored by the Alaska Sea Grant College Program and the Prince William Sound Aquaculture Corporation. We would like to thank our speakers and those who attended for their participation. This publication was produced by the Alaska Sea Grant College Program sponsored by the NOAA Office of Sea Grant, Department of Commerce under grant number NA81AA-D-0009, project number A/75-01, and by the University of Alaska with funds appropriated by the state.

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

INTRODUCTION

Armin Koernig
Prince William Sound Aquaculture Corporation
Cordova, Alaska

Here we are again, six years after the first Alaska Aquaculture Conference held in Cordova in January of 1976. Many of you speakers here today were here then, some of you in different positions but still working in aquaculture.

The subjects to be discussed this time are well-balanced with regard to the various aspects of salmon enhancement. But the emphasis has changed since 1976, from fish culture and biology to the more economic, financial, social, and institutional aspects. This is surely an indication of where the need for realignment is most pressing.

Looking at the list of topics and knowing most of the speakers' involvements and expertise it is difficult, even foolish, for me to get too carried away on any particular subject. Having the undeserved, I believe, reputation of talking too much, I decided to prove a point today and keep this introduction short. However, there are a few points I would like to make.

Since the beginning of Fisheries Rehabilitation, Enhancement, and Development (FRED) division in 1971 and the emergence of private nonprofit (PNP) hatcheries in 1974, substantial progress has been made in Alaska salmon enhancement both by FRED and by the private sector, which is smaller in numbers of hatcheries and overall investment. Successes are becoming more apparent as adult returns to both state and private facilities increase. Since the first salmon eggs were placed into an Alaskan incubator by FRED and since the 1976 fishery council prediction that it may take 200 hatcheries to produce 40 million salmon in Alaska, prevailing conditions have changed. Environmental conditions and good management practices have produced unusually high returns in Prince William Sound over the past three years, and this year a statewide all-time high salmon return is expected for kings, coho and chum in many areas still at the low end of things. The San Juan hatchery for example could get as many as six to seven million pink returns. That is more than the 15 year average return to Prince William Sound during the 60s and 70s.

Environmental conditions will change again, nobody knows when or how much. However, looking at the wildly fluctuating salmon runs of the past, it is not likely that nature will contradict itself and stay favorable from now on. The rationale for salmon enhancement, supplementing wild fish runs by more even and sustained hatchery production, doing away with the traditional boom and bust cycle, is still valid, although it may be hard for some people to believe right now. Salmon aquaculture is a long-term proposition and should be looked at and evaluated as such.

Just as an intelligent aquaculture project has to have a long-term biological plan, up to 12 years and more possible brood build-up for three to seven year species, so it needs a long-term reliable financial basis to make the project realistic. Here of course, some of the current problems appear. State appropriations to FRED are a year-to-year affair and priorities change with political changes, as do appropriations to the enhancement loan fund which was established in 1976 for PNP hatchery funding.

Competition for state dollars is fierce as a result of oil revenue shortfalls, a condition that is probably temporary. But if the list of priorities is closely examined, something else has changed since 1976. Fish is not the most important item anymore. Spending limitation formulas are not compatible with an enhancement program that was devised and set in motion to follow its own expansion rhythm based on primarily biological necessities and parameters. Who should pay for the program? The general public? The user groups? Should fish sales or a tax on fish landings recover the cost? Transfer of state hatcheries to regional aquaculture associations is being discussed, "to have the industry take care of itself." That could only be a partial solution where possible, desirable and workable. How about sport fishing hatcheries or hatcheries delivering salmon to various user groups or in mixed stock situations where cost recovery by fish sales is not possible? Do we have to recover cost? If this should be so, who should do it and how? How many fish do we need? Where and for what user group, gear group, and by what means if feasible? What about the cost benefit? These are some of the questions we hope to gain some insight into during this meeting.

Like aquaculture in other areas of the state, that in Prince William Sound is only starting to build its production potential. There is an incredible amount of work and opportunity still waiting. Prince William Sound Aquaculture Corporation (PWSAC) needs to build Esther hatchery for gillnetters, seiners, and sportsmen. A number of barren lakes and streams can be populated with fish. The Copper River red, king, and coho runs could and should be increased.

It is we, the fishing industry and the fish users, as fishermen, processors, and voters, that really have the responsibility and the chance to either make it happen or let it go. We need to stand together to overcome the present problems, plans, and work together for a rational and liveable future. It may sound strange: "We need our support!" Maybe it would sound better if I said we need to continue to believe in ourselves and in what we are doing.

We will live through the difficulties of 1982, one way or another. The main thing is that we live through it in a way that does not leave us at the docks years from now as we were in 1976--only this time with closed hatcheries, a closed season, and, I can hear somebody say, closed canneries.

This I am sure is also a good opportunity to reminisce for a minute. I would like to say a thank you to two men who are close to Cordova, to the cause of fish, to enhancement, and to PWSAC. The first is to Bob Roys who so abruptly retired last month from his job as FRED director which he had held since FRED was established. Trying to sort things out in the early days, among all unknowns in the new aquaculture field, was sometimes like running across each other in a jungle wearing different combat dress. But we soon discovered that we were on the same side--allies pursuing common goals. The excellent cooperation that PWSAC has enjoyed with FRED division and Alaska Department of Fish and Game (ADF&G) in general produced good results in our area. We hope it will continue to do so, even if we should take over a couple of hatcheries. The other friend, of course, is Wally Noerenberg who did so much for PWSAC. We miss him as a solid professional and a warm friend.

A special thanks to all you fishermen, processors and others who have steadfastly supported PWSAC with voluntary assessments, contributions and moral strength.

At times it seems that the work ahead of us is an endless uphill battle. But the challenge of it all is powerful and a lasting attraction to those who take it up. Your being here is living proof that the rewards are promising and they are within reach. Broodstocks in Alaskan hatcheries are finally building to produce substantial adult returns.

There are many talents, prerequisites, and virtues needed for aquaculture to gain secure longevity as an accepted way of additional fish production. There are those who may still look at hatchery fish as the result of an unnatural act, not as a financially explainable and predictable undertaking, as a producer of well-distributed social benefits including a happy consumer of affordable salmon, a delectable and nutritious form of protein. Patience and perseverence must surely be among the most essential requirements. Instant success as an aquaculturist is just as unlikely as producing instant fish.

Finally, for the PWSAC and all of us Cordovans, I thank all of you who come here today, especially the speakers, to share your views and knowledge with us. We are ready to listen, surely we have lots of questions, and we are willing and eager to learn.

Remembering Ernie Salo's speech closing the 1976 Cordova conference, I hope that Ernie will forgive me for "reusing" his thunder by putting his concluding thoughts, slightly modified, at the beginning of this conference: "I have no vested authority to bless this operation and I do not intend, nor need I, for I believe that one of you following speakers will do that much better than I could."

In anticipation of what will be said here:

1. We will admit that we have a problem, and most of us admit to several problems.

2. We will attempt to define the problems.

3. We are applying the old adage that a problem well-stated is half solved. Well, we have some old problems that were stated then and will be re-stated now and are still half solved.

4. Most of all, this open dialogue is welcome and essential. Thus we must believe that this conference will be a success.

Thank you.

THE CHALLENGE OF CHANGE - CAN WE MEET IT?

Bob Palmer
Coordinator, Special Projects
Office of the Governor
Juneau, Alaska

It's a very sincere pleasure to be here today and my warmest congratulations to Don Rosenberg, Curt Kerns, Armin Koernig and all the rest who are responsible for this Third Alaska Aquaculture Conference.

Frankly, I feel like a rank impostor when I note the presence of many distinguished scientists, the great names of salmonid culture, from whom so much has already come, and from whom so much is yet forthcoming.

It has been my privilege to play a much different role. To have the opportunity to talk with Dr. Donaldson, Dr. McNeil, Tony Novatney and Connie Menken on the Brown Bear; to spend hours with Bill Heard at the Auke Bay Laboratory and at Little Port Walter and to see his gravel incubator encased in six feet of shore ice and pumping out pink fry; to see the nomad coho fry from Sashim Creek growing in the freshwater lens, of a saltwater net pen; to perceive, at least dimly, the enormous potential those techniques might have for Alaska; to have the good fortune to be serving in the Alaska Senate as chairman of the Natural Resources Committee, and a member of the free conference committee on the budget; to have a governor, Bill Egan, who could get just as enthusiastic as I about the proposal I took to him; to get the first state funds appropriated for three pilot projects just ten years ago this spring.

Those were exciting days, and it's even more exciting to see the returns coming back to some of our hatcheries.

Even though Governor Egan was convinced, the most difficult hurdle in getting this program off the ground was the opposition from fishery management people in the Alaska Department of Fish and Game.

I shall never forget the night 10 years ago. Four of the top state fishing people had spent several hours trying to help me understand the error of my ways. The deputy commissioner of the department said, "Even if you're right and hatcheries would be as successful as you believe, what would we do with all those fish?" And that, I think, is the question facing all of us in the salmon business today.

According to certain psychics and soothsayers, 1982 is to be a year of unprecedented change on planet Earth. Volcanic activity is to greatly increase, earthquakes of monstrous proportion and destruction to march relentlessly around the Pacific rim of fire, and the lands of California to begin to slip into the sea. After these warming-up exercises--muscle flexing for Mother Earth--in the 80s and 90s, she really gets down to business. The rocky mountains, upthrust from unconsolidated material and therefore not firmly tied to base rock, quiver, slump and slide into the sea. And in less than 18 years, the waves of the Pacific Ocean lap gently at the great plains of western Kansas. Such a scenario, were it to happen, would certainly subject human mettle to the white-hot test.

While there is room to doubt that such cataclysmic events are bearing down upon us, can anyone among us seriously doubt that upheavals of enormous magnitude are violently threatening the very existence--the roots, framework and superstructure, of the salmon business? Maybe it is not all that bad. Maybe we can muddle through one more time.

For two decades and more, we've talked about improving quality, diversifying processing methods and products; about aggressive marketing. We've watched and done nothing while Charlie and Chicken of the Sea captured the interest of the television audience, the dollars in their pockets, and our markets--with a product inferior to ours.

Each of us could make his or her own catalog of events leading to the morass into which we're now sinking, and I am sure yours could be much more comprehensive and perhaps more accurate than mine. It is vitally important that we do examine events, if we want to put the picture in proper perspective and lay out a clear course of action for recovery. It has been said many times that the future belongs to those who prepare for it. Do you know of a more accurate truism to apply to the salmon business today?

Last week, I checked into a Seattle hospital for a procedure called heart catheterization, or, sometimes, arteriogram. It is the single most effective and accurate method now available to determine how badly the pipes in the heart have been plugged with detritus of various kinds. But never have I had as complete a medical history taken--along with the various and usual lab tests. Only by understanding as thoroughly as possible the condition of the body <u>now</u>--in all its interrelated functions--and how it has come to be in that <u>condition</u>, could the cardiologist best plan a comprehensive route to recovery.

What is the significance of the following to the present condition of the salmon industry?

1. Atlantic salmon at one time were so plentiful that the laborers of an earlier day in Europe insisted, as part of their working agreement, that salmon would not be included in their rations more than seven times per week.

2. Harvests of Alaska salmon in the 1930s were of 100 million adults or more/year.

3. When many of us were youngsters, canned salmon had such a competitive price in the United States that it was a staple food on the tables of even low income families.

4. Original hatchery technology began over a hundred years ago in the United States.

5. In spite of a long period of disuse in the United States, that technology has been embraced by Japan.

6. Improved management techniques were developed by the old BCF, the FRI, NMFS, ADF&G and others.

7. Japanese markets have developed and there is extensive investment of Japanese funds in the United States fishing industry.

8. Japanese and Russian hatchery systems are highly successful.

9. A large measure of control has been achieved by the Japanese salmon fisheries co-ops.

10. The 200-mile limit.

What about these monumental breakthroughs?

1. The Oregon moist pellet--to replace the daily preparation of ground animal by-products.

2. The concept of substrate incubation.

3. Pen-rearing Atlantic salmon in Europe and the Scandinavian countries.

4. McCormick's Fish House in Seattle advertises fresh salmon on its menu, Norweigan, pen-reared Atlantic salmon!

5. Denver: When having dinner at an extremely nice restaurant-Alaskan king crab--the only fin fish on the menu was dover sole. When asked why no salmon, the servers didn't know. The same experience occurred in Jacksonville, Florida.

A small matter perhaps, but how frequently would that scene be repeated in good restaurants across the nation? If McCormick's can feature fresh salmon flown in from Norway, I have to believe that fresh or fresh frozen Alaskan salmon can be available in all the major cities of the United States.

ITEM: Fish traps in Alaska

ITEM: Statehood

ITEM: Unlimited amounts of gear in every salmon fishery in Alaska and overharvesting in most, if not all, cases.

ITEM: Limited entry--and the sudden, among some fishermen at least, philosophy changes.

How well I remember the oft-repeated statement of one of Alaska's most famous seine fishermen when discussing creek robbers who fished inside the markers of salmon-spawning streams, "I'll never be the <u>first</u> to put my seine in the water behind the markers, but I'll never be <u>third</u> either!"

Now, with limited entry, fishermen can, or could, see a future in their business--and a way of life to pass on to their sons and daughters. And creek robbing takes on a different significance.

PERTINENT HISTORICAL LANDMARKS

1971 Discussions by several Alaskans with:
Dr. Lauren Donaldson
Bill McNeil

Bill Heard--Little Port Walter

Manchester--Tim Joiner, Tony Novatney, Connie Mahnken

1971 Legislative creation of FRED Division in ADF&G over very strong opposition from ADF&G officials.

1972 Funding of first three state pilot projects in Alaska to use substrate incubation and saltwater pen rearing.

1972 Debate over "biological overescapement--nonexistent." Natural spawning--3800 percent variation--<u>violent swings</u>.

1972 Philip Daniel, a commercial fisherman from Ninilchik, working in Juneau as a legislative administrative aide, becomes catalyst in the creating United Fishermen of Alaska. For the first time, the majority of commercial fishermen speak with one voice.

1973 The Legislature appropriates funds and instructs ADF&G to build production hatcheries for salmon using substrate incubation.

1974 The Legislature enacts HB 830, establishing the concept of the private, nonprofit hatchery system, and in 1976 SB 688, establishing the concept of the regional association.

1974 Salmon harvest down to 22 million adults. Compare to 1930s harvests of more than 100 million fish annually.

1974 Hatchery bond issue.

In 1974, Japanese took 800 million eggs, Russia somewhat less; Alaska, Canada, Washington and Oregon took 450 million eggs. It seemed highly likely that soon the common oceanic pasture for Asian and North American salmon would be the subject of an international conference. Grandfather rights and quotas would be established. It was high time that Alaska began a program to stake out its claim.

Also, in 1974, a commercial fisherman from Naknek was elected governor of Alaska. As one of his early actions he issued orders to the Department of Fish and Game to "make the hatchery system work."

1976 Governor Hammond creates the Alaska Fisheries Council appoints Dr. Bill McNeil as chairman and Bob Palmer, executive director, and charges it, in cooperation with ADF&G "with the development of a long-range, statewide plan for rebuilding the salmon resource to its former level of abundance."

1981 Ten years after inception of FRED, the capacity of state hatcheries had grown essentially from ground zero to 650 million eggs. Prince William

Sound hatchery at Port San Juan has a return approaching 2.5 million adults; the largest return ever to a hatchery in the western world. Tutka had an adult return of pink salmon that had a 16 percent marine survival.

Crooked Creek kings increased from 38 fish in the beginning years to approximately 5,000 kings annually through the hatchery weir and a major new sport fishery established on the Kasilof River. Crooked Creek hatchery sockeye fry were released as smolts from the Hidden Skilak Lake System, returning from the ocean at a rate estimated to be 38 percent of those fry released.

Japanese salmon hatcheries were returning tens of millions of premium quality chums to the coastal fisheries. While Japanese consumption of salmon decreased and red meat consumption increases, their hatchery production continues to increase at an almost exponential rate, as does the Russian production. The new techniques of salmon lake-stocking and lake fertilization are rapidly developing.

Horace Greeley said, "Go west, young man," Perhaps we should be looking south. What will be the influence, good doctors, on our patient--the United States salmon industry--if the efforts to develop salmon ranching in South America develops to even a sizeable fraction of its apparent potential? Will the vast pastures of krill produce salmon harvests of a magnitude to match or dwarf those of Bristol Bay? Of all Alaska?

1982 forecasts of record harvests in Alaska.

Seventy-five percent federal budget cuts are proposed in the NMFS program. Rumors of massive reductions in state funding are rumored. Discussion of operation of some state hatcheries is shifted to the private sectors begins.

AND BOTULISM!!

Embargoes were imposed by foreign nations; a clean sweep in some states of all half-pound cans of Alaskan salmon.

Alvin Toffler in his book, Future Shock, spoke of modern man being caught in the maelstrom of change--and indeed in danger of being overwhelmed by change, and of the rate of change increasing at an accelerating rate. Previously, the salmon industry has avoided or evaded the most dramatic of the challenges facing the industry. Seldom if ever have those challenges been directly confronted, much less conquered! Future shock is no longer in the future. It's here, it is now, and the issues can no longer be avoided, can no longer be left to the processors. We must all hang stethoscopes around our necks, gather in the consultation room, and work out the prescription for recovery.

Toffler, talking about the sense of overwhelming calamity so many people feel coming down around their shoulders, says people in general are crying out for something or someone to give them reason to hope that things may get better. And I believe that is the element--the vital ingredient--that we can find in this massive challenge facing us today. Finally things have gotten so bad that we are going to confront the problems--and conquer them.

Aggressive marketing on a national and international scale is an obvious part of the prescription for recovery. Improved quality of product is another. Those two things can no longer just be given lip service--they must be accomplished!! Sixteen years ago, when I first entered the Legislature, Jim Reardon of Homer suggested that Alaska really needed a food technology laboratory devoted to perfecting new ways of processing salmon and other fin fish and shellfish to expand and diversity the markets for our fisheries. He was absolutely right--and I'm very glad that it is finally on its way.

A couple of weeks ago, I sampled salmon jerky, salmon sausage, and a couple of other delicacies that were excellent. I saw the letters of enthusiastic acceptance and orders from major grocery firms for those products. The products were made from spawned hatchery fish. The products had been developed after years of effort by an individual fisherman with an idea and determination. Much more of that kind of research and development must be done. But we cannot expect that kind of basic research and development to be carried out entirely by the private sector. We need the Fishery Industrial Technology laboratory to work continually to develop new products.

Of major importance and special relevance to each of you is the necessity major expansion of Alaska's hatchery system. Based on the items noted, I believe that we must accept the very real probability of substantially greater production of salmon in both Asia and Europe and perhaps in South America--with resultant weakening in prices.

Alaska's fishermen may well find it necessary to sell substantially larger numbers of fish at lower prices in order to just maintain income levels. To do so means well-sited, well built and well-run hatcheries, and that means you.

Botulism, as scary as the word is, as costly as the experience is, may be the catalyst that finally requires us to confront the issues squarely and find answers. There are many more elements in a comprehensive prescription for recovery and we need your help to find them and make them work. Within the chaos of today, the seeds of hope are sprouting. The future does belong to those who prepare for it--and the time of preparation is now.

THE FUTURE OF SALMON AQUACULTURE DEVELOPMENT IN ALASKA

Robert S. Roys
Aquaculture Consultant
Juneau, Alaska

Distinguished conferees, ladies and gentlemen, the question of whether or not Alaska will dominate the world's salmon market by the year 2000, maintain its status quo, or slip to third place are again before us on April 27, 1982.

The Russians and Japanese have launched a major salmon enhancement effort that could, by the year 2000, add another 61 million salmon to the world market. I believe Dr. McNeil will present details of that effort later on during this conference.

Beginning about 1975, the department and the private nonprofit sector launched a major enhancement effort consisting of bond issues, grants, loans, laboratories, procuring professional personnel, and establishing regional planning teams with a tentative objective of producing about 50 million salmon. Target completion date was the early 1990s. That effort, if achieved, would have not quite matched Russian and Japanese enhancement endeavors, but would have had a major impact on the world markets.

As of Friday, April 20, 1982, after reviewing recent legislative action affecting FRED (Fisheries Rehabilitation Enhancement and Development) division's operating budget, the lack of a significant capital budget, no bond issue, and the private sector struggling to keep their loan program at an acceptable level, I have come to the conclusion that the whole program is in jeopardy. A magnificant program is grinding to a halt, one that called for managers, fisheries professionals, sport and commercial fishermen, and processors to join hands and launch one of the most magnificent fisheries development programs ever conceived with seed money from a non-renewable resource oil and self-imposed taxes. Why is that program grinding to a halt?

Have we failed in the technological sense?

There is little doubt that technological problems have been encountered and "unknowns" have surfaced since the start of the program. All parties have experienced those, but with the exception of sockeye research, most problems are being rapidly overcome, and who knows, maybe Dr. Grischkowksy and his colleagues have cracked the barrier on sockeye propagation called IHN virus. Continued research in the near future should confirm or reject that possibility if the program is adequately funded.

No, I don't think the program is jeopardized because of lack of reliable technology, as was the case in the late 1960s and early 1970s. We must look elsewhere.

What about the continued positive leadership of the program? Has lack of high level positive leadership been a contributing factor in the program jeopardy? Has leadership been satisfactory at all levels in the private and public sectors?

I obviously am not going to publicly examine myself as former director of FRED division, nor scrutinize lovable Armin Koernig's activities with PWSAC, nor review the intense efforts of Ron Wendte from SSRAA, nor the endeavors of Pete Esquiror from NSRAA, nor ponder the extremely complex problems faced by Floyd Heinbuch and Tom Mears from CIAA. I am convinced that all of us directly involved in the program, in the private sector as well as the public sector, have had a major problem with what I call the influence of peripheral leadership.

Because of that peripheral leadership, the hatchery development program has been delayed or terminated because key personnel in authority do not understand why the central thrust of the enhancement program is hatchery development. Those persons still reside throughout the legislative and, in some cases, the private sector.

An example of peripheral leadership influence is as follows: A few years ago a very influential person came to the conclusion that fish ladders were the most economical way to achieve chum salmon enhancement objectives in Southeast Alaska and perhaps in the state. Now, I will not dispute the fact that there are excellent opportunities along those lines. But, to produce 10 million additional chum salmon from fish passes in Southeast, under existing natural mortality factors, requires the discovery and development of one hell of a lot of fish pass sites. In fact, it would require finding and developing passage facilities for approximately three times the amount of natural spawning area now used in Southeast. I do not care to remember how much time and effort was expended explaining reality to that peripheral leader.

There are several very influential legislators who believe that with miracle surgery on a few beaver dams, stream improvement here and there, and restocking decimated runs, major production increases will be possible, and that type of activity will also increase and stabilize production levels. As you all know, there are many salmon producing areas of the state that don't even have significant beaver populations. There is of course a necessity for carrying on appropriate activity where problems arise, but that activity will not deliver reliable significant production increases. In my opinion many legislators propose and support those activities instead of hatcheries because they appear to cost much less and still demonstrate to fishermen that officials are seeking legislative solutions to their problems.

Many professional and lay people throughout the state believe in simple solutions. Expression of those beliefs within and outside of the profession is hurting the program. A massive education program is in order.

The last type of peripheral leadership originates in the Legislature and in many cases can be traced back to issue analysis performed by legislative administrative assistants who have very little, if any, expertise in fisheries. A classic example of that type of documentation served as a basis for cutting the FRED division's budget. That position paper, sprinkled with innuendo and prevarication, should have impacted fisheries issues like an extra quart of water down the Copper River. Unfortunately, there were many people in the press and Legislature who believed every bit of that diatribe.

The last reason I believe the hatchery development program is jeopardized is because there is little doubt that declining oil revenues have triggered a panic throughout the state and hatcheries, in these days of good natural runs, are not needed. Everyone appears to be scrambling for their fair share of declining revenues. But three questions need be re-asked of every program based on those declining oil revenues:

1. Does the expenditure improve health?

2. Does the expenditure really improve education?

3. Most important, does the expenditure create new self-perpetuating income sources for a broad spectrum of industry?

In conclusion, during the upcoming political campaigns, weigh carefully the statements of political candidates, particularly those whose constituents are not of the land or water. Beware of candidates who speak of capital expenditures derived from non-renewable resource revenues for non-income generating facilities. Brasilia is the classic example of that type of mentality.

We in the hatchery development program are faced with an unusual election, another reapportionment, everyone in the legislature running except two senators, and a gubernatorial race. The number of fisheries supporters in the Legislature has been declining. Unless sympathetic candidates are carefully selected, supported, and elected, our vital aquaculture program will grind to a halt. We have come a long way during the past eight years, and are beginning to witness the fruits of that labor. Unfortunately, short-sighted leaders do not remember the devastating winters of the late 1960s and 1970s, nor do they grasp the impact of the Asian effort on Alaska's domestic salmon fisheries. The salmon enhancement effort must be revitalized or we will be dancing to the Asian tune in the market.

STATUS OF THE FRED PROGRAM

John McMullen
Acting Director
Fisheries Rehabilitation, Enhancement and Development Division
Alaska Department of Fish and Game
Juneau, Alaska

The Fisheries Rehabilitation, Enhancement, and Development (FRED) division created in 1971, when salmon runs to the state were about 22 million fish. Now, 11 years later, we are projecting a return of 135 million catchable salmon.

Most commercial fishery oriented people tend to smile, cough politely, or display outright indignation at such a statement.

I know that aquaculture projects operated by the state probably accounted for fewer than three million adult salmon in 1981, with only about two million documented at hatcheries and terminal fisheries. We are expecting numbers in the low millions again in 1982. However, I like to use the 135 million figure up front when talking of salmon programs so that discussions can then face the real instability of our salmon resources and the long term need for, and objectives of, a fisheries rehabilitation and enhancement program in Alaska.

FRED division was created by the Legislature in 1971. Between that date and February 15, 1982, it was led by one director, Rob Roys.

The formation of the Private Nonprofit Hatchery Program and the regional aquaculture associations resulted in a need and desire for close coordination between them and FRED program. At the same time, growth and projected growth in aquaculture activities resulted in the formation of a technology and development group within FRED. This group provides technical guidance and laboratory services to both state and private nonprofit projects and hatcheries throughout the state.

Active laboratories and technical groups include: pathology, Anchorage; genetics, Anchorage; limnology, Soldotna; tag recovery, Juneau; and engineering, Juneau and Anchorage. In addition, we have specialists in fish culture and field biology, who serve the entire program.

Another very important function administered by the FRED division is the Private Nonprofit Hatchery Program coordinator's office. This group handles hatchery permits, organizes and facilitates regional fishery planning teams, processes fish transport requests, and writes grant money contracts for private nonprofit--FRED cooperative projects.

Somewhere down on the list of trained personnel come people like myself--and Bob Roys before me. My job, as I see it, is to maximize production at our hatcheries in accordance with long range plans, encourage and support our scientific efforts, seek program opportunities and budgets, and cooperate and coordinate positively with the regional aquaculture organizations, the smaller hatchery corporations, and sister fishery divisions within the Alaska Department of Fish and Game (ADF&G).

I would like to say that one of my attributes is excellent budgeting for FRED division needs. However, the past few months have taught me something of the complexities of that process, and I am truly thankful for the support FRED is receiving while attempting to establish a meaningful funding level for fiscal year 1983.

Everyone who reads newspapers has been exposed in the last few months to the concept of hatchery transfer from state government to the regional aquaculture associations. If initiated, FRED will be placed on the leading edge of the move away from government and toward the people. The results might include a longer range funding plan for hatcheries which are transferred, and a more clearly defined association between the state and private aquaculture programs.

I would like to set the concepts of program organization aside and recap some of FRED's activities in 1981 and early 1982 before closing with an overview of the program.

FRED operates 20 hatcheries throughout Alaska (projection). Over two million salmon returned to these projects in 1981. This was an increase from the previous year's return of 880,000 fish. The most publicized return was the one million pinks at Tutka, near Homer. Kitoi Hatchery on Afognak returned about 800,000 pinks. The new Cannery Creek Hatchery in Prince William Sound received 70,000 hatchery pinks. The chum salmon hatcheries, which are relatively new to southeastern, are not receiving the attention gained by our pink salmon hatcheries because chums return from sea as three- and four-year-old fish. Although our chum salmon hatcheries have not operated long enough to return large numbers of adults, brood stocks at Beaver Falls near Ketchikan and Hidden Falls on Baranof Island will be aided appreciably by hatchery returns in 1982.

The schedule of stock development at Beaver Falls is representative of what is expected to happen at other chum salmon hatcheries in southeastern. In 1982 we expect about 5,200 females at the hatchery following an estimated 50 percent fishing mortality. By 1984, the number of usable female chums at the hatchery should increase to over 23,000 with an egg yield of about 50 million.

The Klawock Hatchery is of special interest because we are linking its program to that of Beaver Falls and its chum salmon stock. We propose to supply chum eggs to Klawock from Beaver Falls, thereby deleting expensive and unproductive attempts at finding enough disease-free chums on the west coast of Prince of Wales Island for Klawock broodstock.

In the southeastern region, king salmon are handled in four of six facilities. Crystal Lake now has a chum stock of Stikine River chinook and is shooting for about 700,000 smolts plus another 200,000 cohos. The Snettisham Hatchery, near Juneau, which has the largest potential of any FRED hatchery in Southeast for chinook and salmon smolt production, already has about 300,000 fingerlings on hand, which may eventually translate into 6,000 adults for the fishery and broodstock development program there.

In Cook Inlet, coho rehabilitation within Knik Arm's streams is encouraging, and we've documented 10 percent ocean survivals from smolts to adults. Sockeye rehabilitation projects at Big Lake, Hidden Lake, Tustumena Lake and Leisure Lake are indicating our ability to farm around the IHN virus problem that has resulted in large hatchery sockeye die-offs in past years. Stocked fish which migrated as smolts have returned as adults at rates of up to 20 percent, an encouraging ocean survival rate.

The good news for Cook Inlet sportsmen is that the totally reconstructed Fort Richardson Hatchery will come on line this summer. Our expanded rainbow trout program there will supply fish to land-locked lakes throughout central Alaska.

FRED division released 130 million salmon fry, fingerlings and smolts in 1981. The division took 250 million salmon eggs statewide, and is in the process of taking 5 to 6 million rainbow trout eggs at the Elmendorf Hatchery.

Egg-take objectives for FY 83 are 363 million statewide, but this figure may be revised downward, depending on FRED's final FY 83 budget.

Three additional hatcheries are scheduled to become operational this spring. Main Bay Hatchery in Prince William Sound, is expected to deal with returning fish resulting from fry released there in 1981 in a cooperative project with Prince William Sound Aquaculture Corporation. The other two new hatcheries are Trail Lakes on the upper Kenai River system and the Noatak investigational hatchery near Kotzebue.

Rather than delve into a facility-by-facility discussion of this past year's activities, I will refer you to our annual report, which can be obtained from our regional and headquarters offices upon request. This report details individual hatchery production and performance along with discussions of our involvement in lake fertilization, fish pass construction, lake stocking, research, and private nonprofit hatchery program activities.

PROGRAM STATUS

Frequent discussions reveal to me that people from many sectors of Alaska's population understand the long-term benefits of Alaska's salmon enhancement activities. However, those who wish to argue against the program will cite the relatively small return of adult salmon attributable to a program in its 11th year of operations.

My response to this statement summarizes the status of the FRED hatchery program. This information is included in Figures 1 and 2, the first of which depicts cumulative capital funding and operational egg capacity for FRED facilities.

Although the program has been in existence since 1971, hatchery construction was not funded until the 1976 and 1978 bond issues passed. The hatchery construction program now totals about $79 million. Egg capacity of the combined hatcheries increased as the individual construction projects were completed and facilities became operational. The operational capacity in 1982 is about 550 million eggs. This is expected to reach 670 million eggs as the new facilities come on line this summer.

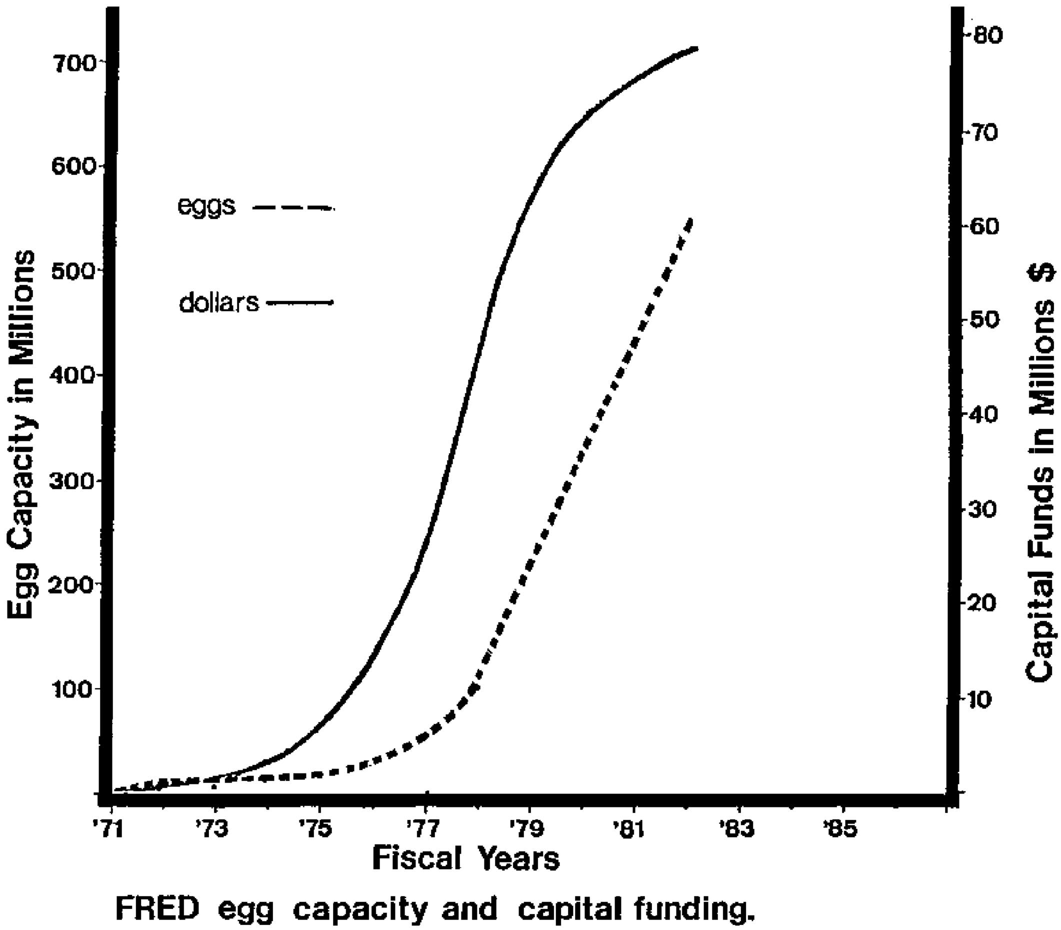


Figure 1. FRED egg capacity and capital funding.

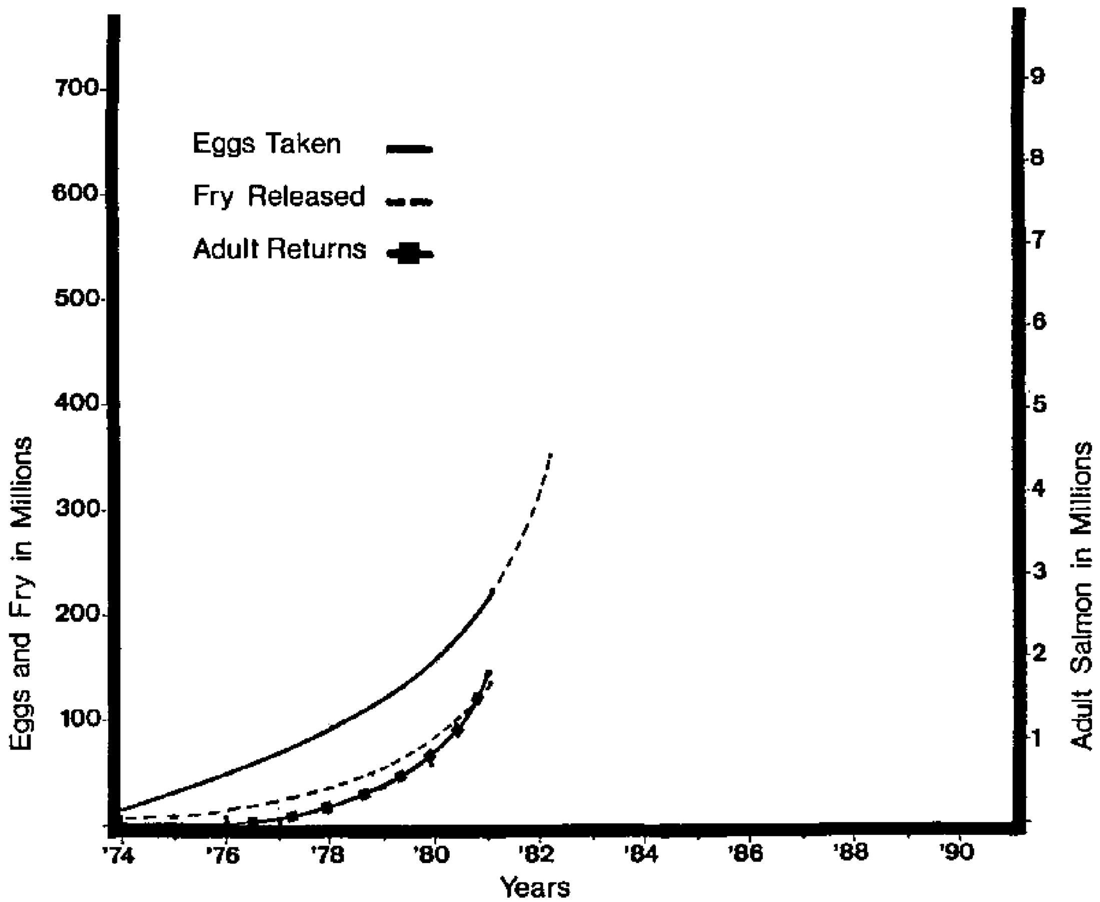


Figure 2. FRED hatchery production.

Figure 2 summarizes the status of the FRED hatchery program, illustrating annual advances in eggs taken, fry released, and adults returned, with the exception of fish stocked in lakes for sport harvest.

The program was in an organizational and pathfinding mode prior to 1974. This period is followed by one of broodstock development, with egg incubation numbers trailing operational potential by two years. For example, our hatcheries reached an operational capacity of 300 million eggs in 1980. Our 1981 egg-takes totaled 250 million, and our 1982 egg-takes are projected at 350 million. These comparisons use design capacities for existing hatcheries, capacities which might differ from increased production capacities resulting from improved incubation technology.

Hatchery production is definitely increasing. Results appear promising, especially if the hatchery production curves are projected. However, this is happening when state revenues are faltering and the abundance of natural salmon is at a historic high. Pressure for funding restrictions must be countered with a biological and economic plan that provides the best possible benefit/cost and the largest net state income from the program.

You will learn more of FRED's specific work on this type of analysis when Jeff Hartman speaks on his project. For the moment, I'd like to steal some of Jeff's results and say that preliminary analysis of FRED hatchery operations indicates an overall benefit/cost of 2.8:1.0 and a program net present value of $438 million.

THE STATUS OF SALMON AQUACULTURE IN ALASKA: THE PRESENT AND THE FUTURE

Curt Kerns
Aquaculture Specialist
University of Alaska Marine Advisory Program
Juneau, Alaska

THE PRESENT

It is often difficult to accurately assess a complex endeavor in which one is deeply immersed. The perceptions of individuals long involved in salmon ranching elsewhere may offer certain insight, however, into how the Alaskan program's performance is viewed (see Figure 1).

1975: $10x10^3$ fish returned and $35x10^6$ eggs taken; no one had heard of us.

1977: $200x10^3$ fish returned and $100x10^6$ eggs taken; very few had heard rumors about us.

1979: $1.25x10^6$ fish returned and $240x10^6$ eggs were taken; people were starting to take notice of us.

1981: $4.5x10^6$ fish back and $450x10^6$ eggs taken; the question most often asked was "Who are those guys?"

THE FUTURE

The future of the Alaskan salmon industry is, of course, unknown. There are, however, certain forces evident that will undoubtedly forge the shape of that future: advances in salmon aquaculture biotechnology; plans of other salmon producing countries and their effects on world salmon supply; trends in analogous segments of the food industry. These are a few of the more notable underlying causes of change.

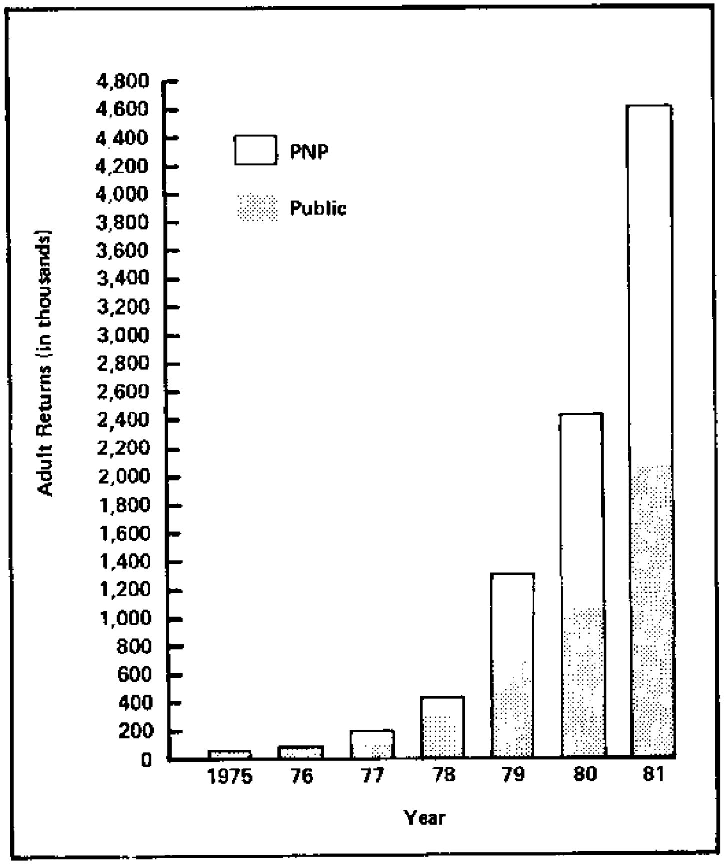
SALMON CULTURE ADVANCES

In research-dependent industries, technological progress moves in two basic ways; generational quantum advances resulting from long-term basic research, and numerous small changes made by those using the new technology as experience is gained. Societial forces outside of the particular industry set the rate at which both types of progress move.

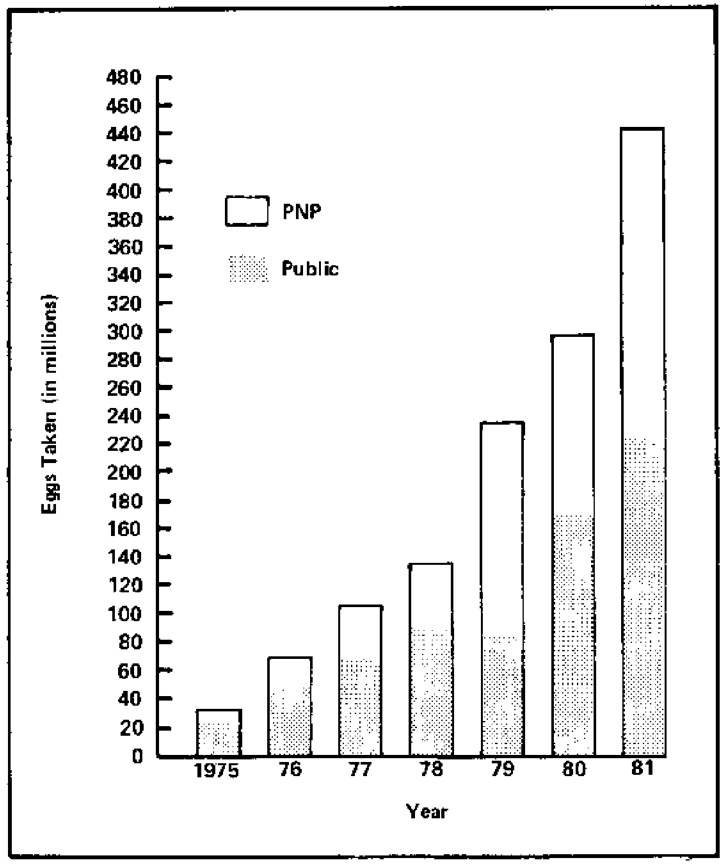
Salmon have been cultured in the United States for over a century. Progress was leisurely for the first 80 years. King and coho were the only species successfully raised in any numbers. Plentiful wild stocks and scant recreational demand resulted in low societal pressures for more fish.

The development of pelleted rations signaled the birth of the second generation. Increasing recreational demand caused by a marked increase in leisure time following World War II was a primary outside incentive.

The third generation resulted from research on substraight incubation. Pink and chum culture became technically possible. The scarcity of brood stock



Salmon production of Alaska hatcheries, 1975-81. Source for both charts: FRED 1981 annual report to the Alaska Board of Fisheries.



Salmon eggs taken at Alaska hatcheries, 1975-1981.

Figure 1. Alaska hatchery salmon production and eggs taken, 1975-81.

and political opposition forestalled its application in the region of the discovery despite the rising value of salmon. The severely depressed Alaskan salmon harvests of the early 1970s did, however, spur the more insightful members of the Legislature to write enabling statutes. They wisely chose a structure that was a mix of state and private nonprofit efforts.

Salmon aquaculture came to Alaska once more. This time the biological and technical knowledge provided by researchers and culturists elsewhere provided the solid base lacking in the earlier attempt. Experience developed here has resulted in a demonstrable return to scale. A 250 million egg hatchery is now regarded with the same trepidation as 20 million was in 1975: "Seems like a hell of a lot eggs, but we can do it." The rapid development of the past five years indicates that the focal point of change has geographically shifted north. British Columbia and Alaska have become the spawning grounds for future generations of salmon aquaculture and the areas where rapid incremental changes resulting from experience are most likely.

The next generation, yet gestating, is that of extensive vs. intensive rearing. Lake fertilization for sockeye, stocking lakes with coho, and perhaps kings, are examples. Short-term rearing of pinks and chums in nearly-natural estuarine enclosures is as yet a gleam in the eye of nutritionists. Extensive rearing using space instead of concrete, should produce smolts of unequaled fitness.

At least one more generation may be spawned before the ocean's pastures fill. The harbinger of this generation is the oft noted observation that fry and smolts released at different sizes and times have highly variable marine survival rates. Short-term rearing and monitoring estuarine conditions, while poorly understood, have already doubled and tripled survivals. But even with Tutka's and San Juan's enviable survival rates, 90 to 95 percent of the fry released do not return. By understanding the early life history of salmon, their interrelationships with the marine food web, and their environment, it may well be commonplace to have fry to adult survivals of in excess of 25 percent, instead of the 5 to 10 percent it is today.

OTHER FORCES

Later speakers will address trends in other countries and the resulting influence on domestic and international markets. The forces at work in other segments of the food industry, however, bear close observation.

Food Industry Trends

Extrapolations of trends between industry segments cannot be taken literally. It is, however, useful to look at the forces that cause changes in similar industries, particularly those that are more mature.

Commodity canning companies such as Del Monte, Swift, Green Giant, and most recently a subsidiary of Nestle-Libby, are accelerating their move away from concentrating on seasonal commodities, such as canned vegetables and fruit. They are expanding into added-value prepared food lines, such as French-cut green beans in hollandaise sauce. Value-added foods shift preparation time away from the home or food service kitchen into the processing plant.

A little over a decade ago Libby was selling a billion dollars a year in canned commodities. Their recent divesture was prompted by several reasons, all inherent in commodities vs. value-added production.

Canned commodities are seasonal products. Their availability is influenced considerably by weather from year to year. The processing plants have the high overhead common to plants that operate just a few months of the year. Canned goods being a more or less standard product, competition has been keen, therefore, mark-up low. Sales are relatively flat as well. Widely held companies, particularly in an uncertain economic climate, must have increases in profitability, if not quarterly, then certainly yearly in order to keep stock prices up.

Value-added products can be produced year round, have higher mark-ups and, with proper advertising, sales can rapidly expand. They offer the consumer convenience, variety, and taste. They can consequently offer the plant management more freedom than commodity products from irate stockholders.

So who is canning Libby's peaches? The people that grow them, through a cooperative called California Canners and Growers. It pays 50 to 60 percent of the value of the crops grown to members at the time of sale. The rest is supplied as dividends, paid after the pack sale. Each grower contracts with the cooperative for a specified quantity of crop. If more crops are needed, the grower can sell more; if less are needed, all member growers share in the trimming. As the grower's productivity increases and more acreage is added, additional plant capacity is purchased, and marketing and new product development research efforts are increased.

SUMMARY

So what does all of what I've been saying mean?

The potential for harvesting the solar-leased productivity of $2\frac{1}{2}x10^6$ mi^2 sq of, the subarctic Pacific, some of this planet's richest waters, is vast. Alaska stands poised to usher in what could well become the greatest era of its salmon industry. Fishermen, be they sport, subsistence, or commercial, do not have to sit idle because the naturally spawning stocks cannot withstand harvesting. The specter of idle processing plants, common in the past, need not be present. Using salmon aquaculture, a baseline quantity of fish can be produced, even in the worst of years. Investment in upgrading and expanding existing plants, and construct of new plants that use state-of-the-art food processing technology is thereby made much more financially attractive.

But we're not there yet. At the present stage of Alaskan aquaculture program development, the good council and strong support of the governor, the Legislature, and above all the salmon industry, are necessary. We cannot falter. If we do, the pastures of the Pacific will have been filled from the Asian side before we get going again.

REFERENCES

Hollingsworth, P. Jr. 1982. Libby sale marks another milestone. Processed Prepared Foods 151:2:9

Lewis, J. D. 1982. Technology, enterprise, and American economic growth. Science 215:1204-1211.

Przybyla, A. 1982. California Canners and Growers introduces new products and processes. Processed Prepared Foods 151:2:50-53.

FISHERIES PLANNING: STATEWIDE AND IN THE PRINCE WILLIAM SOUND REGION

Tom Namtvedt
Fisheries Planner
Prince William Sound Aquaculture Corporation
Cordova, Alaska

Alaska's salmon fisheries have historically been fraught with problems. Varying abundance, fishery closures and price disputes have long been a fact of life. The botulism scare and the resultant pack recalls and embargoes are new and we hope short-lived problems. User group conflicts plague the Cook Inlet salmon fisheries, and may spread to Prince William Sound as the population expands and access is improved. Industrial development and increased population growth and urbanization threaten fisheries habitat.

Fisheries planning is a means of addressing and alleviating some of these problems. Through the orderly application and refinement of management techniques, habitat protection, rehabilitation, and enhancement, we can maintain existing stocks, increase catches, reduce the severity of low catch years and minimize user group conflicts.

From a statewide standpoint, fisheries planning began in 1975 when work commenced on the statewide salmon plan. Regional planning began shortly thereafter when legislation authorized formation of planning regions, regional aquaculture associations, and regional planning teams. Planning grants were also authorized. Planning regions have been established in Northern Southeast, Southern Southeast, Prince William Sound, Cook Inlet, Bristol Bay, and Lower Yukon-Kuskokwim. A planning region is currently being formed in the Kodiak area.

Regional aquaculture associations include representatives of user groups, agencies, and interested parties. Associations have various rights, responsibilities and authorities, including the authority to form a private nonprofit corporation for building and operating salmon hatcheries and the authority to appoint three members of the regional planning team.

Planning in each region is performed by a seven-member team. Three members of the team represent the three fisheries divisions within the Alaska Department of Fish and Game (ADF&G), and three members represent the regional association. A non-voting chairman is elected by the team. Planning teams bring biological and technical expertise together with the needs and concerns of user groups in an effort to achieve a consensus on the directions of resource development. It is the responsibility of the teams to:

1. Develop and recommend for approval regional comprehensive salmon plans

2. Solicit public input and arrange for public review of the plans

3. Review and comment on hatchery permit applications and other proposed enhancement and nonregulatory rehabilitation projects

4. Review and comment on proposed hatchery permit suspensions or revocations

The commissioner of ADF&G has sole authority to approve plans and approve hatchery permit applications, suspensions and revocations.

Fisheries plans will be developed in two phases. The Phase I plans deal with a 20-year period and integrate and assemble all relevant information regarding the development and protection of the salmon resources into a long-range strategic plan. These plans establish 20-year goals and set forth the framework upon which the more detailed Phase II planning will take place. The Phase II plans deal with the short-term or two- to five-year objectives and the operational plans for the individual projects.

Phase I plans have been completed and approved by the Commissioner of ADF&G in three regions: Northern Southeast and Southern Southeast (a joint plan) and Cook Inlet. The Prince William Sound Phase I Plan will be completed in 1982.

The Prince William Sound regional planning team has undertaken an intensive public involvement effort to identify and plan for user needs. This has been accomplished by use of a questionnaire (Appendix A). In the questionnaire, the team asked about catch satisfaction levels by user group, species, preference, gear preference, problem areas, objectional techniques, etc. The questionnaire was aimed at commercial, subsistence and sport fishermen as well as non-consumptive users. Provisions were made for fishermen who have never fished in the region, but would some day like to. The planning team felt that these people have legitimate needs and desires also.

Questionnaire participants were solicited through newspaper ads, printed notices and letters, and by direct contact. To reach sport fishermen, future fishermen and non-consumptive users, ads with mail-in coupons were placed in 13 newspapers circulated within and around the region. Printed notices with mail-in coupons were placed in ADF&G offices within and around the region (Appendix B). Subsistence fishermen were contacted through a list of 1981 permit applicants. Commercial fishermen of the region were contacted through the mailing list of the Prince William Sound Aquaculture News. All commercial fishermen of the region receive this periodical.

Approximately 1,500 requests for the questionnaire were received. To date, 811 completed questionnaires have been returned. Of these, 473 were sport fishermen, 496 were subsistence fishermen and 230 were commercial fishermen. Some respondents, obviously, were members of more than one user group. The results of the questionnaire, when coupled with 20-year population projections, will provide estimates of future user demands. These data will be an integral part of the plan.

To meet future user demands, salmon production will be increased by three means: improved management efficiency, rehabilitation and enhancement. Habitat protection and access procurement will also be strategic elements of the plan.

Management efficiency can be improved and thereby lead to increased catches, better use of natural stocks and higher quality fish. Areas lacking or needing refinement include: pre-season forecasts, in-season run size projections, stock separation, optimum escapement estimations, timely escapement enumeration, and knowledge of migration paths and habits.

Rehabilitation and enhancement opportunities are numerous and include: many potential hatchery sites, expansion of existing hatcheries and stream-side incubators, various lake fertilization candidates, numerous lake and streams suitable for stocking, and numerous streams suitable for fish pass installation or stream improvement.

In closing, as a former commercial fisheries biologist, a sport fisherman, subsistence fisherman, and an aspiring commercial fisherman, I am encouraged that Alaska has so actively pursued fisheries planning. The future of the salmon fisheries, despite a number of potential problems, looks good. What's needed now is "follow through," Continued interest and funding is mandatory. Fishermen must insure that this occurs, for their future and the future of Alaska's most valuable renewable resource is at stake.

APPENDIX A

QUESTIONNAIRE FOR FISHERMEN AND NON-FISHERMEN WHO USE OR MAY USE THE SALMON RESOURCES OF THE PRINCE WILLIAM SOUND — COPPER AND BERING RIVER REGION

Dear salmon fisherman or non-fisherman:

The Prince William Sound Regional Salmon Planning Team needs your input in the preparation of the twenty-year plan for the rehabilitation, enhancement, and management of the region's salmon resources. This region encompasses the marine waters and freshwater drainages of the Prince William Sound, Copper River and Bering River Region (see map).

This questionnaire gives you the opportunity to quickly and easily tell us your needs as a fisherman or non-fisherman. We will present the results of this survey in the Comprehensive Fisheries Plan. The twenty-year goals and objectives of the plan will be developed from your input and the input of other users, agencies, and groups.

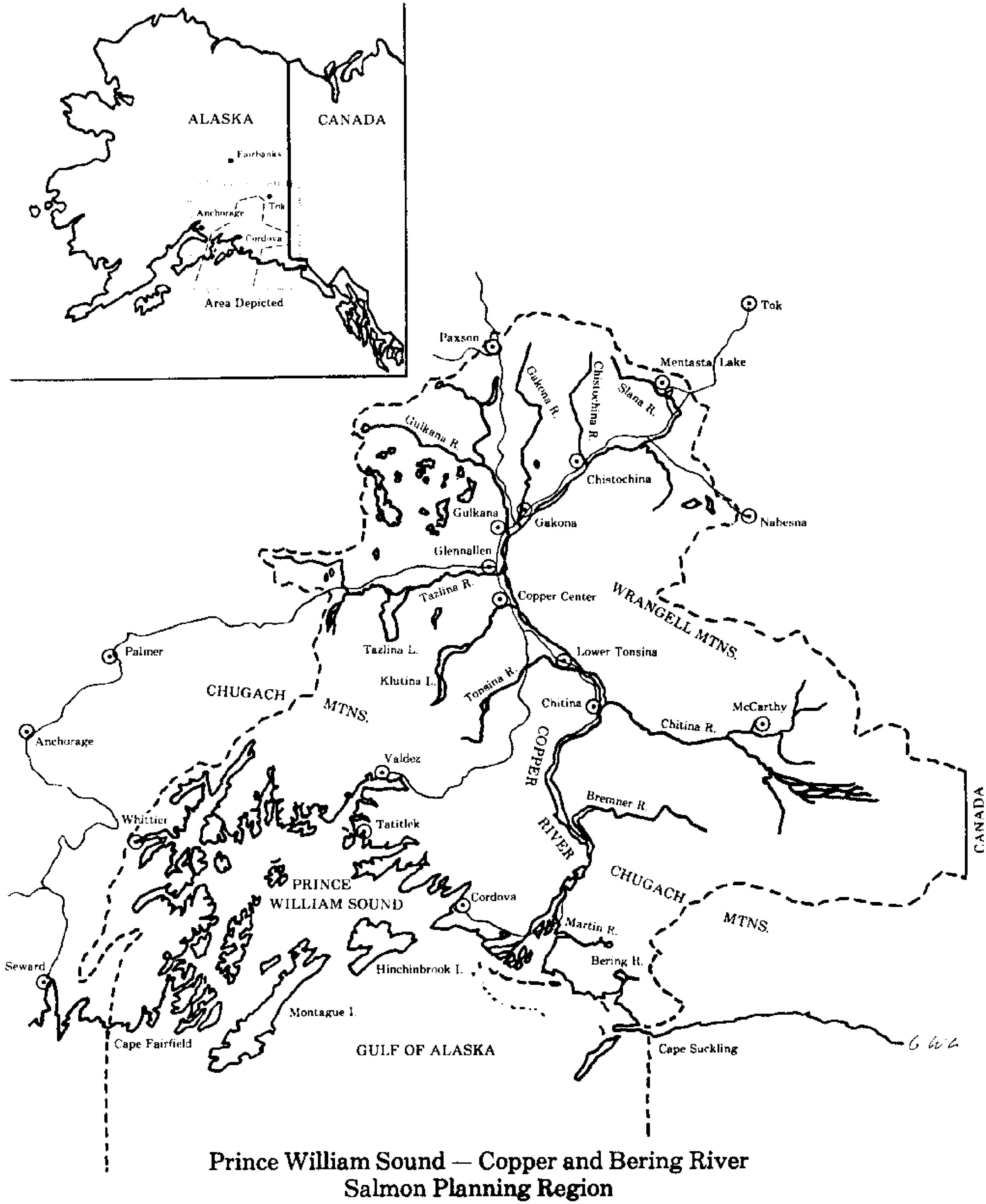
***We need you** to fill out the questionnaire and drop it in the mail before May 31, 1982.*

Sincerely,

Mike McCurdy

Mike McCurdy
Chairman,
PWS Regional Planning Team

Do you need help filling this out?
Call or stop by your local Alaska Dept. of Fish and Game office



Prince William Sound — Copper and Bering River Salmon Planning Region

1. Check the categories that describe your sport fishing activities in the Prince William Sound — Copper and Bering River Region?

____ (012) I have sport fished for salmon in the region.

____ (013) I plan or hope to sport fish for salmon in the region.

If you are not a sport fisherman or do not expect to become a sport fisherman, please skip over to question number 15.

SPORT FISHERMEN

2. In which areas in this region have you sport fished for salmon?

____ (014) Valdez Bay
____ (015) Passage Canal (Whittier)
____ (016) Orca Inlet
Other marine waters (please list):
____ (017) ________
____ (018) ________
____ (019) ________
____ (020) Gulkana River
____ (021) Eyak River
____ (022) Coghill River
____ (023) Eshamy Creek
____ (024) Eshamy Lake
____ (025) Shrode Creek
____ (026) Shrode Lake
Other lakes and streams (please list):
____ (027) ________
____ (028) ________
____ (029) ________
____ (030) ________

3. In which areas in the region do you think your the catch of salmon per day is too low?

____ (031) Valdez Bay
____ (032) Passage Canal (Whittier)
____ (033) Orca Inlet
Other marine waters (please list):
____ (034) ________
____ (035) ________
____ (036) ________
____ (037) Gulkana River
____ (038) Eyak River
____ (039) Coghill River
____ (040) Eshamy Creek
____ (041) Eshamy Lake
____ (042) Shrode Creek
____ (043) Shrode Lake
Other lakes and streams (please list):
____ (044) ________
____ (045) ________
____ (046) ________
____ (047) ________

4. How many years have you sport fished in this region?

____ (048-9) years.

5. Which four methods of salmon sport fishing do you prefer? Rank in order of preference, your first preference number "1", etc.

____ (050) Casting from a boat
____ (051) Trolling
____ (052) Drift fishing in a boat
____ (053) Fishing from shore or wading
____ (054) Ice fishing for land-locked salmon
____ (055) Snagging in marine waters
Other (specify):
____ (056) ________
____ (057) ________

Answer questions for the Prince William Sound — Copper and Bering River salmon planning region only.

12345678987654

6 . Which four aspects about salmon sport fishing are most important to you? Rank in order of importance, the most important number "1", etc.

____ Scenery (058)
____ Catching your limit (059)
____ Fishing by yourself (060)
____ Boating (061)
____ Peace and quiet (062)
____ Fishing with your friends (063)
____ Eating your catch (064)
____ Hooking, playing and landing the fish (065)
Other (specify):
____ ____________ (066)
____ ____________ (067)

7 . In view of your answers to question 6, rank your four favorite salmon fishing areas, your first preference number "1", etc. Do not rank those areas that you have not fished.

____ Valdez Bay (068)
____ Passage Canal (Whittier) (069)
____ Orca Inlet (070)
Other marine waters (please list):
____ ____________ (071)
____ ____________ (072)
____ ____________ (073)
____ Gulkana River (074)
____ Eyak River (075)
____ Coghill River (076)
____ Eshamy Creek (077)
____ Eshamy Lake (078)
____ Shrode Creek (079)
____ Shrode Lake (080)
Other lakes and streams (please list):
____ ____________ (081)
____ ____________ (082)
____ ____________ (083)
____ No opinion (084)

8 . Which species of salmon do you prefer to fish for? Rank in order of preference, your first preference number "1", etc.

____ King (chinook) (085)
____ Red (sockeye) (086)
____ Dog (chum) (087)
____ Humpback (pink) (088)
____ Silver (coho) (089)

9 . How many salmon did you catch on sport gear in 1981 in the region?

____ King (chinook) (090-2)
____ Red (sockeye) (093-5)
____ Dog (chum) (096-8)
____ Humpback (pink) (99-101)
____ Silver (coho) (102-4)
____ Did not fish in the region in 1981 (105)

1 0 . Overall, was your 1981 sport salmon catch adequate?

____ Yes
____ No
____ No opinion
(106)

1 1 . Do you need to catch your daily limit to feel satisfied?

____ Yes
____ No
____ No opinion
(107)

1 2 . As a sport fisherman, how many of the following fish do you need to catch per season to feel satisfied?

____ King (chinook) (108-10)
____ Red (sockeye) (111-3)
____ Dog (chum) (114-6)
____ Humpback (pink) (117-9)
____ Silver (coho) (120-22)

Answer questions for the Prince William Sound — Copper and Bering River salmon planning region only.

12345678987654

13. What species of salmon do you think need to be enhanced?

____ King (chinook) (123)
____ Red (sockeye) (124)
____ Dog (chum) (125)
____ Humpback (pink) (126)
____ Silver (coho) (127)

14. What are the four most important problems with the salmon sport fisheries of the region? Rank them in order of importance, the most important number "1", etc.

____ Lack of fish (128)
____ Management of the fisheries (129)
____ Lack of enforcement (130)
____ Overcrowded fishing areas (131)
____ Lack of access (132)
____ Lack of campgrounds (133)
____ Inadequate campgrounds (134)
____ Lack of boat slips (135)
____ Restrictive regulations (136)
Other (specify):

____________________________ (137)

15. Check the categories that describe your subsistence fishing activities in the Prince William Sound — Copper and Bering River Region? A subsistence user is a person who harvests salmon under the current subsistence regulations and while in posession of a current subsistence use permit.

____ I have subsistence fished for salmon in this region. (138)
____ I plan or hope to subsistence fish for salmon in this region. (139)

If you are not a subsistence fisherman in this region and/or do not expect to become a subsistence fisherman in this region, please skip over to question number 24.

16. What type of fishing gear do you use?

____ Dip net (140)
____ Fishwheel (141)
____ Drift gill net (142)
____ Set gill net (143)
____ Purse siene (144)
____ Other ____________ (145)

17. Rank the species of salmon you like to eat in order of preference, your first preference number "1", etc.

____ King (chinook) (146)
____ Red (sockeye) (147)
____ Dog (chum) (148)
____ Humpback (pink) (149)
____ Silver (coho) (150)

18. How many subsistence salmon did you or your family catch in this region in 1981?

____ King (chinook) (151-3)
____ Red (sockeye) (154-6)
____ Dog (chum) (157-9)
____ Humpback (pink) (160-2)
____ Silver (coho) (163-5)
____ Did not fish in 1981 (166-8)

19. Was this adequate?

____ Yes
____ No
____ No opinion (169)

20. Where did you fish in this region in 1981.

____ Upper Copper River (170)
____ Copper River Flats (171)
____ Bering River District (172)
____ Unakwik District (173)
____ Coghill District (174)
____ Eshamy District (175)
____ Other ____________ (176)

Answer questions for the Prince William Sound — Copper and Bering River salmon planning region only.

2 1 . Where do you prefer to fish? Rank in order of preference, your first preference number "1", etc.)

____ Upper Copper River (177)
____ Copper River Flats (178)
____ Bering River District (179)
____ Unakwik District (180)
____ Coghill District (181)
____ Eshamy District (182)
____ Other ____________ (183)

2 2 . How many salmon do you and your family need per year?

____________ (number) salmon (184-7)

2 3 . What are four most important problems with the salmon subsistence fisheries of the region? Rank them in order of importance, the most important number "1", etc.

____ Lack of fish (188)
____ Management of the fisheries (189)
____ Lack of enforcement (190)
____ Overcrowded fishing areas (191)
____ Lack of access (192)
____ Lack of campgrounds (193)
____ Inadequate campgrounds (194)
____ Too many other fishermen (195)
____ Restrictive regulations (196)
____ Lack of open areas (197)
Other (specify):

____________________________ (198)

2 4 . Check the categories that describe your commercial fishing activities in Area E? Area E is the commercial salmon district in the Prince William Sound — Copper and Bering River Region; the district's eastern boundary is Cape Suckling and its western boundary is Cape Fairfield.

____ I have commercial fished for salmon in this region. (199)

____ I plan or hope to commercial fish for salmon in this region. (200)

If you are not a commercial fisherman in the region and/or do not plan to become a commercial fisherman in this region, please skip over to question number 45.

2 5 . If you are not now a commercial fisherman in Area E but you plan or expect to become one, indicate in which fishery and in which capacity?

____ Salmon seine entry permit holder (201)
____ Salmon seine crew member (202)
____ Salmon drift net entry permit holder (203)
____ Salmon drift net crew member (204)
____ Salmon set net entry permit holder (205)
____ Salmon set net crew member (206)

2 6 . If you are now a commercial fisherman in Area E, indicate in which fishery and in which capacity?

____ Salmon seine entry permit holder (207) ____ years (208-9)
____ Salmon seine crew member (210) ________ years (211-2)
____ Salmon drift net entry permit holder (213) ____ years (214-5)
____ Salmon drift net crew member (216) ______ years (217-8)
____ Salmon set net entry permit holder (219) ____ years (220-1)
____ Salmon set net crew member (222) ______ years (223-4)

2 7 . If you are now a commercial fisherman in Area E, indicate in which capacity you would like to participate in the future.

____ Wish to continue in same capacity (225)

Wish to change to the following capacity in the future:
____ Salmon seine entry permit holder (226)
____ Salmon seine crew member (227)
____ Salmon drift net entry permit holder (228)
____ Salmon drift net crew member (229)
____ Salmon set net entry permit holder (230)
____ Salmon set net crew member____________ (231)

2 8 . What percent of your gross 1981 income did you derive from the following sources:

Salmon seining (Area E)	________% (232-4)
Salmon drift gillnetting (Area E)	________% (235-7)
Salmon set gillnetting (Area E)	________% (238-40)
Other fisheries in Area E	________% (241-3)
Fisheries in other areas	________% (244-6)
Non-fishing sources	________% (247-49)
Total	________%

Answer questions for the Prince William Sound — Copper and Bering River salmon planning region only.

23456789987654

29. Were you satisfied with the 1981 breakdown of your income?

____ Yes

____ No

____ Did not fish in 1981

____ No opinion
(253)

30. If not, what percent of your gross income would you prefer to come from the following sources:

Salmon seining (Area E)	________% (254-6)
Salmon drift gillnetting (Area E)	________% (257-9)
Salmon set gillnetting (Area E)	________% (260-2)
Other fisheries in Area E	________% (263-5)
Fisheries in other areas	________% (266-8)
Non-fishing sources	________% (269-71)
Total	________%

31. Was your commercial catch of salmon in Area E adequate in 1981?

____ Yes

____ No

____ No opinion
(272)

32. Were you satisfied with your earnings from commercial salmon fishing in Area E in 1981?

____ Yes

____ No

____ No opinion
(273)

33. What do you need to gross in an average year to pay your fishing and living expenses and make a reasonable profit from fishing investments?

$________________
(274-80)

34. Are you paying for your permit?

____ Yes

____ No
(281)

35. Do you have a boat?

____ Yes

____ No
(282)

36. Is your boat financed?

____ Yes

____ No
(283)

37. Which species do you prefer to fish for? Rank in order of preference, your first preference number "1", etc.

____ King (chinook) (284)

____ Red (sockeye) (285)

____ Dog (chum) (286)

____ Humpback (pink) (287)

____ Silver (coho) (288)

38. Do you take a portion of your commercial salmon catch home for personal use?

____ Yes

____ No
(289)

39. Which species do you prefer to take home for personal use? Rank in order of preference, your first preference number "1", etc.

____ King (chinook) (290)

____ Red (sockeye) (291)

____ Dog (chum) (292)

____ Humpback (pink) (293)

____ Silver (coho) (294)

40. How many of the following species did you to take home for personal use during the 1981 commercial season

____ King (chinook) (295-7)

____ Red (sockeye) (298-300)

____ Dog (chum) (301-3)

____ Humpback (pink) (304-6)

____ Silver (coho) (307-9)

Answer questions for the Prince William Sound — Copper and Bering River salmon planning region only.

4 1 . In which district do you prefer to gill net for salmon? Rank in order of preference, your first preference number "1", etc.

___ (310) Bering River
___ (311) Copper River
___ (312) Unakwik
___ (313) Coghill
___ (314) Eshamy

4 2 . In which district do you prefer to purse seine for salmon? Rank in order of preference, your first preference number "1", etc.

___ (315) Eastern
___ (316) Northern
___ (317) Northwestern
___ (318) Southwestern
___ (319) Montague
___ (320) Southeastern
___ (321) Unakwik
___ (322) Coghill

4 3 . Recognizing that hatcheries are in place at Port San Juan, Cannery Creek, Main Bay, Valdez, and Perry Island, which district would you prefer to have enhanced or rehabilitated? Rank in order of preference, your first preference number "1", etc.

___ (323) Bering River
___ (324) Copper River
___ (325) Eastern
___ (326) Northern
___ (327) Northwestern
___ (328) Southwestern
___ (329) Montague
___ (340) Southeastern
___ (341) Unakwik
___ (342) Coghill
___ (343) Eshamy

4 4 . What are the four most important problems with the commercial salmon fisheries of the region? Rank them in order of importance, the most important number "1", etc.

___ (344) Lack of fish
___ (345) Management of the fisheries
___ (346) Lack of enforcement
___ (347) Too much gear
___ (348) Unstable prices
___ (349) Lack of processors
___ (350) Lack of loans
___ (351) Restrictive regulations

Other (specify):

___ (352) ______________________________

NON-FISHERMEN ONLY

4 5 . What is most important thing to you about the salmon resource of the region?

____
____
____
____
____
____

4 6 . What do you think should be done to increase man's benefits from the salmon of the region?

____
____
____
____
____
____
____

Answer questions for the Prince William Sound — Copper and Bering River salmon planning region only.

12345678987654

FISHERMEN AND NON-FISHERMEN

47 . Enhancing and rehabilitating the salmon runs and increasing man's benefits from this resource will require various activities to take place. Please indicate if you approve, disapprove or have no opinion concerning the following activities.
Circle your answer.

Approve	Disapprove (353)	No Opinion	Construct fish hatcheries
Approve	Disapprove (354)	No Opinion	Install incubation boxes in or near streams
Approve	Disapprove (355)	No Opinion	Build fish ladders
Approve	Disapprove (356)	No Opinion	Fertilize lakes
Approve	Disapprove (357)	No Opinion	Remove undesireable fish from selected lakes and restock with desirable fish.
Approve	Disapprove (358)	No Opinion	Clear streams of logs and boulders
Approve	Disapprove (359)	No Opinion	Transport fish to barren lakes
Approve	Disapprove (360)	No Opinion	Build roadside viewing areas
Approve	Disapprove (361)	No Opinion	Build access roads
Approve	Disapprove (362)	No Opinion	Install boat slips and launching ramps
Approve	Disapprove (363)	No Opinion	Other (specify)

____

____

48 . Please write down your suggestions or comments below.

____

____

____

____

____

____

____

____

____

____

Answer questions for the Prince William Sound — Copper and Bering River salmon planning region only.

15678987654

APPENDIX B

PRINCE WILLIAM SOUND
REGIONAL FISHERIES PLANNING TEAM

Using Biology, Finance, Land, Engineering and Public Input to rehabilitate Prince William Sound fisheries.

☑ Alaska Dept. of Fish and Game
P.O. Box 669
Cordova, Alaska 99574

☐ Prince William Sound Aquaculture Corporation
P.O. Box 1110
Cordova, Alaska 99574

March 8, 1982

Dear Salmon Fisherman,

The Prince William Sound Regional Planning Team needs your input in the preparation of the twenty-year plan for the rehabilitation, enhancement, and management of the region's salmon resources. The region encompasses the marine waters and freshwater drainages of Prince William Sound and the Copper and Bering River areas.

We want to give you the opportunity to tell us how many salmon you desire to fulfill your sport, subsistence, and commercial needs.

If you are interested in participating in the planning process, please fill in your name and address on the enclosed postcard and drop it in the mail today. We will send you a brief questionaire. Your prompt reply will help us plan for the future needs of all fishermen.

Sincerely,

Mike McCurdy

Mike McCurdy

ECONOMIC FEASIBILITY MODEL FOR THE ALASKA SALMON ENHANCEMENT PROGRAM

Jeff Hartman and Kit Rawson
Fisheries Rehabilitation, Enhancement and Development Division
Alaska Department of Fish and Game
Anchorage, Alaska

INTRODUCTION

This presentation is a progress report on the Alaska Department of Fish and Game's continuing endeavors to model the public value of enhancement activities.

It would be nice to predict with absolute assurance what fishery enhancement will bring. But changing technology and a host of environmental and man-induced uncertainties dictate that we instead strive for a reasonable projection of the effects of various enhancement alternatives on Alaska. This model should be viewed in this light. We seek to organize, to clarify, and to interrelate the information presently available, and that which we anticipate will be available in ongoing studies. We do not pretend to have developed a crystal ball, but rather a tool, which, when properly managed, can help make informed, reasonable decisions. As with any useful model, a number of simplifying assumptions have been made and some questions have been left unanswered. Future work may allow us or others to refine or relax some of these assumptions and to answer many of those questions.

A legitimate question one might ask is: If we haven't developed a crystal ball, how can enhancement economic modeling be a useful aid, and what does it tell us?

A wide range of models have been developed to help answer specific regional, state, and national salmon enhancement policy questions. Typical policy questions are: Should a given project be expanded, continued, or even undertaken? Who or what individuals in a geographical area will benefit from a project? How much will they benefit, and over what period of time?

Answers to these questions are often used by administrators to make decisions such as who gets existing and future enhancement resources, or who bears the direct costs of a given enhancement project or program. No single model (known to these authors) is tailored to answering more than a small portion of each of these questions.

In short, potential uses of enhancement modeling are as follows:

1. We anticipate that this model will be used to identify the worth of existing programs.

2. The model will be used to identify specifically who benefits in the primary industry and (in coordination with other models) new income benefits to satellite businesses and households of Alaska.

3. The model will be used to produce internal comparisons of alternatives to help make the best use of existing hatcheries; identify the best capacity size, new facility locations, alternative incubation and rearing schemes.

MAJOR COMPONENTS OF THIS MODEL

The enhancement economic feasibility model is composed of two separate computer programs. The first is a modification of an existing ADF&G model called FACSIM which was developed in 1980 by Dan Reed. In the modified version (FACSIM2), information is combined on salmon life cycle assumptions, hatchery capacity and survival assumptions, and wild or marine survival rate assumptions. These are all combined into a simulation of adult brood stock development over a period of years.

Each year adult returns are then broken down into the portion harvested by the commercial fishery and that used in the sport fishery. The natural stream escapement and the hatchery escapement are also estimated by applying the projected escapement rates and by internally calculated estimates of annual brood fish requirements. The FACSIM2 portion of the model will also allow adult returns to be estimated and accrued from one or more levels of life stage survivals for a given brood source in the hatchery. For example, a specific facility may choose to release 40 million fed fry at a known marine survival of 2 percent and 20 million emergent or unfed fry from the same brood source at a 1 percent survival. These capacity and release ratios in FACSIM2 can be adjusted for any year through the projected life of the facility.

The output from FACSIM2 is then combined with data inputs from the second program, the Salmon Hatchery Economic Feasibility Model (SHEFM2). SHEFM2 estimates a series of present value[1] income and cost streams through the life of the enhancement project which include the following: A gross annual harvest value, gross wholesale processed value, and gross egg sale value; then harvest cost, processing cost, and hatchery-related costs are accumulated. All future streams of benefits and costs are adjusted to the base economic year dollars (1982) with a discount rate[2] equivalent to the interest earned on current AA corporate bonds. The particular bond chosen is one with a maturity approximately equal to the expected 20-year life of the hatchery. This interest rate (approximately 13.5 percent) stands as the most likely low risk opportunity investment alternative.

---

[1]Present value: The amount which one person would be willing to pay today to obtain the right to a certain amount or series of amounts in the future, estimated by using a discount rate.

[2]Discount rate: The interest rate (r) used in calculating present value. In the case of a single future amount coming in "t" years the discount factor is:

$$\frac{1}{(1+r)^t}$$

The economic model (SHEFM2) adjusts all past fishery and processing benefits and costs as well as all hatchery-related construction and operational costs with several specific price level indexes. These indexes allow for adjustments in the purchasing power of the dollar spent for a narrow range of goods and services and are kept on a separately edited computer file to be updated yearly. They include indexes for:

1. Wholesale price of fresh/frozen or canned products, by species
2. Ex vessel price by year for each species in the round
3. Daily use value of sport fish out-of-pocket expenses
4. Fisherman's costs
5. Processor's costs
6. Hatchery construction costs
7. Hatchery operation costs

TUTKA HATCHERY EXAMPLE

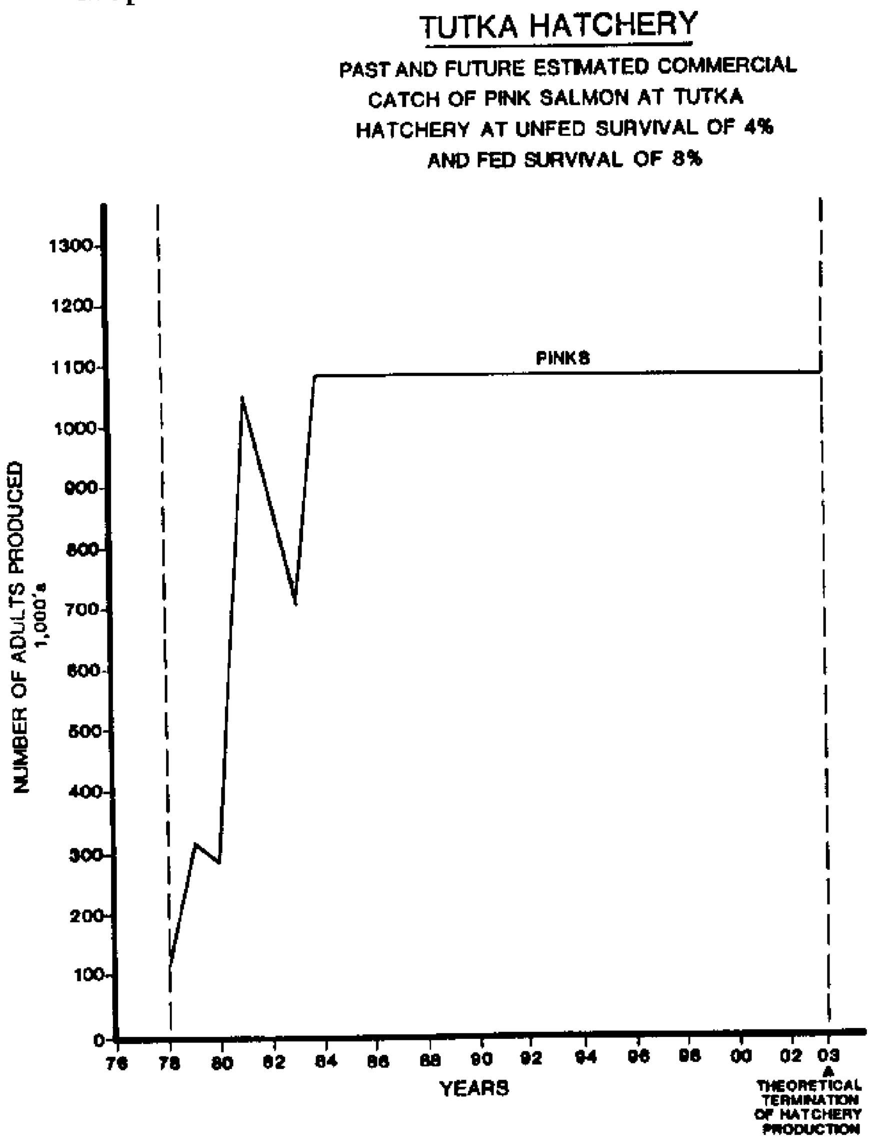
The most effective method of illustrating the collective effects of enhancement-produced income and costs is to view them independently in an example.

Tutka Hatchery, a pink salmon facility in Kachemak Bay, Alaska, is a particularly useful case for demonstrating our approach. First, Fisheries Rehabilitation, Enhancement and Development (FRED) division biologists have developed several years of marine and hatchery survival data; and second, the harvest zone is separated from other potentially interactive fishing activities.

By 1983, the facility will have an expanded incubation capacity of 40 million eggs, and historical in-hatchery survivals approaching 86 percent from green egg to unfed fry and 77 percent from green egg to fed fry (fingerling). Evidence from past mark recoveries (average of years 1979, 1980, and 1981) suggests that the average survival rate to returning adult is 10.3 percent from fingerling releases and 8 percent from unfed fry releases. What the future will bring for long-term survival rates is uncertain. However, for this analysis we have chosen a conservative projected survival of 8 percent for the 12 million fingerling releases and 4 percent for 21.5 million unfed fry releases resulting from the full capacity egg take. Past and future estimated returns are illustrated in Figure 1, graph 1.

Income streams and site-specific assumptions for Tutka Hatchery appear in Figures 2 and 3. Note that present value estimates are summations of either benefits or costs for each accumulated year (Figure 1, graph 2). This graph demonstrates the accumulated gross income to commercial fishermen from enhancement-produced fish at Tutka Hatchery. The general economic feasibility model can accept any short- or long-term price predictions from any market demand model. This is accomplished by manual inputs of multiplicative or additive variations in the projected nominal price.

Graph 1.



Graph 2.

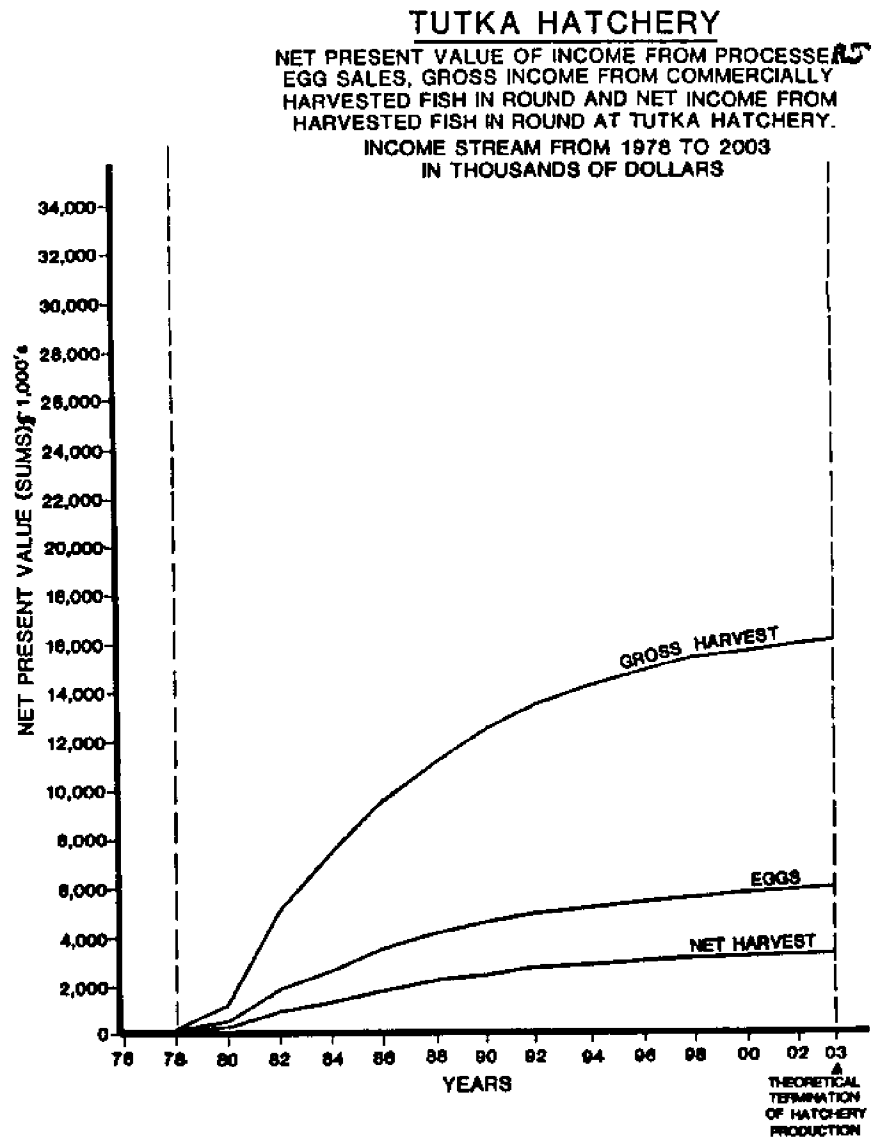


Figure 1. Graph 1: Past and future estimated commercial catch of pink salmon at Tutka Hatchery at unfed survival rate of 4 percent and fed survival rate of 8 percent.

Graph 2: Net present value of income from processors' egg sales, gross income from commercially harvested fish in the round at Tutka hatchery.

The Tutka Hatchery analysis presented here assumes that all prices for salmon (sold in the round or at the wholesale level) will be characterized by real annual price growth rates of zero. Furthermore, the analysis assumes that the effects of inflation over time will be equally weighted for the value of salmon goods produced as well as for the costs incurred from artificial propagation through harvesting and processing. The base 1982 nominal ex vessel price for pink salmon is taken to be the same predominant 1981 price of $0.44 per pound. The present value gross income curve produced in this case results in a value of $16 million over the projected 20-year hatchery life.

FISHERY COST PROJECTIONS AND NET HARVEST VALUE

Changes in harvest efficiency and processing efficiency (net gains or losses) are certain to occur with time because of independent factors such as increases in the supply of enhancement-produced fish or changes in the capital investment in fleet and processing plants. It is essential that any effective model be flexible to these short-run variations on an annual basis. Thus, total average cost (cost per given number of salmon harvested) can be varied for any year through the hatchery life.

Total costs of the fishery yield/effort relationships are determined by published surveys and/or site-specific interviews of fishermen. Harvest costs identified in this analysis include all the implicit and explicit costs of fishing, including the opportunity cost[3] of investment in vessel, gear and license as well as fixed costs such as insurance. Also included are all the variable costs of fishing, including labor, energy, food, and other consumables.

A financial profile of two local fishermen (personal communication 1981)[4] and discussions with commercial fish biologist Tom Schroeder (personal communication 1981), suggest that 65 to 70 local permit holders participated in the 1981 harvest of hatchery fish. The average vessel harvested 15,000 fish and the cost per vessel was between $8,000 and $10,000 for the Tutka portion of an average fisherman's salmon effort. In 1982 adjusted dollars this is approximately $11,600 per vessel or an average total cost of $1.29 per fish. Furthermore, in this scenario it is assumed that the level of harvest efficiency will remain constant over time. The cost stream generated by the fishing effort has a considerable effect on economic profitability of the life cycle net income produced and, in this case, enhancement-produced fish are approximately 3.5 million, as shown in Figure 1, graph 2.

Similarly, all costs associated with the fixed and variable inputs of processing enhancement-generated salmon must be adjustable to accommodate short run changes in processing efficiency. Thus, the annual fixed and variable cost per case of canned salmon or pound of fresh-frozen salmon can be varied for any specific year.

---

[3]Note that the opportunity costs of most likely alternative employment are not included in this analysis.

[4]Personal communication with two Kachemak Bay fishermen, September 1981, by telephone. Names released only with prior permission of people interviewed.

Nearly all hatchery-produced pink salmon commercially harvested in 1981 were processed by either Seward Fisheries or by Whitney-Fidalgo processors. According to estimates by Tom Schroeder, ADF&G Commercial Fish Division, these two plants received 60 percent and 40 percent respectively of the commercially-caught fish. Seward Fisheries packaged most of these salmon for fresh/frozen sales. Approximately 56 percent of the whole fish weight (in the round) contributed to a salable canned biomass. Pink salmon sold to fresh/frozen markets retain approximately 73 percent of original round fish weight.

Most canned pink salmon from the two major processors receiving Tutka Hatchery fish sold at a price of $1.75 per pound in 1981. Fresh/frozen sales from processors ranged from about $0.90 per pound to $1.40 per pound. For this scenario, $1.20 per pound is used. Current prices are taken from 1981 National Marine Fisheries Service "pink sheets."

Vern Rush of Alaska Renewable Resource Corporation (ARRC)[5] estimated that after all implicit and explicit costs of production were included, a typical processor's net economic profit was approximately 6 to 10 percent of gross wholesale value. The profitability income stream estimate for Tutka is depicted in Figure 2, graph 1. The estimate is based upon the annual processing costs at 92 percent of the gross wholesale processed value and results in a net income of approximately $3.7 million to packers.

Estimates of egg sale revenue for pink salmon are based on an egg biomass portion of the mean harvested weight of female fish. Kizevetter (1971) estimated that the harvestable portion is 7.7 percent of the average weight for this species. It is assumed in this analysis that 85 percent of these female fish produce eggs of harvestable quality (this results in a 3.3 percent total biomass recovery). A current price used for this analysis is $4.95 per pound for medium grade eggs. See Figure 1, graph 2.

SPORTFISHING EFFORT AND VALUE

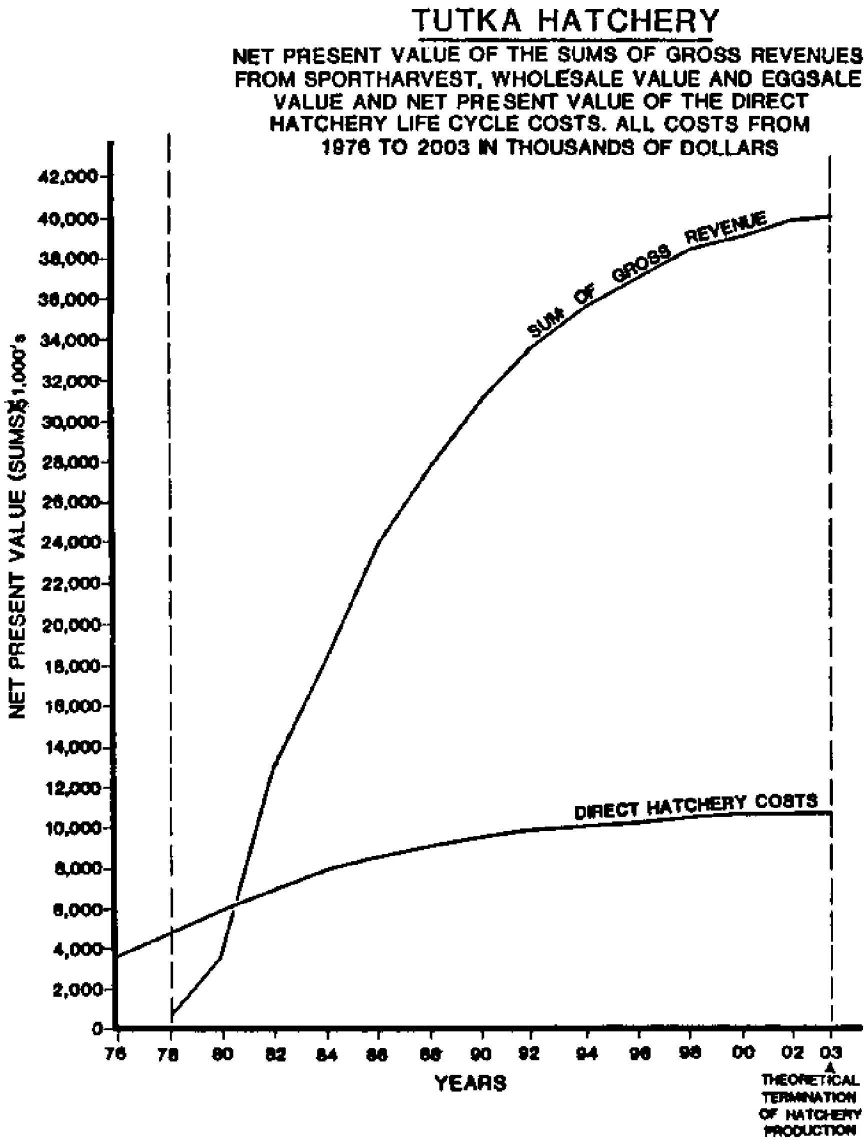
Since the basic economic output of a recreational fishery is not just fish but the experience of fishing, the intensity of the effort is typically measured in angler days. Though the income generated from this sportfishing activity appears to be small at Tutka Hatchery compared with the commercial output, it is worth mentioning. The net income stream of approximately $600,000 is based upon a three-year creel census study of the terminal harvest site. Results of this study suggest an annual catch rate of approximately 0.86 percent of the total hatchery-produced harvest.

Considerable increases in Alaskan sportfishing effort (Mills 1981) over the last three years, in conjunction with decreasing yields, suggest that demand curves for sportfishing effort are shifting outward and that sportfishing effort is not highly substitutable for other recreational activity. The daily use value of $84 per day of angler effort is adjusted from the 1973 Boeing Computer study estimate of out-of-pocket expenses for southcentral Alaska anglers. Since not all sport fishing out-of-pocket expenses can be attributed

---

[5]Personal communication by telephone with Vern Rush of Alaska Renewable Resource Corporation, January 1982.

Graph 1.



Graph 2.

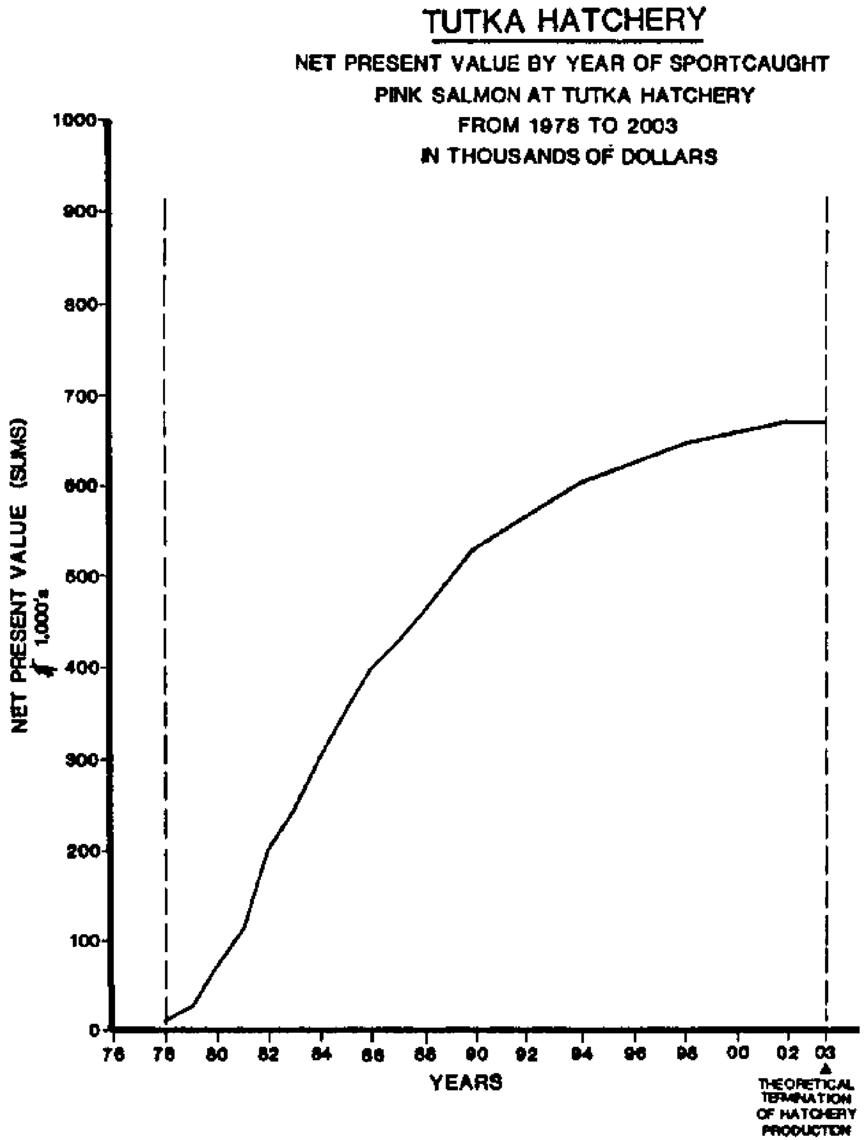


Figure 2. Graph 1: Net present value of the sums of gross revenues from sport harvest, wholesale value and egg sale value and net present value of the direct hatchery life cycle costs.

Graph 2: Net present value by year of sport caught pink salmon at Tutka Hatchery from 1978 to 2003.

to increased state income, it is assumed that approximately 50 percent of the out-of-pocket expenses leak to out-of-state sources and that 75 percent of the additions to income are attributed to only this sportfishing activity, which would not have been spent on alternate recreational activity in the state.

HATCHERY LIFE CYCLE COSTS

A review of past major expenditures suggests that Tutka was constructed for not more than $3.3 million (1982 dollars). The original hatchery investment was approximately $450,000 in 1975. Additional investments were for a settling system costing approximately $160,000 in 1977; original equipment costing approximately $100,000 in 1977; housing and bunkhouse costing $450,000 in 1979; shop costing $110,000 in 1976; and a new intake system at a price of approximately $150,000 in 1981. Miscellaneous equipment and capital expenditures are assumed to be approximately $550,000 in 1982 dollars.[6] The above costs, adjusted to 1982 dollars, equal $3.0 million. An estimate of $3.4 million is used in this analysis. The above estimates of past capital costs were provided by Steve Flodin (personal communication September 1981).[7]

Operational costs are taken from past years of production as provided by Nick Dudiak (personal communication September 1981). They were $150,000 in 1976; $235,000 in 1977; $290,000 in 1978; $340,000 in 1979; and $400,000 in 1980. This analysis assumes that production costs will continue at a rate of $400,000 annually.

Additional costs of evaluation were estimated as follows (Dudiak, personal communication 1981):

CY 1977	$10,000
CY 1978	20,500
CY 1979	17,200
CY 1980	31,200
CY 1981	44,900

It is assumed that evaluation costs will continue to year 1985 at 10.0 percent of the annual operating cost and that administrative costs are an additional 10.0 percent of the annual operating budget. Thus, total operational costs are as follows (in real 1982 dollars):

CY 1976	$176,000
CY 1977	268,500
CY 1978	339,500
CY 1979	391,200
CY 1980	471,200
CY 1981	484,900
CY 1982-2002	480,000

[6]Based on construction price index of Hanscomb Associates 1981.

[7]Personal communication with Steve Flodin, FRED Division, southcentral region project engineer for Tutka Hatchery.

The direct cost stream for Tutka Hatchery is shown in Figure 2, Graph 1. Though costs incurred to construct and operate salmon hatcheries result in some additions to state income in this analysis, all hatchery costs are conservatively treated as non-income producing and as out-of-state dollar leakages.

NEW ADDITIONS TO STATE INCOME

Multiplier models have been developed (Youmans, Kempa, and Ives 1977) for communities in Oregon to help quantify the economic impacts of various resource management decisions on a broad industry base. Such gross and net income multipliers for the fishing and seafood processing sectors appear to be large in these regions compared with those of other businesses. Although gross indexes are only relative indicators of net income, actual net income factors have been developed for the major businesses of Alaska via the state Policy Planning Model developed by Dave Reaume.

Unfortunately, precise estimates of additions to Alaskan income from the Tutka Hatchery (those which would not otherwise occur without the enhancement project) do not exist. However, the locally based fishery of 65 to 70 vessels is over 90 percent Alaskan-owned. Labor for the fleet is composed of a high concentration of local residents.

According to Lynn Pistoll (Pistoll, Baker, and Miller 1980), primary author of the Alaska Fisheries Labor Statistics Bottomfish Labor Study, Part IV, "The majority of seafood processing workers were (are) Alaska residents." Furthermore, Kachemak Bay, with its two locally owned processing plants (estimated to have processed the entire 1981 Tutka pink harvest), is thought to have an atypically high contribution of resident Alaskans.

Though it is probable that additions to state income in this analysis may be greater, it is conservatively assumed that approximately 50 percent of gross income from the wholesale demand for salmon products results in additions to regional and state income.

Finally, if we take one-half of the gross income as state income additions and 100 percent of the life cycle costs, to be costs which will have no positive impacts, then the final net income stream can be seen in Figure 3. The $10 million in net life cycle benefits for Tutka Hatchery on this scenario would suggest that this facility has been a sound public investment for Alaska.

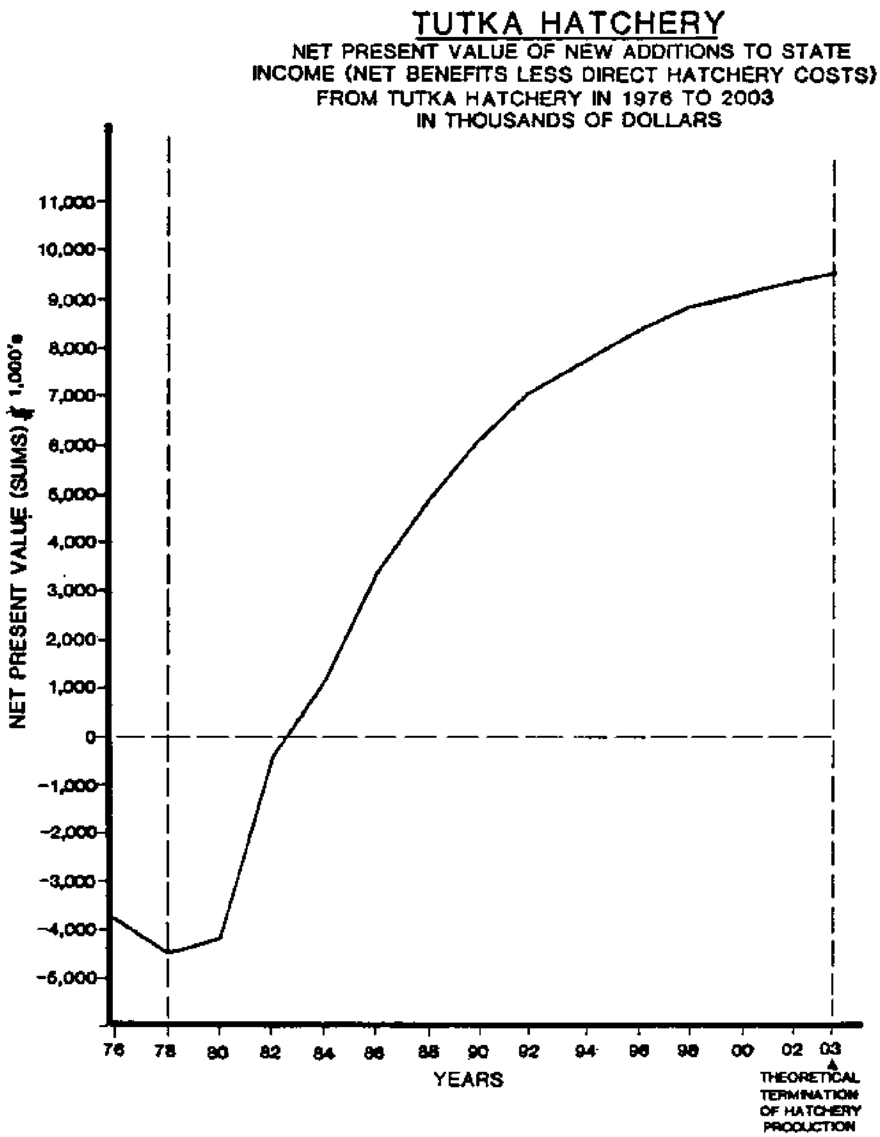


Figure 3. Net present value of new additions to state income (net benefits less direct hatchery costs) from Tutka Hatchery in 1976 to 2003.

REFERENCES

Kizevetter, I.V. 1971. Chemistry of Pacific fishes. Translation by National Marine Fisheries Service.

Mills, Michael J. 1981. Statewide harvest study. Juneau: Sport Fish Division, Alaska Department of Fish and Game.

Pistoll, Lynn, Barbra Baker, and Robert Miller. 1980. Alaska fisheries labor statistics bottomfish labor study, part IV. Alaska Department of Labor.

Youmans, Russell, William Kempa, and Edward Ives. 1977. The Tillamook County economy: A working model for evaluating economic change. Oregon State University Extension Service Special Report 478.

BIBLIOGRAPHY

Brown, William C., Douglas Larson, Richard Johnston, and Roy Wahle. 1976. Improved evaluation of commercially and sport-caught salmon and steelhead of the Columbia River. Oregon State University Agricultural Experiment Station Special Report 463.

Clark, Colin W. 1976. Mathematical and bio-economics: The optimal management of renewable resources. New York: John Wiley & Sons, Inc. 337 pp.

Crutchfield, James A. 1962. Valuation of fishery resources. Land Economics 38:145-154.

Johnson, Fredrick C. Hatch. 1974. A model for fish hatchery analysis. National Bureau of Standards Report No. 74521.

McKusick, Robert B., Glenn Keto, Diane Dempster, Susan Bochsler, Hans Radtke. Unpublished 1981. CRFDP operators manual production and economic data collection and reporting for the Columbia River fisheries development program. Vanouver, Washington: Northwest Economic Associates.

Reed, D. Unpublished 1980. FACSIM, A computer program to aid in hatchery facility planning. Juneau: Alaska Department of Fish and Game, Fisheries Rehabilitation and Enhancement Division.

STRUCTURE AND ECONOMICS OF SOVIET AND JAPANESE SALMON RANCHING EFFORTS

William J. McNeil
Oregon Aqua-Foods, Inc.
Springfield, Oregon

INTRODUCTION

Salmon ranching is an important industry in Asia. Hokkaido is in the center of salmon ranching activities, which currently are concentrated from northern Honshu to southern Sakhalin. Chum and pink salmon are the target species. Releases of juveniles from Asiatic hatcheries are approaching three billion annually.

A comparison of chum salmon catch statistics for Hokkaido and Alaska indicates the significance of salmon ranching in Asia. The 1981 harvest of ranched chum salmon off Hokkaido reached a record 22 million fish. The 1981 harvest of chum off Alaska was almost 13 million fish--the second largest catch on record. The record Alaska harvest is almost 14 million fish, caught in 1918. Figure 1 compares the trend of chum catches off Alaska with that of Hokkaido.

Hokkaido currently provides about two times more chum salmon for world markets than Alaska. Thirty years ago, the opposite prevailed. Salmon ranching has quadrupled catches off Hokkaido. Chum catches off Alaska have remained dependent on naturally-produced populations. Alaska catches have remained relatively stable over the past 30 years, with some recent improvement.

The purpose of this report is to examine the structure and economics of Soviet and Japanese salmon ranching programs. My economic assessment will focus on the Hokkaido chum program, and comparisons will be made with emerging chum ranching projects in Alaska.

STRUCTURE OF ASIATIC RANCHING

Numbers of juveniles released from hatcheries are about the same for Japan and the U.S.S.R. (Currently about 1.5 billion for each country.) Chum salmon constitute about 95 percent of Japanese releases; the remainder are pink and masu salmon. Pink salmon constitute about 60 percent of Soviet releases and chum salmon about 40 percent. The Soviets also release experimental groups of other species from hatcheries (Roukhlov 1982). Institutional structures of the Japanese and Soviet ranching programs are different.

JAPAN

Japan has a long history of salmon ranching, dating back to 1876. Useful references on the history and institutional structure of Japanese ranching programs include Japan Fisheries Resource Conservation Association (1966), Atkinson (1976), and Kobayashi (1980).

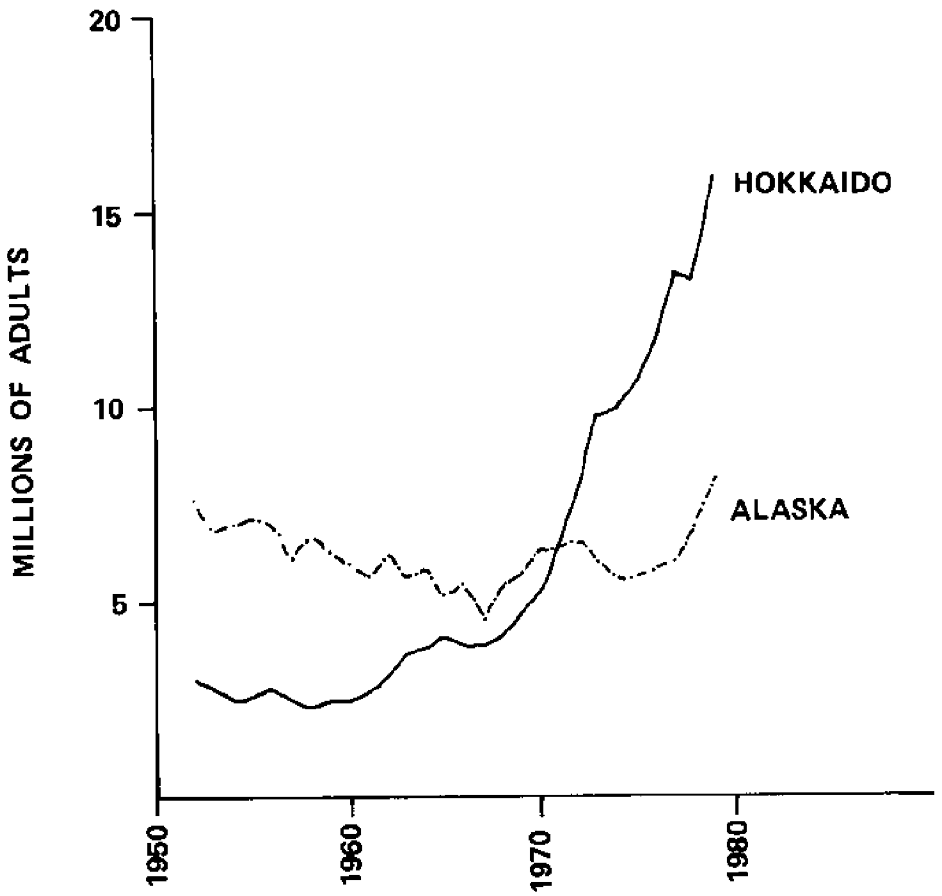


Figure 1. Five-year moving average of chum catches.

Approximately one-third of all chum juveniles are released from private hatcheries on northern Honshu and two-thirds are released from a mix of government and private hatcheries on Hokkaido. The central government controls hatchery production in Japan by retaining ownership of fertilized eggs for artificial propagation. Hatchery operation is shared by central and prefectural governments, and the private sector. Institutional structures differ somewhat between Honshu and Hokkaido.

Honshu

All production hatcheries are operated by the private sector. The central government retains responsibilities for eggs allocation among hatcheries, stock transplants, hatchery program coordination, and planning. Prefectural governments provide research and technical support and participate in coordination and planning. Production hatcheries are operated by fishermen's cooperatives, private groups and individuals. Weirs used to recapture adult salmon for brood stock are usually operated by cooperatives. Carcasses of spawned fish and fish not needed for hatchery brood stock are sold for human consumption.

About 90 percent of the returning run is harvested in coastal trap nets before entering hatchery streams. Trap nets are licensed by government and operated by cooperatives and private parties.

Hokkaido

The central government operates a large hatchery system on Hokkaido and produces most of the hatchery fish. The private sector is assuming an increasingly important role in hatchery operation. The prefectural government also operates a few hatcheries.

The role of the central government is much stronger on Hokkaido than on Honshu, since it assumes the major responsibility for juvenile production as well as controlling eggs. Institutional arrangements for harvesting returning adult fish follow the pattern described for Honshu.

U.S.S.R.

There are 23 Soviet hatcheries (Roukhlov 1982), operated by state-owned fishing companies. They are located mostly on Sakhalin, the southern Kuril Islands, and the lower Amur River. About 75 percent of the production originates from hatcheries on Sakhalin, the southern Kurils, and the lower Amur River. About 90 percent of Soviet production originates from hatcheries on Sakhalin and the Kuril Islands, operated by a company called "Sakhalinrybvod." Salmon ranching represents a small part of Sakhalinrybvod's investments in Indo-Pacific fisheries. Sakhalinrybvod harvests and markets about 850,000 mt of seafood annually, equivalent to about one-third of the tonnage harvested by all United States domestic fisheries.

The Soviet hatchery program dates back to 1924, when the Japanese established hatcheries on south Sakhalin. The Soviets acquired south Sakhalin and the Kuril Islands near the end of World War II, and have since expanded the hatchery program. Planned releases for all Soviet Far East hatcheries are scheduled to increase from 1.1 billion juveniles in 1980 to 2.1 billion in 1985, 3.2 billion in 1990, and 5.0 billion in 2000 (Konovalov 1980). Five billion juveniles would represent a potential for production roughly equivalent to natural production in Alaska (all species combined).

ECONOMIC CONSIDERATIONS

The cost of producing juvenile chum salmon in Japanese hatcheries is reported to be relatively low and the value of returning adults relatively high (Japan Fisheries Resource Conservation Association 1966; Okamoto 1975; Atkinson 1976; Kobayashi 1980). Kobayashi (1980) estimates production cost per adult return to be 85 yen for Hokkaido hatchery fish over the period 1966 to 1972. This equates to about $0.50 per adult for that period.

Soviet hatcheries are also presumed to be highly cost-effective. Their technology is similar to that employed in Japan. Return rates are reported to range from less than 1 percent to more than 4 percent (Kanid'yev, Kostyunin and Salmin 1970; Atkinson 1976; Rukhlov and Lubaeva 1978). Kanid'yev, Kostyunin and Salmin (1970) provide an economic assessment of a Soviet chum hatchery (Kalinin hatchery) and conclude that the level of profitability is high.

MODEL FOR ECONOMIC ASSESSMENT

A simple model is developed here to assess the economics of salmon ranching. An important variable used in the model is return per spawner. Other variables include value of brood fish, cost of government support, and cost of artificial propagation. The general relationship is defined as:

$$T = B + G + H, \text{ where} \qquad (1)$$

T = total cost per adult return,

B = cost of brood fish per adult return,

G = cost of government support per adult return, and

H = cost of hatchery production per adult return.

Cost of brood fish per adult return (B) is defined as:

$$B = \frac{P-S}{k}, \text{ where} \qquad (2)$$

P = price of an adult used for brood stock,

S = salvage price of a brood fish at the hatchery, and

k = number of adults returning per spawner ($k \geq 1$).

Cost of hatchery production (H) includes investment and operations expenses, and value of land (yearly lease or rental value). The relationship is defined as:

$$H = \frac{I+O}{kE}, \text{ where} \qquad (3)$$

I = annual amortized investment cost,

O = annual operations cost, and

E = number of spawners.

Costs associated with planning, constructing, and starting facilities can be allocated to investment and amortized over a defined period of years. The start-up period is the time required for a particular project to achieve a target level of production and is likely to vary with species and location.

Investment costs are multiplied by an amortization factor to spread them over the useful life of a project. In examples that follow, I will use an amortization factor of 0.1175, which retires investment costs over 20 years at a 10 percent annual interest rate.

ECONOMIC ASSESSMENT OF CHUM HATCHERIES

Data are available to use the model described above to compare the economic outlook for chum hatcheries in Japan and Alaska. Hokkaido hatcheries averaged 17 to 18 adult returns per spawner over the period 1966 through 1972 (Kobayashi 1980). There are no comparable data to estimate return per spawner to Alaska chum salmon hatcheries. A value of 17.5 adult returns per spawner will be assumed for Alaskan as well as Japanese hatcheries.

Brood fish cost is probably higher for Japan than Alaska. In Japan, brood fish are sold as spawned carcasses and surplus unspawned males, so there is salvage value. Salvage value is less likely in Alaska. However, the commercial value of chum salmon is likely to be considerably higher in Japan than in Alaska because of Japan's close proximity to large markets for fresh and fresh-frozen fish. Many Alaska chum salmon will enter the lower value canned fish market or will bring lower prices for fresh and fresh frozen product because of long distances to markets.

For Japan, it is assumed that the equivalent ex vessel price (P) is \$10 per fish and that the average salvage value (S) at the hatchery is \$3 per fish. The value for k is assumed to be 17.5 adult returns per spawner. From equation (2),

$$B \text{ (Japan)} = \frac{\$10 - \$3}{17.5} = \$0.40 \text{ per adult return}$$

For Alaska, it is assumed that the ex vessel price (P) is \$5 per fish and there is no salvage value (S=\$0). Using K=17.5, we obtain:

$$B \text{ (Alaska)} = \frac{\$5-\$0}{17.5} = \$.29 \text{ per adult return}$$

Cost of government support (G) is allocated to ongoing government activities in regulating and administering salmon ranching programs and in providing technical support through research and advisory services. For Japan, Atkinson (1976) reports that government apportions 19 percent of total hatchery expenditures to categories not related to construction and operations. Atkinson also reports that cost per adult return averaged \$0.32 in the 1960s. If we assign 19 percent to government support, we obtain G = \$0.06 per adult return to Hokkaido in the 1960s. Adjusting for inflation, a value G = \$0.18

per adult return seems reasonable for Japanese hatcheries today. The same value will be used for Alaska, but its validity should be assessed.

Data on cost of constructing and operating hatcheries is available for Japan and Alaska. Okamoto (1975) has summarized costs for five Hokkaido hatcheries. Similar data have been reported for selected Alaska chum hatcheries (McMullen and Kissel 1982).

In Japan, the five hatcheries described by Okamoto (1975) have a combined capacity for 98 million chum eggs. This would require 72,600 brood fish assuming equal sex ratio and 2,700 eggs per female. The five hatcheries were constructed in 1971-72 for a combined cost of $0.6 million. Adjusted for inflation, equivalent 1982 construction costs are estimated to be $1.5 million. Start-up operations are assumed to require three years at an annual cost of $0.3 million in the early 1970s, which adjusts to an annual cost of $0.75 million in current dollars or $2.25 million for a three-year start-up period. Values used for variables in equation (3) to estimate cost of hatchery production in Japan are:

$$I = [\$1{,}500{,}000 + \$2{,}225{,}000]\ 0.1175 = \$440{,}600 \text{ per year}$$

$$O = \$750{,}000 \text{ per year}$$

$$k = 17.5 \text{ adult returns per spawner}$$

$$E = 72{,}600 \text{ spawners}$$

Cost of hatchery production is calculated as follows for Japan:

$$H \text{ (Japan)} = \frac{\$440{,}600 = \$750{,}000}{17.5\ (72{,}600)} = \$0.94 \text{ per adult return}$$

Economics of producing chum salmon in Alaskan hatcheries is examined for four hatcheries in southeastern Alaska (Beaver Falls, Klawock, Hidden Falls, and Snettisham). Combined capacity is 238.8 million eggs (McMullen and Kissel 1982) requiring 177,000 brood fish, assuming equal sex ratio and 2,700 eggs per female. Combined construction cost of the four hatcheries is estimated to be $35.7 million at completion. The combined 1982 operating costs for the four hatcheries is estimated at $1.466 million. Start-up costs are assumed to be three times this value, or $4.4 million. Annual operating costs after start-up are estimated at $2.1 million (McMullen and Kissel 1982). Values used for variables in equation (3) to estimate cost of hatchery production of chum salmon in Alaska are:

$$I = [\$35{,}700{,}000 + \$4{,}400{,}000]\ 0.1175 = \$4{,}711{,}750 \text{ per year}$$

$$O = \$2{,}100{,}000 \text{ per year}$$

$$k = 17.5 \text{ adult returns per spawner}$$

$$E - 177{,}000 \text{ spawners}$$

Cost of hatchery production is calculated as follows for Alaska:

$$H \text{ (Alaska)} = \frac{\$4{,}711{,}750 = \$2{,}100{,}000}{17.5\ (177{,}000)} = \$2.20 \text{ per adult return}$$

Summarizing values for B, G, and H and comparing Japan with Alaska in the above examples, we obtain:

Variables	Japan	Alaska
B (cost of brood fish per adult return)	$0.40	$0.29
G (cost of government support per adult return)	0.18	0.18
H (cost of hatchery production per adult return)	0.94	2.20
T (total cost per adult return)	$1.52	$2.67

The cost of producing an adult chum salmon appears to be considerably lower for Japanese than Alaskan hatcheries. Nevertheless, cost of production appears to be sufficiently low for Alaska to be optomistic about the economic viability of hatcheries. The major assumption underlying this conclusion is that return per spawner for Alaska hatcheries will compare favorably to that for Japan's.

There has not been sufficient experience to evaluate return per spawner to Alaska chum hatcheries. Facilities are new and in their start-up phase. However, there are early indications with pink salmon that return per spawner to Alaska hatcheries is high compared with Asian hatcheries. McMullen and Kissel (1982) report marine survival for hatchery pink salmon in Alaska to range as high as 15.6 percent for 1981. This high survival would generate 100 or more adult returns per spawner. A more realistic 3 percent marine survival for pink salmon would generate 20 or more adult returns per spawner. Marine survivals of 3 percent or more are not uncommon for hatchery pink salmon in Alaska.

Salmon ranching in Alaska is placing major emphasis on pink and chum salmon, which cost less to produce in hatcheries than other species. Marine survival of hatchery pink salmon in Alaska appears to compare favorably with survival observed in Asia. It remains to be determined however if marine survival of hatchery chum salmon in Alaska will compare favorably with survival in Asia. The economic outlook for salmon ranching in Alaska will largely depend on return per spawner (survival) and costs of constructing and operating hatcheries.

REFERENCES

Altukhov, Yu P. 1981. The stock concept from the viewpoint of population genetics. Can. J. Aquat. Sci. 38:1523-1538.

Atkinson, C. E. 1976. Salmon aquaculture in Japan, the Koreas and the U.S.S.R. In Proceedings of the conference on salmon aquaculture and the Alaska fishing community, ed., D. H. Rosenberg, pp. 79-154. Univ. of Alaska Sea Grant Report 76-2.

Japan Fisheries Resource Conservation Association. 1966. Propagation of the chum salmon in Japan. Tokyo. 55 pp.

Kanid'yev, A. N., G. M. Kostyunin, and S. A. Salmin. 1970. Hatchery propagation of the pink and chum salmons as a means of increasing the salmon stocks of Sakhalin. J. of Ichthyol. 10:249-259.

Kobayashi, T. 1980. Salmon propagation in Japan. In Salmon ranching, ed., J. Thorpe, pp. 91-107. London: Academic Press.

Konovalov, S. M. 1980. U.S.S.R.: Salmon ranching in the Pacific. In Salmon ranching, ed., J. Thorpe, pp. 63-89. London: Academic Press.

McMullen, J. C. and M. W. Kissel. 1982. Annual report, 1981. Division of Fisheries Rehabilitation, Enhancement and Development (FRED). Alaska Dept. Fish and Game. 101 pp.

Okamoto, Y. J. 1975. A preliminary study of the chum salmon stock rehabilitation program.... Anchorage: Pacific Rim Development Research Associates. 43 pp.

Roukhlov, Fin. 1982. The role of salmon production and the perspectives of its development in the Sakhalin region. In Proceedings of the North Pacific Aquaculture Symposium, B.R. Melteff, R.A. Nevé, eds., pp. 99-103. Alaska Sea Grant College Program Report 82-2.

Roukhlov, F. N., O. S. Ljubaeva, and L. D. Khorevin. 1982. Effectiveness of pink salmon reproduction at hatcheries of the Sakhalin region. In Proceedings of the North Pacific Aquaculture Symposium, B.R. Melteff, R.A. Nevé, eds., pp. 119-122. Alaska Sea Grant College Program Report 82-2.

Rukhlov, F. N. and O. S. Lubaeva. 1978. On the efficiency of the Sakhalin pink hatcheries. Biology of Salmons, Ministry of Fisheries, U.S.S.R., Vladivostok. pp. 35-36.

OREGON AND WASHINGTON PERSPECTIVES IN SALMON RANCHING

Brian J. Allee
Prince William Sound Aquaculture Corporation
Cordova, Alaska

INTRODUCTION

The present status of Pacific salmon (Oncorhynchus sp.) ranching in the states of Washington and Oregon is characterized by long-term, successfully developed programs of publically funded hatcheries; and more recently developed programs from Indian tribes which are publically funded in Washington together with private/profit programs, and privately funded in Oregon.

WASHINGTON

Washington state is the nation's unprecedented leader in Pacific salmon (Oncorhynchus sp.) production. An evaluation of the historical production trend shows that the 1981 production level, 287 million, is more than double the 1970 production level, 127 million (Table 1). The majority of salmon, released in the 1981 production year, were released from state facilities (78 percent), followed by federal hatcheries (12 percent), tribal hatcheries (6 percent), state-cooperative releases (3 percent), and school programs (1 percent) (Table 2).

Published statistics on species composition for the 1980 production year indicate that chinook salmon, Oncorhynchus tshawytcha, represent 45 percent of the total releases, followed by coho salmon, Oncorhynchus kisutch, (26 percent); chum salmon, Oncorhynchus keta, (24 percent); sockeye salmon, Oncorhynchus nerka, (3 percent); and pink salmon, Oncorhynchus gorbuscha, (2 percent) (Table 3).

OREGON

By comparison, total production of Pacific salmon in Oregon (105 million) represents only 29 percent of the total release in Washington (366 million). The majority of Oregon-released salmon in the 1981 production year are from publically-funded state hatcheries, with 70 million salmon released. The federal programs in Oregon released 3 million salmon in 1980. Since data is not yet available for 1981, it will be assumed to be the same as 1980 (Table 4).

An innovative institutional arrangement for Pacific salmon production from private hatcheries has resulted in 30 million salmon to be released in 1981 (Table 4). Legislation authorizing private salmon hatcheries was developed in 1971 for chum salmon, and extended in 1973 to include coho and chinook salmon. Presently, a moratorium is in effect on new permits for salmon ranching. There are four permits issued for coho, five for chinook, and 11 for chum salmon (Cummings 1981).

TABLE 1. Pacific salmon (*Oncorhynchus* sp.) releases by Washington State Department of Fisheries from 1970 to 1981

Year	Release Numbers (millions)
1970	127
1971	177
1972	160
1973	148
1974	154
1975	150
1976	149
1977	179
1978	181
1979	213
1980	250
1981	287

TABLE 2. Total Pacific salmon (*Oncorhynchus* sp.) releases in Washington state for 1981

	Release Numbers (millions)	Percentage
State (WDF)	287	78
Federal	44	12
Tribal	21	6
WDF - Cooperatives	11	3
School	3	1
TOTAL	366	100%

TABLE 3. 1980 Pacific salmon (*Oncorhynchus* sp.) releases by species in Washington state

Species		Release Numbers (millions)	Percentage
Chinook salmon			
(*Oncorhynchus tshawytcha*)			
State		104	
Federal		43	
Tribal		5	
	TOTAL	152	45%
Coho salmon			
(*Oncorhynchus kisutch*)			
State		76	
Federal		7	
Tribal		4	
	TOTAL	87	26%
Chum salmon			
(*Oncorhynchus keta*)			
State		63	
Federal		6	
Tribal		10	
	TOTAL	79	24%
Sockeye salmon			
(*Oncorhynchus nerka*)			
State		11	
Tribal		.3	
	TOTAL	11.3	3%
Pink salmon			
(*Oncorhynchus gorbuscha*)			
State		5	
Tribal		.3	
	TOTAL	5.3	2%
	GRAND TOTAL	335	

TABLE 4. 1981 Pacific salmon (*Oncorhynchus* sp.) releases in Oregon

	Release Number (millions)	Percentage
State	70	67
Federal	* 3	3
Private	32	30
TOTAL	105	100%

*Data not available - assume equal production as previous year (1980).

The 1978 to 1981 species composition of salmon released from private hatcheries shows that coho salmon production has increased to 23.9 million, about 75 percent of the releases in 1981 (Table 5). The next most abundant species released in 1981 was chum salmon, 5.5 million; followed by spring chinook, 1.8 million; and fall chinook with 0.5 million (Table 5). The variability in annual production of chum salmon and the low number of fall chinook releases since 1978 reflects the variability in egg availability for chums, and the general lack of eggs for chinook salmon.

Data present in Table 6 suggests that total marine survival is improving for coho salmon released from private hatcheries from 1978 through 1980.

FUTURE STATUS

WASHINGTON

Public salmon ranching and tribal programs in the state will most probably see production declines due to cuts in both federal and state funding. Professionals in the state feel that any long-term gains in hatchery production must come from improved technology at existing hatcheries, better management of wild stocks to increase smolt production, and stream rehabilitation (Hopley 1982).

OREGON

Budgetary constraints similar to those in Washington exist in Oregon, thus public ocean ranching production will most probably decline (Cummings 1982).

The private-profit programs have a potential permitted production capacity of 175 million, however, the motivation for increasing this maximum depends on the probability of achieving returning adults. The variables effecting marine survival determine the potential revenue generated in private ocean ranching. Therefore, an understanding of the marine phase of the life history is absolutely essential in the growth of this business in Oregon.

LITERATURE CITED

Cummings, T.E. 1981. Private Salmon Hatcheries. Oregon Department of Fish and Wildlife.

Cummings, T.E. 1982. Personal Communication. Oregon Department of Fish and Wildlife.

Hopley, W. 1982. Personal Communication. Washington Department of Fisheries.

TABLE 5. Pacific salmon (*Oncorhynchus* sp.) releases by private-profit ocean ranching firms in Oregon, 1978-1981

	1978	1979	1980	1981
Coho Salmon (*Oncorhynchus kisutch*)	9.9	5.8	14.8	23.9
Spring Chinook (*Oncorhynchus tshawytcha*)	<.1	1.4	1.3	1.8
Fall Chinook (*Oncorhynchus tshawytcha*)	.5	.2	.4	.5
Chum (*Oncorhynchus keta*)	.5	10.9	<.1	5.5

TABLE 6. Coho salmon (*Oncorhynchus kisutch*) releases and return statistics from private-profit hatcheries summarized by Oregon Department of Fish and Wildlife

Release Year	1978	1979	1980	1981
Release Number (millions)	9.9	5.8	14.8	23.8
Catch (n + 1)	63,000	54,000	142,000	[1]194,000
Hatchery Return				
Jacks	6,557	1,445	14,639	19,030
Adults	47,726	27,856	98,573	[2]---
Percent Survival				
Hatchery	0.55	0.5	0.77	---
Total	1.18	1.43	1.73	---

[1]Projected estimate

[2]Two-year fish, returning this year

CANADIAN PERSPECTIVES ON SALMON RANCHING

F. Keith Sandercock
Salmonid Enhancement Program
Department of Fisheries and Oceans
Vancouver, British Columbia

Salmon ranching is alive and well in Canada. However, as I am sure most of you are aware, all of the salmon released to the ocean pasture come from government hatcheries or are reared under government contract. Once released, the fish become part of the common property resource. There is no intention at this time to permit private, profit or non-profit, salmon hatcheries in British Columbia. What I would like to do is to give you some perspective on how we got where we are, what is currently going on, and where we expect to go.

By 1970, the technology for producing large numbers of salmonids was in hand. A commitment on the part of government was required to get funding for facilities, then we would produce the fish. We proposed to Jack Davis, the Minister of Fisheries at that time, that five hatcheries be built around the Strait of Georgia to produce chinook, cohos, and steelhead. Funds were found within the department allocation, and we were instructed to proceed. Three million dollars was provided for the Capilano Hatchery (completed in 1971) followed by $5.5 million for Quinsam Hatchery (completed in 1974).

By now some difficult questions were being asked. Where were these fish going? To what fisheries would they contribute? Who would they benefit? What about species balance? And, most importantly, how were federal dollars contributing to the overall goals of government?

Fish biologists simply wanted to produce more fish, and knew intuitively that somebody, somewhere would obviously benefit, but the question of government goals was a tough one. Sure, the politicians and bureaucrats sitting back in Ottawa had conjured up goals for the good of all Canadians, but what did that have to do with of fish producers?

One thing it did was tighten the purse strings. Our answer to their question, that we wanted to produce more fish because obviously more is better, was greeted with complete disinterest. The funds dried up and our plans for the three remaining hatcheries fell by the wayside.

It did not take us long to realize that fish, per se, meant nothing to those in Ottawa. If we wanted to sell our program to government, we had to express our objectives in economic terms and clearly identify to which government goals we would contribute. The fish would be merely the means for achieving these goals.

In February of 1975, the cabinet approved a two-year planning period for us to develop a Salmonid Enhancement Program (SEP) and directed that an agreement be struck with the Province of British Columbia to cover cooperative planning with the intention of developing a comprehensive, 15-year plan. During this two-year planning period, studies were undertaken on economics, social aspects, bioengineering, and environmental impacts of the proposed program. Public support was also necessary if we were to succeed, so we consulted with people in communities throughout British Columbia.

While all this was going on, a few of us biologically-oriented types were somewhat furtively looking back to see how the fish were doing and what the prospects were for enhancement. We found that at the turn of the century the harvestable catch was 300 to 360 million pounds per year and that major losses, through over-fishing and environmental damage, had reduced this figure to less than half by 1960. What we proposed was to reverse this decline and protect the resource base through application of fish culture technology and improved management and habitat preservation. Our target would be 150 million pounds additional annual catch. This production capacity was to be brought on-line over a 15-year period.

On May 30, 1977, the Minister of Fisheries Romeo LeBlanc, announced that the federal government, in cooperation with the Province of British Columbia would immediately implement a two-phased SEP.

The program would have $150 million in federal funds for a five-year first phase. Later, Phase I was extended to seven years with no additional funding. Under the federal/provincial agreement the province would contribute $7.5 million to Phase I, as well as land and water rights. Fish production was targeted at an additional 50 million lbs of fish and a condition was attached that the program be cost recoverable.

The federal cabinet further directed that there be a substantial degree of public participation in planning and implementation of the program, and implementation of Phase II was dependent on the level of success achieved in Phase I.

The Phase I program objective was, "to generate the maximum social and economic benefits to meet five essential goals of government through the annual production of an additional catch of 50 million lbs."

The first of these goals was national income. Every year, millions of salmonid fry and smolts are released from hatcheries, spawning channels, and other enhancement projects. The commercial fishing fleet harvests both wild and enhanced salmonid stocks when they return as adults. Trollers, seiners, and gillnetters annually harvest a catch with a market value estimated at $160 million. SEP also benefits many thousands of sport fishermen who are residents of, or visitors to, British Columbia. Sport fishing makes a large contribution to tourism, British Columbia's third largest industry behind forestry and mining. Salmon charters, marinas, hotels, restaurants, and associated businesses all reap economic benefits related to tourism, which in 1979 added $1.6 billion to the British Columbia economy.

The second goal is regional development. SEP facilities and projects are distributed province-wide and therefore make enhanced fish stocks available to local fishermen along the north coast, the central coast, and in southern British Columbia. Many projects contribute to the growth and stability of coastal communities. To meet some of the social goals, a community development program was established. This consisted of smaller enhancement projects employing local residents.

The third goal is to benefit Native people through enhanced fish stocks. Native employment in the commercial fishing and processing industries and in community development projects promotes family unity when one or both parents earn a living close to home. The SEP has generated both long-term and short-term employment opportunities in many regions of British Columbia.

Lastly, resource and environmental preservation are of direct concern to the SEP. Volunteer labor donated by individuals, schools, and conservation groups has restored many small streams that, despite their size, are important fish producers.

Now, for those of you still interested in fish--how were we going to increase production? The answer is: any way that could be justified economically--and, in some cases, uneconomically!

We would resume hatchery construction, we would build more spawning channels, and more fishways, we would work to restore freshwater habitat and, significantly, we would move lake enrichment out of the research realm and into the operational one. In support of these activities, we would continue bioengineering feasibility studies. We would also support new management-ability and stock-assessment studies as well as research into new techniques or improving old ones, and we would begin evaluation activities to define and measure our performance.

The public was keen on the program from the outset. Gradually they became active in all parts of the program including an advisory task group; in education and information; and in "hands on" enhancement activities. The objective of public participation was to increase community awareness of the needs of salmonids and to lend support to the conservation and protection of stocks and their habitat.

So much for 1977! Where are we now in 1982?

From our pre-SEP investments like the Capilano and Quinsam hatcheries, the Big Qualicum River Project, the spawning channels at Babine Lake, the fertilization of Great Central Lake, we have a productive capacity of 8.1 million pounds, broken out as follows:

Species	Percent
sockeye	50
chum	25
pink	2
coho	15
chinook	7
steelhead/cutthroat	1

New capacity now on line and developed with SEP funds amounts to an additional 27.0 million pounds. This is made up of:

Species	Percent
sockeye	50
chum	37
pink	02
coho	03.5
chinook	06.5
steelhead/cutthroat	01

This productive capacity results from the fertilization of nine lakes in British Columbia, the operation of 18 major and nine minor facilities, the development of 14 community projects, the establishment of about 100 small projects, and the enthusiastic involvement of more than 8,000 volunteers.

So far the program has achieved about two-thirds of the Phase I target with the expenditure of about two-thirds of the approved funds.

Although the first returns to many of the SEP funded projects will not occur until this year, we are confident the technology can work as we have predicted because of the great success experienced in our pre-SEP facilities.

This fish may be yet to come but the SEP funded projects have already generated social benefits. For example, the construction of hatcheries, spawning channels, and fishways have provided employment opportunities to those who would otherwise be unemployed. Projects located in the north and central coast areas of British Columbia redirect income away from the south, thus contributing to regional development.

The community development program has been highly successful in generating social and distributional benefits through salmonid production. Employment, regional development, and Native well-being are all enhanced as Natives and community groups construct and operate small production facilities under contract to SEP. The many small projects undertaken throughout the province have contributed to restoration of freshwater habitat, promising to generate significant benefits to wild stocks.

By the end of Phase I we expect to have 42.1 million pounds of SEP funded production capacity on line. We do not however expect to reach our Phase I target of 50 million pounds. There are several reasons:

1. When we received approval for $150 million, an annual inflation allowance was expected. No additional funds have been provided.

2. When the Phase I program was extended from five years to seven years, the operating costs for the two additional years had to be met out of the total budget, thus dollars available for new production were reduced.

3. A scarcity of person-years has meant a higher level of contracting out with an associated higher cost.

In spite of these setbacks we expect to achieve about 84 percent of our original Phase I target with approximately 52 percent of the funds we had originally expected to receive.

Without going into a detailed economic analysis, of which I am incapable anyway, the projected benefit-to-cost relationship for the overall program is 1.3:1.0.

We still feel that the original projections of the biological potential inherent in British Columbia salmonids, and the technical and economic rationale for salmonid enhancement are valid and need only to be applied. Planning for Phase II of SEP is now underway and we are confident that significant social and economic benefits can be derived as we attempt to restore salmonid stocks to their historic levels.

ADVANCES IN RED SALMON CULTURE

Joseph R. Sullivan
Assistant Pathologist/Disease Control Specialist
Fisheries Rehabilitation, Enhancement and Development Division
Alaska Department of Fish and Game
Anchorage, Alaska

The culture of red, sockeye, or blueback salmon (Oncorhynchus nerka), suffers from one additional handicap beyond those visited upon the other species of Pacific salmon in North America. That is the occurrence of a catastrophic disease, namely infectious hematopoietic necrosis (IHN), in every significant stock of these fish. Although IHN virus (IHNV) is also found in other members of this family, particularly to the south of Alaska, in no other species is there such universal occurrence. Since there is no treatment for this disease and losses can be near total, it has been a major factor in the decline of the hatchery culture of sockeye outside of Alaska. Its history here is similar to that elsewhere. A hatchery may run for years with no incidence of the disease, then have one or two years of severe mortalities.

In the 1979 brood year, major epizootics occurred at three of the four Fisheries Rehabilitation, Enhancement and Development (FRED) division hatcheries raising large numbers of sockeye. All three locations had seen epizootics in the past and it was obvious to division director Bob Roys that continued existence of these hatcheries as sockeye facilities could not be supported if IHN became a regular occurrence. He therefore appointed the IHNV team composed of the chief of technology and development (Robert Burkett), the principal pathologist (Roger Grischkowsky), the principal fish culturist (Bernard Kepshire), the virology specialist (John Burke), and the assistant pathologist/disease control specialist (myself), to find a means of reducing or eliminating this problem.

Using the best information we had, the team addressed every conceivable mode for the transmission of the disease and put together a plan of action to dilute or neutralize these routes for each sockeye facility. Later this evolved into the Sockeye Culture Policy. Possible routes considered were the transmission of the virus from a female to her own eggs, from the ovarian fluids of an infected female to the eggs of an uninfected female during fertilization, from infected fish in the hatchery water source, within and between incubators via water flows and aerosols, and from virtually any contaminated items to any susceptible life stage of the fish in the hatchery. In addition to this, the Sockeye Culture Policy took pains to ensure that there would be little chance of hatchery to hatchery transmission or from red salmon to the other species.

We felt that even if egg-take procedures had successfully eliminated the virus before entering the hatchery, a virus-laden water source could provide sufficient reinfection to initiate an epizootic. It is significant to note that the only major Alaskan sockeye facilities which have never had IHN outbreaks were also the only facilities which did not have adult salmon in their water source. The Gulkana Egg Incubation Facility near Glenallen has been operated by Commercial Fisheries Division since 1973 and took 9.1 million eggs this past year. Crooked Creek Hatchery, south of Soldotna, also began in

1973, and is up to 21.5 million eggs. It was not possible to remove kokanee (landlocked sockeye) from Kitoi Bay's water source and therefore the sockeye component of its program was terminated. Big Lake Hatchery went to well water, which limits the numbers of fry they can handle (7 million eggs in 1981). It was feared that the cold well water temperatures (several degrees Celsius above freezing) would affect egg survival. Pick-off at the eyed-egg stage has been about 10 to 20 percent per tray.

East Creek Hatchery is located at the confluence of East Creek and Lake Nunavagaluk. Although adults could be weired off from the creek, allowing it to be used as a disease-free water source, the intake clogged with frazel ice in winter requiring water to be drawn from the lake. Because beach spawners were present, the area around the lake intake was cordoned off with nets and use of lake water was prohibited until frazel ice required it. By this time, general levels of virus in the water would be low and no remains of rotted carcasses would be nearby to cause higher levels of infectious particles.

The weir on the creek had been just downstream from that intake. It was moved further downstream so that any back eddies could not carry virus upstream to the intake. In order for the area around the hatchery and its water sources to be freer of virus, the egg-take operations were moved 200 ft north of the mouth of East Creek along the lake shore, and carcasses were loaded into boats and discarded in a remote area of the lake (onshore disposal would have attracted bears).

Egg-take procedures were severely changed because many modes of transmission were possible here. All utensils and equipment were disinfected with iodophor prior to spawning each fish. The egg-take crew would dip their hands into the disinfectant, wipe a female fish's belly lightly with the solution and then dry it with a clean paper towel. This removed external virus in the water and in the mucous clinging to the fish which could contaminate the eggs during stripping. Next, the spawning knife was removed from a container of iodophor solution and rinsed in virus-free water (transported to the site for remote takes); the female was slit and the knife returned to the disinfectant. The eggs from each female were stripped into separate containers and fertilized with the milt from the appropriate number of surface-disinfected males. The eggs water-hardened in virus-free water and were then disinfected with iodophor. The spawning, water-hardening, and egg disinfection took place outside the hatchery in areas which could be disinfected or which would not otherwise interact with the hatchery.

We know that some females have millions of infectious virions per milliliter of ovarian fluids, while others have much less, and still others none. There is a possibility that an infected female's eggs may be protected by maternal antibodies, thus the virus in her fluids largely would be infecting the eggs of other females. If a dozen females' eggs are fertilized and water-hardened in a single bucket, a high concentration of virus in only one female's fluids could be sufficient to infect the other eggs. If the virus is drawn in through the micropyle during the one hour of water-hardening prior to disinfection, it could be safely within the egg, unreachable by iodophor. Thus if all eggs are disinfected separately, eggs from virus-free females at least, will not be exposed to the virus from infected females. Even if a female's eggs may be infected by virus in her own fluids, fewer total eggs going into an incubator will be infected. This could buy enough time in the progression of the disease to plant fry before an epizootic could occur.

Before crew members entered a hatchery containing eggs, their boots and rain gear were disinfected or the eggs were passed to a "disease-free" person who had not been exposed to live viral particles. Containers to be reused were then disinfected again. Estimates indicate that these additional steps initially increased egg-take effort tenfold. By the end of that summer, efficiency had increased to the point that only four times as much effort as used in traditional takes was needed. By the end of 1981, just twice as much effort was required. Keith Pratt, regional fish culturist, expects efficiency may reach 1.2 times previous effort this summer.

Several varieties of incubators were used at these hatcheries during the epizootics. At Big Lake and East Creek, these were replaced by the Zenger No-Pads, a stack of five aluminum trays which drain into each other, each tray holding 200,000 to 250,000 eggs. Any given female's eggs were seeded into only one tray. If they started to die, particles would be shed only into that tray and lower trays. If projections indicated that eggs could be spread out, they would be, in order to improve the environment, make seeding less dense decreasing the odds of a particular egg being exposed to virus, and to permit fewer casualties should an incubator, or portion of one, come down with the disease.

Several aspects of routine hatchery procedures were changed in order to decrease the chances of spreading disease and to contain an epizootic should it begin in an incubator or other rearing container. Disinfectant foot baths were placed at the entrances to the hatchery to prevent introduction of the disease on boots and other protective clothing from outside sources (e.g., creeks near the hatcheries, personnel traveling between hatcheries). All water is single pass, manifolds supplying separate water to each stack, each incubator having a separate in-current and ex-current water supply. Physical barriers such as plastic sheets or walls placed between stacks decrease the potential of aerosols spreading the disease from stack to stack. Only one stock is now allowed in any given incubator group. This prevents exposure of the virus to a stock naive to that strain, avoiding potentially greater mortalities than would occur in an epizootic involving the strain of virus to which the stock has adapted. It also isolates high carrier rate stocks of sockeye from low carrier stocks. A designated group of incubators or an incubator is connected with only one rearing container. Again, this action should prevent cross-contamination should the virus be present in any unit.

Floors are disinfected daily. Any containers, pump hoses or other devices used with salmon are disinfected after eggs or fish are removed. Nets, gloves, hands and other utensils are to be disinfected between contacts with any fish or egg holding container. If IHN were to occur in a hatchery, these procedures should make it possible to isolate and contain the epizootic and prevent other sockeye stocks from being lost to this disease. There has not been any significant rearing beyond emergence in order to avoid the disease.

Equipment is not to be moved between sockeye hatcheries unless it is absolutely necessary and can be adequately disinfected. Whatever supplies enter a sockeye hatchery stay there unless they can be disinfected.

There have been no IHN outbreaks in our red salmon hatcheries for the past two years. We do not know whether this is due to luck or to these special procedures. In the interim, we have been trying other approaches. One of the more promising ventures is water-hardening in iodophor. Under current practices, eggs are water-hardened for an hour before being disinfected. If water-hardened in iodophor, virus would have almost no opportunity to be sucked into the protective interior of the egg. Fear of additional egg mortalities prevented disinfection before eggs had hardened for an hour. But trays of eggs hardened in iodophor at Big Lake this past year had better survival than all but a few other trays in the hatchery.

The new Trail Lakes Hatchery has been designed with fixed wall modules so that several stocks of sockeye (totaling 6 million) and other susceptible species could be raised at this facility. In order to prevent adaptation of the disease, the Sockeye Culture Policy does not allow a hatchery to raise other historically susceptible species with sockeye, nor to plant sockeye in the water sources of hatcheries that raise these species unless compartmentalization is established precluding interspecies transmission of the disease. Thus, each module at Trail Lakes is treated as a separate hatchery, complete even with disinfectant foot baths at the doors.

Theoretically, an IHN epizootic should be containable within a module isolated by its walls, foot baths, and separate water systems. Pressure on the system will be applied by raising a relatively "hot," but important, stock of sockeye in one of the compartments of this system.

Sockeye are planted mainly as unfed fry or raised up to 2 months of age (Crooked Creek Hatchery). Raising them for extended periods beyond that would seem to increase the risk of IHN if we have only delayed rather than eliminated it. We will not be able to demonstrate any positive effect until many years pass without an epizootic.

ADVANTAGES OF SELECTIVE BREEDING

Lauren R. Donaldson
Professor Emeritus
School of Fisheries
University of Washington
Seattle, Washington

The present day salmonid stocks are the product of natural evolution and selection dating back to the late Pliocene and early Pleistocene, periods regarded as comprising about the last million years (Neave 1958). During the period the present day 60± species and countless distinct racial stocks evolved. Neave concludes his paper, "The Origins and Speciation of Oncorhynchus" with the statement:

> The existing situation (many species occupying a common geographical area and showing only a relatively slight degree of ecological divergence) is probably quite transitory in evolutionary terms. It could be expected that competition would either eliminate certain species or stimulate more pronounced ecological specialization--or both--and that relatively slight changes in climate might markedly affect the existing balance between species. It cannot be overlooked, however, that the Pleistocene epoch which produced the Pacific salmon also produced the "unpacific predator" (man) whose ability to alter environments may play a part in determining the future course of events for Oncorhynchus.

Dr. William F. Thompson (1965), in a paper published just after his death, wrote of the Darwinian principle of racial stock adaptation by natural selection:

> This principle applies to the salmon along our coasts. Each stream or lake has its own extremely complex characteristics, and if salmon live in one of them we find that these salmon are adapted in an equally complex way to that environment. We are far from understanding these two complexes, the fish and the environment, but we do know that in order to return to the place for which it has been fitted, the salmon returns from the sea to its home stream, there to meet and breed with its own kind. Thus, it develops and perpetuates the genetic characteristics which fit it for survival in that stream. So we have a multitude of groups of salmon, each self-perpetuating which we loosely term races, and which the scientist calls gene pools, each fitted to survive in a particular home. If it leaves this home the race either dies off or readapts.

With the arrival of the "unpacific predator" in the area, the salmonid fishes were subjected to completely different kinds of stress to which they have had to adapt or perish.

The first Pacific salmon hatchery, built on the McCloud River in California in 1870, robbed the river of its wild chinook stock to start the hatchery. This practice of robbing the rivers for initial hatchery stocking continued along the Pacific Coast from California to Japan. Since there was little or no chance for the hatchery salmon to adjust to a new environment, such efforts contributed little to the salmon runs, in fact, many were actually destructive.

In 1895, Washington state built a hatchery on the Kalama River, a tributary of the Columbia River (Berg 1968). This station evolved a procedure for controlling the whole life cycle, from stock spawning, hatching, rearing, release, recapture, and spawning the seed for the next generation. This simple, straightforward procedure led to the selection of stock fish that could adjust to the new system.

As the system developed, surplus spawn was available for transfer to other stations.

CHINOOK SALMON

The Green River hatchery, built in 1901 and completely rebuilt in 1907, 1926, and 1948, required chinook eggs from the Kalama hatchery, and over the years evolved a program that was so successful that the chinook surplus formed the donor stock for many hatcheries around Puget Sound including that at the University of Washington.

The transfer of the chinook stock to the university in 1949, together with the rainbow, cutthroat, and silver salmon stocks already in place made it possible to carry out a number of selective breeding programs. Both family and mass selection could be used.

The emphasis of the selection program has changed from time to time, but the overall thrust has been to develop stocks of fish that better meet our management needs.

For example, the objectives (Donaldson and Menasveta 1961) of the selective breeding program for chinook salmon were to try to develop a stock that would 1) return to the ponds at the university, 2) mature and produce eggs after a short migration from the sea, 3) spawn at the desired season of the year, 4) mature at an early age, 5) produce maximum growth, 6) have a large egg yield, 7) have a high survival rate of egg fry and fingerlings, 8) be resistant to disease, 9) migrate to sea at an early age, and 10) have a high survival rate in the sea.

Progress on all 10 selection objectives has been made over the years.

1. Each fall 2,000 to 3,000 adult chinook salmon return to the home pond.

2. Fish are mature for spawning a few days after migrating the 4.6 miles from the sea to the pond.

3. Spawning peak was gradually changed from late September to late October, to take advantage of student participation.

4. In the parent stock, the majority of the fish now return as 3-year-olds rather 4 or 5-year-olds.

5. Continued selection for more robust-bodied fish with better dress-out qualities has resulted in a mean average weight increase of about 1 kilogram, without a comparable increase in length.

6. Average fecundity has increased by about 1,000 eggs per female.

7. Rearing mortalities continue to be low.

8. Disease resistance is difficult to measure, but with good fresh- and salt water survival, we must be making progress.

9. With increased growth, time to smoltification has been reduced one month, thus allowing for early release to avoid the warmer temperatures that increase chance of bass, perch, and squawfish predation.

10. Marine survival has more than doubled from less than 1 percent to more than 3 percent. The annual release now is 150,000 to 160,000 smolts with a return of 3,000± adults that produce 5 to 6 million eggs, 20 times the number needed to maintain the run, leaving a great surplus for further selection.

COHO SALMON

Since 1967, the coho salmon selection program has concentrated on the development of a stock that would respond to accelerated growth in the hatchery to produce coho smolts in 6 to 7 months, instead of the normal 18 months as in most state and federal hatcheries, with the adults returning at 2 years of age instead of the usual 3 years. (See Table 1.)

Donaldson and Brannan (1976) summarized the early efforts and concluded that over a 6 year period, 0.017 percent of the smolts released returned at 1 year of age, 1.608 percent at 2 years, and only 0.021 percent as 3-year-old fish. The ocean survival for the six brood years returning to the home pond was 2.56 percent of the 6 to 7 month old smolts released.

For the 1979 brood year, 51,489 smolts released May 22, 1980 had a total return to the home pond of 4.79 percent (see Table 2). The 1-year-old "jacks" numbered 257 fish, or 0.5 percent, and the 2-year-old adults 2,209 fish, or 4.29 percent of the release.

The 1979 brood year acclimated coho release was made up of seven separate lots that had experienced different rearing conditions and hence different growth rates and stress factors. The size at release ranged from 7.9 g to 22.4 g with the calculated return rate from a low of 2.5 percent to 6.8 percent. The rate of growth and ocean success was inversely related to the population densities during the rearing period in the hatchery.

RAINBOW TROUT

Of all the salmonids, the rainbow trout (Salmo gairdneri) has received the most attention for stock development. The worldwide commercial rainbow trout industry is dependent upon stocks that grow fast, are hardy, and are available through the entire year for marketing.

TABLE 1. Summary of releases and returns of accelerated coho at the University of Washington hatchery for the brood years 1967 to 1979

Brood year	Release $\bar{x}$ wt (g)	Release number	Return number	Percent return
1967	15.8	17,743	219	1.25
1969	6.1	37,342	145	0.39
1970	9.2	63,882	1,075	1.68
1971	12.1	35,100	850	2.42
1972	15.7	57,133	1,851	3.24
1973	15.2	29,140	1,871	6.42
1974	9.0	25,937	884	3.41
1975	16.3	27,638	1,255	4.54
1976	12.5	25,514	679	2.66
1977	11.6	47,300	1,441	3.05
1978	10.5	29,083	1,462	5.03
1979	16.6	51,498	2,466	4.79

TABLE 2. Summary of the release and return data for the 1979 brood year

Mark	Number released	Size (g)	1980 Return (No.)	(%)	1981 Return (No.)	(%)	Total (Return)	(%)
Ad+(16-33)	14,374	18.0	28	.195	382	2.66	410	2.85
Lv	2,127	18.0	-		43	2.12	43	2.12
RSBH	17,151	12.7	2	.01	419	2.44	421	2.45
LSBH	2,006	12.7	-	-	14	.7	14	.7
RSUB	10,689	22.4	216	2.02	292	2.73	508	4.75
LTBH	2,722	7.9	-		23	.84	23	.84
N.M.	2,429	12.7	11	.45	1,036			
N.M.*	returning		11	.02	1,036	2.0	1,047	2.03
Total	51,498	16.6	257	.5	2,209	4.29	2,466	4.79

Ad. and Lv = fed food made from trawler waste with final rearing in outside circular ponds

RSBH and LSBH = genetic selection study fed hatchery diet reared in hatchery troughs

RSUD = production of lot fed hatchery diet but final rearing in the large circular pond

LTBH = last lot spawned in the fall of 1979 reared as a separate lot in hatchery trough

*Fish that returned that mark could not be positively identified.

Rainbow trout historically spawned only in the spring. By selection it is now possible to have stocks that spawn nearly every month in the year--in fact, a commercial firm advertises "year-round delivery" of eyed rainbow trout eggs.

A long-term program of selective rainbow trout breeding has been underway at the School of Fisheries since 1932. The broad objective of this program has been to produce large numbers of strong, healthy, acclimatized fingerlings for use in lake and stream management programs and an efficient stock for commercial farms. Some of the important results of this program have been reported in the literature (Donaldson and Olson 1957; Donaldson 1970, 1971; and Hines 1976).

In the early years, the trout reached maturity in their fourth year at an average weight of 680 g (1.5 lbs) and produced 400 to 500 eggs at their first spawning. Some of the males of the select stock now reach maturity in their first year at an average weight of about 1.5 lbs. The females all mature in their second year at an average weight of 4,500 g (10 lbs) and produce 10,000± eggs. Although the rate of increase in average length of fish selected for broodstock has slowed, the average weight of the fish continues to increase. This change in weight is accompanied by an increase in condition factor, to 1.88, providing a deep-bodied fish with more useful flesh--a real asset to the commercial fish farmer.

With greatly increased fecundity, a low mortality, and rapid rate of growth, single families spawning for the second time as 3-year-olds have produced a calculated 98 tons of fish in 21 months.

INTERRACIAL HYBRIDS

The crossing of closely related stocks or races of plants or animals often results in hybrid rigor. Fish also seem to show this tendency.

Interracial crosses between anadromous rainbow trout (steelhead) and the highly selected, non-migratory stock of rainbows developed at the School of Fisheries produce hybrids that grow much faster than the steelhead stock, but more slowly than the non-migratory stock. It is evident that the dominant growth factor of the school select stock has been transmitted, in part, to the steelhead strain. In field tests, the hybrids retain the steelhead migratory characteristics and migrate to sea, where they grow rapidly. On their return from the sea they provide a fine sport fishery--for they have the rainbow urge to bite and so can be harvested rather than die of old age.

With continued effort over the years, it should be possible to develop, by genetic selection, fish that rival the broad-breasted turkey as a food resource.

RECOMMENDATIONS FOR CONSIDERATION

1. The inherent adaptability of the salmonid fishes should be used to form the base for purposeful selective breeding.

2. Local stocks of fish, if available, should be used to start the selections.

3. If foundation stocks are not available locally, they should be obtained from fish having similar environmental characteristics.

4. Selections should be based on the entire life span of the stocks, not just the hatchery phase.

5. Programs to change fish by selective breeding must be carried on with a fixed plan over many generations.

REFERENCES

Berg, I. I. 1968. The history of the Washington State Department of Fisheries 1890-1967. Wash. Dept. of Fish.

Donaldson, L. R. 1970. Selective breeding of salmon fishes. In: Marine Aquaculture, ed. William K. McNeil, pp. 65-74. Oregon State University Press.

Donaldson, L. R. 1971. Development of select strains of salmonid fishes for use in management. Atlantic Salmon Workshop, pp. 19-31.

Donaldson, Lauren R. and Ernest L. Brannon. 1976. The use of warmed water to accelerate the production of coho salmon. Fisheries 1(4):12-16.

Donaldson, L. R. and D. Menasveta. 1961. Selective breeding of chinook salmon. Trans. Amer. Fish. Soc. 90:2:160-164.

Donaldson, L. R. and P. R. Olsen. 1957. Development of rainbow brood stock by selective breeding. Trans. Amer. Fish Soc. 85:93-101.

Hines, N. O. 1976. Fish of rare breeding. Washington, DC: Smithsonian Institution Press.

Neave, F. 1958. The origins and speciation of Oncorhynchus. Trans. Royal Soc. Canada Series III:52:Sec. V:25-39.

Thompson, W. F. 1965. Fishing treaties and salmon of the North Pacific. Science 150:3705:1785-1789.

CHINOOK SALMON ENHANCEMENT AND RESEARCH ACTIVITIES IN SOUTHEASTERN ALASKA

William R. Heard
National Marine Fisheries Service
Auke Bay Laboratory
Auke Bay, Alaska

INTRODUCTION

Chinook salmon (Oncorhynchus tshawytscha) fisheries in southeastern Alaska and the stocks involved in these fisheries during the past decade have become the focus of intense regional, interstate, and international attention. In general, the reasons for this attention can be attributed to four factors: (1) depressed stocks that contribute to these fisheries include those of coastwide origin from California to northern British Columbia and southeastern Alaska; (2) the Magnuson Fisheries Conservation and Management Act (MFCMA) of 1976 led to fishery management plans (FMP's) regulating ocean troll fisheries for chinook salmon in jurisdictional waters of the United States; (3) prospects of an international Pacific salmon fisheries accommodation between the U.S. and Canada; and (4) a strong commitment in Alaska toward restoring and increasing depressed salmon stocks and fisheries. In Alaska, the latter led to the Fisheries Rehabilitation, Enhancement, and Development (FRED) division within the Alaska Department of Fish and Game (ADF&G) in 1972, the Private Non-Profit hatchery statutes (PNP) in 1974, and regional aquaculture associations in 1976.

Unlike other salmon fisheries in Alaska, the Southeast chinook salmon fisheries are confined to salt water. These include commercial troll, and recreational fisheries, drift gill net, and power seine fisheries. Only troll and recreational fisheries target on chinook; net fisheries take this species incidentally to the primary intent of catching other salmon. Historically, however, rivermouth gill-net fisheries for chinook occurred on all major systems in southeastern Alaska (Kissner 1976).

Sport fisheries for chinook are concentrated in urban area marine waters around Juneau, Sitka, Ketchikan and Petersburg-Wrangell. In 1977, an estimated 17,096 chinook were caught in the southeastern Alaska sport catch (Mills 1979). By combining this with the commercial chinook catch in northern and southern Southeast Alaska of 285,220 fish in 1977 (SSRAA and NSRAA 1981), a commercial-sport catch estimate of 302,316 provides a rough basis for estimating the percentage taken by each gear type. The proportion of chinook caught in 1977 by troll, seine, gill net, and sport fisheries in southeastern Alaska was about 89.9, 1.7, 2.7, and 5.6 percent, respectively. The commercial harvest of chinook in 1977 was about 10 percent below the 15 year average (1964-78) (SSRAA and NSRAA 1981). It is not known if the sport catch that year was also lower than average.

The initial FMP in 1978, a joint effort of the North Pacific Fisheries Management (NPFMC) and the Alaska Board of Fisheries, established an upper range of optimum yield (OY) in southeastern Alaska of 320,000 chinook per year. This OY, based essentially on the average harvest during the 1971-77 period was controversial because the fishery is known to harvest fish from certain Washington and Oregon stocks (Parker and Kirkness 1956; Geist 1978). Many of these stocks are badly depressed and in need of increased protection. Also major stock allocative considerations have been given to recent U.S. judicial decisions concerning western Washington and Columbia River Indian treaty tribes. The upper OY range was reduced to 272,000 fish in 1980. The troll fishery harvest of chinook in 1981 was 268,100 fish, and the OY for 1982 was set at 255,500 fish. Finally, these and other restrictive changes in southeastern Alaska chinook regulations have been implemented partly to conserve and rebuild depressed local stocks. Major time-area closures for chinook troll and recreational fisheries around Juneau, Petersburg, and Ketchikan have been in effect in recent years to protect spawners returning to streams in those areas.

Against this backdrop of change in the status of chinook fisheries and stocks in southeastern Alaska, there has also been a growing level of hatchery-related enhancement activity and other research. The purposes of this report are: (1) to provide a general overview of chinook salmon enhancement activity in southeastern Alaska; (2) to review the stocks and facilities involved; (3) to briefly consider some non-hatchery related research programs; (4) to review preliminary results of some of these projects, especially cooperative National Marine Fisheries Service (NMFS) and ADF&G research at Little Port Walter; and (5) to discuss some implications of these data and consider possible future trends in southeastern Alaska.

FACILITIES AND STOCKS

By the end of 1981, six hatchery facilities in southeastern Alaska were culturing chinook salmon. Three of these--Crystal Lake, Snettisham, and Hidden Falls--are state facilities operated by the Fisheries Rehabilitation, Enhancement, and Development (FRED) division. One, Deer Mountain (owned by the City and Borough of Ketchikan), is operated by FRED under cooperative arrangements. Whitman Lake Hatchery is owned and operated by the Southern Southeast Regional Aquaculture Association (SSRAA) and Little Port Walter, an experimental research station, is operated by NMFS. Three other southeastern Alaska facilities, now discontinued, made at least one release of chinook smolts during the 1970s and include saltwater rearing pens at Fish Creek and Starrigavan Creek, both operated by FRED, and Mendenhall Pond, operated by Sport Fish Division. The location of these facilities and the initial brood year for the six operational programs are summarized in Figure 1.

Five chinook stocks from southeastern Alaska streams are presently involved in the six operational facilities. These include Situk River near Yakatut; King Salmon River from Seymour Canal Admirality Island; Andrews Creek, a lower Stikine River tributary; Cripple Creek, a tributary of the Unuk River; and Chickamin River (Heard and Wertheimer 1976; McMullen and Kissel 1981, 1982).

Three other chinook salmon stocks, nonindigenous to southeastern Alaska, were released from the discontinued rearing facilities at Fish Creek, Starrigavan Creek, and Mendenhall Ponds. These stocks included Ship Creek from upper Cook Inlet, Crooked Creek, a tributary of the Kasilof River in lower Cook Inlet and Wind River, a tributary of the Columbia River. The

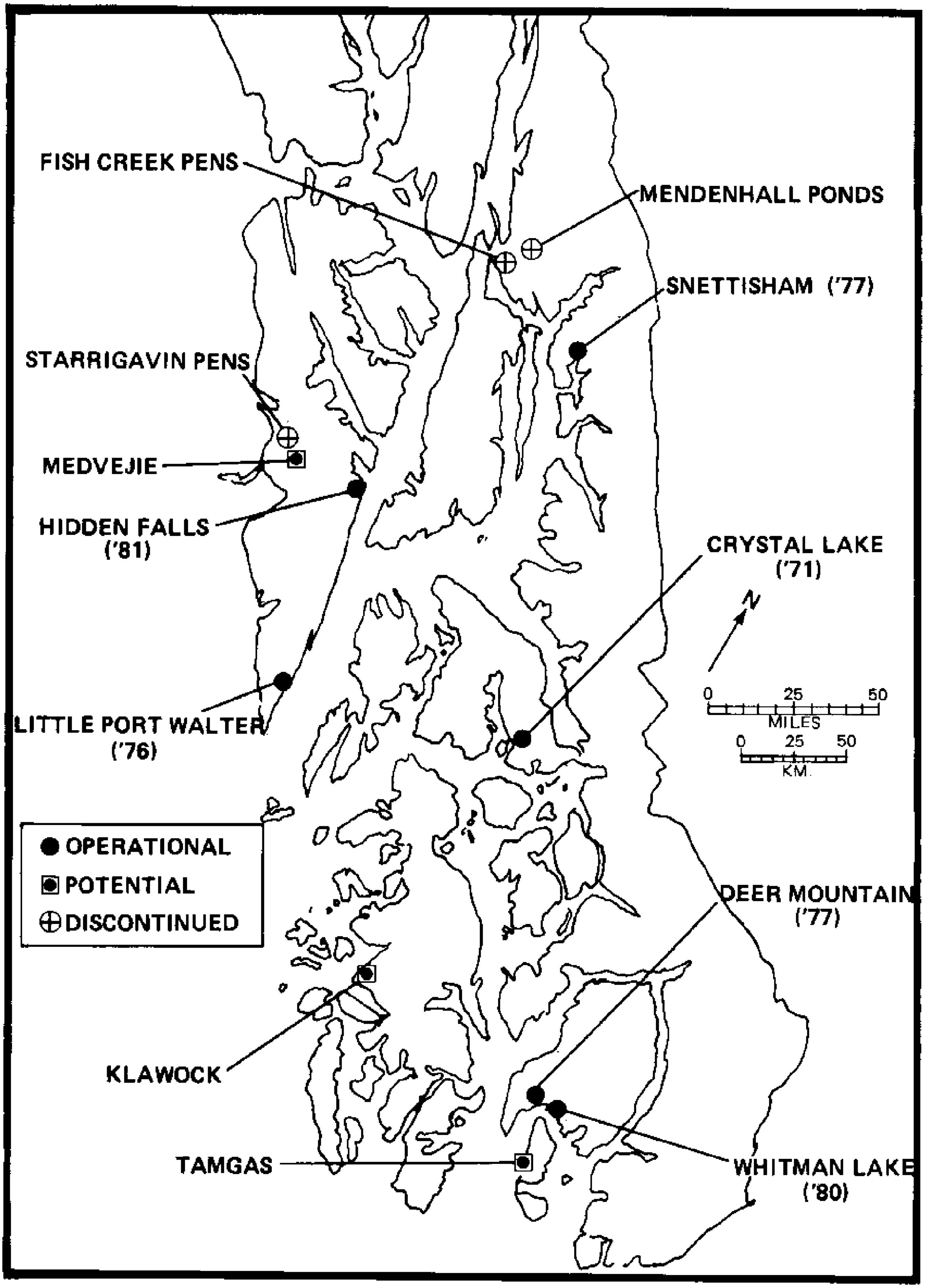


Figure 1. Location of sites in southeastern Alaska associated with chinook salmon culture 1971-1981 including operational, discontinued, and potential facilities. Number in () identify initial brood year for the six operational facilities.

latter, a 'composite' stock, was developed at the Carson National Fish Hatchery (Zimmer 1963; Wahle and Chaney 1981). The Carson stock was also initially Wahle and Maltzeff used at Crystal Lake Hatchery (1971 and 1972 broods). Finally groups of pen reared smolts from this stock were released at Little Port Walter (1971 brood) and Starrigavan (1971 and 1972 broods). Although some adult returns occurred from smolt released from these stocks non-endemic to southeastern Alaska, they were not continued due to facility closures and changing stock policies. Several groups of first filial (F-1) generation eggs were collected from the Carson stock returning to Mendenhall Ponds and Crystal Lake Hatchery in 1976 and 1977 but were destroyed due to subsequent developments.

Figure 2 identifies the natal stream location of the five stocks presently used in operational facilities in southeastern Alaska. The locations of several other stocks that may have brood potential for enhancement projects are also shown.

Reviewed in the following sections are accounts from 1976 through 1981 of the six chinook facilities presently operating in southeastern Alaska including the stocks and broods involved at each station. These data are summarized in Table 1.

CRYSTAL LAKE HATCHERY

This facility became operational with chinook in 1971. The stocks and numbers of smolts released during the 4 years, (1971-75) are reviewed by Zorich (1978). In 1976, four separate groups of eggs from three stocks were used at Crystal Lake. Transplants of wild first parental (P-1) Andrews Creek and King Salmon River eggs were made to this facility. Eggs from (F-1) Wind River Carson Hatchery stock returning as 4-year-old adults to Mendenhall Ponds were also transplanted to Crystal Lake. The Mendenhall Ponds project was for rearing only. Egg incubation and early-stage fry rearing for this program was done at Crystal Lake. Finally, in 1976, eggs were also collected from 4-year-old F-1 Carson stock adults returning to Crystal Lake.

In 1977, wild (P-1) Andrews Creek eggs were again transplanted to Crystal Lake. Carson stock eggs from 5-year-old F-1 adults were also transported to Crystal Lake from Mendenhall Ponds and collected from adults at the hatchery. Virological tests on ovarian fluids of Carson stock females from Mendenhall Ponds in 1977 proved to be positive for infectious hematopoietic neurosis virus (IHNV). This fact led to a politically sensitive but courageous decision by FRED to destroy all Carson stock chinook in southeastern Alaska. A series of internal FRED and ADF&G memorandia by R. Grischkowsky, R. Roys, and others (1978 personal communication) reviewed in depth factors associated with this decision. Subsequent viral challenges of Carson stock along with Alaska stocks from Cripple Creek and Situk River, under laboratory conditions (Wertheimer and Winton 1982), lend support to the destruction of Carson stock chinook in southeastern Alaska hatcheries.

Wild (P-1) Andrews Creek eggs were transplanted to Crystal Lake in 1978, 1979, and 1980. In addition, adults returning to Crystal Lake in 1980 provided two stock groups of F-1 hatchery generation eggs: (1) known Andrews Creek stock (4-year-old adults from 1976 brood releases) and (2) a mixed

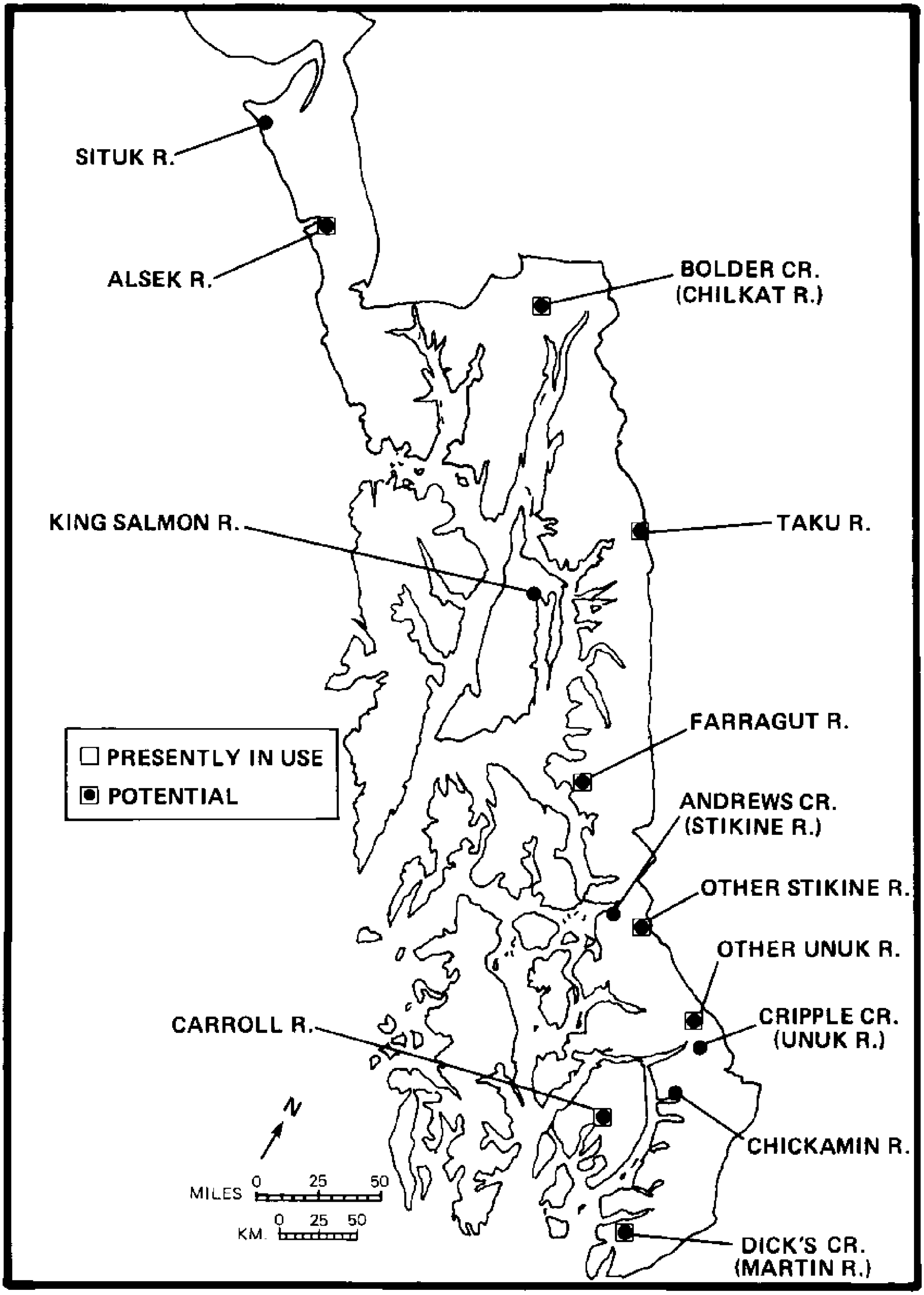


Figure 2. Location of southeastern Alaska chinook salmon stocks used in current programs and others that may have brood stock potential.

Table 1. Summary of chinook salmon stocks used at southeastern Alaska Enhancement Facilities 1976-81

1. Crystal Lake Hatchery
   - 1976 Andrews Creek (Stikine River)
     - King Salmon River
     - Mendenhall Ponds (F-1; H)[1]
   - 1977 Andrews Creek
     - Mendenhall Ponds (F-1; H)
   - 1978 Andrews Creek
   - 1979 Andrews Creek
   - 1980 Andrews Creek
     - Andrews Creek (F-1; H)
     - Mixed Stocks (F-1; H)
   - 1981 Andrews Creek (F-1; H)
     - Mixed Stocks (F-1; H)

2. Deer Mountain Hatchery
   - 1977 Cripple Creek (Unuk River)
   - 1978 Cripple Creek
   - 1979 Cripple Creek
   - 1980 Cripple Creek
   - 1981 Cripple Creek
     - Cripple Creek (F-1; H)

3. Snettisham Hatchery
   - 1977 Andrews Creek
     - Situk River
   - 1979 King Salmon River
   - 1980 King Salmon River
     - Situk River
   - 1981 Andrews Creek
     - Situk River
     - King Salmon River
     - Andrews Creek (F-1; H-CLH)

4. Little Port Walter
   - 1976 Chickamin River
     - Cripple Creek (Unuk River)
   - 1977 Cripple Creek
   - 1978 Cripple Creek
     - Situk River
   - 1979 Cripple Creek
   - 1980 Cripple Creek
   - 1981 Cripple Creek
     - Cripple Creek (F-1; H)
     - Chickamin River (F-1; H)

5. Whitman Lake Hatchery
   - 1980 Cripple Creek
   - 1981 Cripple Creek (F-1; H-LPW)
     - Chickamin River (F-1; H-LPW)

6. Hidden Fall Hatchery
   - 1981 Andrews Creek

[1] (F-1; H) = First filial generation of recycled brood at hatchery; (LPW) = Little Port Walter; (CLH) = Crystal Lake Hatchery.

stock group primarily of Andrews Creek origin but with some likelihood of other stocks as well (B. Zorich and T. Kron 1981, personal communication).

In 1981, no wild Andrews Creek eggs were taken to Crystal Lake. Two groups of eggs were spawned at the hatchery in 1981: (1) known Andrews Creek stock eggs from marked 4- and 5-year-old adults, and (2) eggs of unknown stock origin. Age assessments of the unmarked parents showed that almost all 1981 spawners were from year classes in which only Andrews Creek stock had been raised at the hatchery (B. Zorich 1982, personal communication). Potential non-Andrews Creek genetic influence at Crystal Lake was sufficiently low in 1981 that all chinook salmon at this facility are now considered "Andrews Creek genotype" (B. Davis 1982, personal communication). One group of known 1981 brood F-1 hatchery Andrews Creek stock eyed eggs were shipped to the Snettisham Hatchery from Crystal Lake Hatchery.

Hatchery-to-hatchery shipments of chinook salmon eggs are now permitted only under a vigorous screening process where eggs are incubated in isolation while samples from both parents are checked for specific disease pathogens by the Fish Pathology Section of ADF&G.

LITTLE PORT WALTER (LPW)

A cooperative NMFS-ADF&G agreement was developed in 1976 for joint research on chinook brood stock development and enhancement technology at Little Port Walter. The agreement called for FRED to provide some manpower and funding support and NMFS to commit most of its aquaculture research funds and capability of the Little Port Walter station to chinook issues. In 1976, eggs from two Behm Canal stocks, Chickamin River and Cripple Creek, were transported to the Baranof Island facility. The culture and release of these 1976 brood stocks is reviewed by Heard et al. (1979). In 1977, only Cripple Creek eggs were taken to LPW, and the culture and release of this brood is reported by Wertheimer et al. (1981). In 1978, Cripple Creek eggs were again taken to Little Port Walter, in addition to a small group of Situk River eggs. Both groups of eggs were used in the viral challenge tests reported by Wertheimer and Winton (1982). The culture and release of this brood at Little Port Walter (Wertheimer et al. 1982) was related mostly to effects of age, time, and size at release and culture density on marine survival.

In 1979 and 1980, smaller numbers of Cripple Creek eggs were transported to Little Port Walter. Some P-1 eggs in both years were fertilized with milt from P-1 Cripple Creek cohorts and some with milt from F-1 Cripple Creek stock males returning to Little Port Walter (age 1.1 and 1.2 adults, respectively, in 1979 and 1980). These F-1 X P-1 crosses of the same stock are designed to quantify paternal influence in transplanted stock adaptation.

Similar F-1 X P-1 crosses with Cripple Creek stock were expanded in 1981 to include maternal factors provided by F-1 eggs returning to Little Port Walter as 5-year-old (age 1.3) females. A generalized summary of the 1976 through 1979 brood chinook release made at Little Port Walter (Table 2) reviews the stock, number of smolt groups by age, and treatment categories.

Five-year-old (age 1.3) Cripple Creek and Chickamin River stock females, returning in 1981, provided for spawning F-1 eggs of these fish at Little Port

Table 2. Summary of chinook releases at Little Port Walter Experiment Station, 1977-81

BROOD YEAR	SMOLT RELEASES				TREATMENT[1]
Release ($X10^3$)	Stock	Groups (No.)	Age	Release ($X10^3$)	
1976	Unuk River	5	1+	22.5	Stock: T/S: Culture effects
(40.9)	Chickamin River	1	0+	5.0	Age: T/S: Culture effects
		3	1+	13.4	Stock: T/S: Culture effects
1977	Unuk River	8	0+	66.5	Age: T/S Emigration behavior
(116.4)		6	1+	49.9	Age: T/S
1978	Unuk River	7	0+	28.9	Age: T/S
(194.1)		12	1+	156.6	Density: Culture effects
	Situk River	1	1+	8.6	Stock: T/S: Disease research
1979	Unuk River (♀)	1	1+	15.0	Transplant stock adaptation
(30.0)	X				
	Unuk River (♂)				
	Unuk River (♀)	1	1+	15.0	Transplant stock adaptation
	X				
	Unuk River (LPW ♂)				

[1] T/S = Effects of time and/or size at release.

Walter. Mature males and females were presorted and spawned only according to known stocks. Some eggs from both stocks were kept at Little Port Walter whereas others were transported to two facilities in the original natal Behm Canal area. Cripple Creek stock eggs were shipped to Deer Mountain Hatchery (eyed) and Whitman Lake Hatchery (green) whereas Chickamin stock eggs were shipped only to Whitman Lake Hatchery (eyed).

DEER MOUNTAIN HATCHERY

Wild P-1 Cripple Creek stock eggs were transplanted to Deer Mountain Hatchery facility in each of the five years, 1977-81, in addition to 1981 brood F-1 Cripple Creek stock eggs from Little Port Walter. Novak (1981) has reviewed the initial returns of 1977 and 1978 brood released at Deer Mountain Hatchery. Returns of 2-, 3-, and 4-year-old adults occurred to this hatchery in 1981, respectively, from 1979, 1978 and 1977 brood smolt releases (M. Ward 1982, personal communication). Additional 4-year-old fish (age 1.2) from Deer Mountain Hatchery were recovered in the commercial troll fishery in 1981 (ADF&G wire-tag recovery data from 1981).

SNETTISHAM HATCHERY

In 1977, chinook eggs (wild, P-1) from Andrews Creek and Situk River were transplanted to Snettisham Hatchery. No 1978-brood chinook were taken to this facility. In 1979, King Salmon River eggs and in 1980, Situk River eggs were taken to Snettisham Hatchery. Four groups of 1981 brood were transplanted to this hatchery including eggs (wild, P-1) from Situk River, King Salmon River, and Andrews Creek and eggs (F-1 hatchery) from Andrews Creek stock at Crystal Lake Hatchery. Data on Snettisham Hatchery chinook activity was provided by T. Kron (1982, personal communication).

WHITMAN LAKE HATCHERY

In 1980, chinook P-1 eggs from Cripple Creek were transplanted to Whitman Lake Hatchery. In 1981, Cripple Creek stock and Chickamin River stock eggs (both F-1) from Little Port Walter were shipped to this hatchery.

HIDDEN FALLS HATCHERY

In 1981, chinook eggs (wild, P-1) from Andrews Creek were transplanted to Hidden Falls Hatchery.

NON-HATCHERY PROGRAMS

Several non-hatchery research projects are important in the overall effort to provide information needed for management, rehabilitation, and enhancement of chinook and associated fisheries in southeastern Alaska. Projects include studies on juveniles and adults in major river systems, stock separation studies, a research troll fishery, rehabilitation research on fry plants in streams and lakes, and a troll logbook program.

ECOLOGICAL STUDIES ON WILD STOCKS

For several years, a study on chinook in the Taku River, Stikine River, and other southeastern rivers has provided valuable biological and escapement data on these stocks (Kissner 1975, 1976, 1977, 1981, and 1982). Annual escapement estimates or peak spawner counts are made for some of the main spawning populations. Biological information on age, size, and sex ratios is collected on some stocks of spawning chinook. A carcass weir is usually installed on Nakina River, a principal tributary of Taku River, to facilitate collection of these data. The coded-wire tagging study on wild chinook juveniles in natal streams that began in 1977 is continuing. Tagging has included both age 1 emigrant smolts collected during spring and age 0 (young-of-the-year) juveniles collected during fall prior to stream freeze.

RESEARCH TROLL FISHERY

A research troll fishery was conducted jointly by the Alaska Troller Association (ATA) and ADF&G during spring 1981. Purposes of the program were to study the stock composition of chinook in certain northern southeast waters and to study hooking mortalities of single and treble hooks (Bethers 1981). During the study, 764 chinook were caught with troll gear, tagged with Petersen disc tags and released. The study focused on inner Icy Straight and Cross Sound, including adjacent outer coast approaches to the north and south. Although the study will continue for two to four years, the recovery of 45 disc tags in 1981 suggested results may be similar to a prior study by Parker and Kirkness (1956). In both cases, chinook tagged along the outside coast tend to be recovered in southern non-Alaskan waters to a greater extent than those tagged in inside southeastern waters.

SCALE AND ELECTROPHORESIS STUDIES

Two new stock separation studies involving southeastern chinook started in 1981; one is based on biochemical genetic techniques, the other on discriminant function analysis of scale characteristics. By collecting baseline data from known stocks, researchers will attempt to quantify unique biological features of individual stocks or related groups of stocks according to provisions of the two techniques. The ultimate aim of the stock separation program is to subsequently use unique biological characteristics to proportionally determine stock composition in mixed-stock fisheries. The biochemical genetics study using starch gel electrophoresis procedures is under the direction of A.J. Gharett of the University of Alaska Juneau, and the scale analysis study is directed by Scott Marshall of ADF&G Commercial Fisheries Division.

STREAM AND LAKE PLANTS OF FRY

Two research projects are underway in southeastern Alaska to explore the feasibility of planting chinook fry into suitable stream or lake habitats as an enhancement tool. Although implementation of these concepts would likely involve hatcheries, they are listed here as non-hatchery programs because of the ecological interaction with natural freshwater rearing systems. Instream fry plants could, theoretically, be used to reestablish historic runs, to establish new runs in some circumstances (Blackett 1979) or to increase natural production where suitable fry-to-smolt rearing habitats exist above barrier falls. The Southern Southeast Regional Aquaculture Association (SSRAA), in cooperation with ADF&G, is presently exploring some of these options. Some important considerations raised by instream plants of chinook fry include: (1) suitability of various sources of fry including "surplus" hatchery fry; (2)

significance of a small endemic run in a given stream; (3) interactions of planted chinook with food webs and other fishes; (4) ability to identify and categorize suitable underutilized chinook rearing or spawning habitat; (5) genetic and disease effects of hatchery influence on fry; and (6) ability to evaluate results at subsequent life stages. Most of these factors also apply to planting chinook fry in lakes. A small-scale study underway on lower Baranof Island (Hard 1981) is designed to measure the suitability of lakes as rearing environments for chinook fry.

TROLL LOGBOOK PROGRAM

In 1976, a troll logbook program was initiated by ATA in cooperation with the University of Alaska Sea Grant Program, NMFS, and ADF&G for the Southeastern Alaska troll fishery. This program is designed to use participating trollers as vessels of opportunity to make and record observations on water temperature, salmon and bottomfish catches, salmon food species, and marine mammal sightings from daily positions on the fishing grounds. These data, when analyzed, provide valuable information on some of the factors that influence the yearly success of the troll fishery within separate statistical areas of southeastern Alaska (Alaska Trollers Association 1977).

PRELIMINARY FINDINGS

HATCHERIES

Adult returns and fishing contribution patterns are available for 1976 and 1977 brood hatchery smolt releases. Crystal Lake and Little Port Walter made releases from both broods whereas Deer Mountain and Snettisham made releases only from the 1977 brood.

The 1976 brood at Crystal Lake was released as 10.3 g age 0 smolts after accelerated rearing in heated water. The same brood at Little Port Walter was released in nine separate groups including one age 0 (36.0 g) and eight age 1 smolt (63.9-82.8 g) groups. In addition to age and size-at-release differences between Crystal Lake and Little Port Walter, there were also two stocks and different release times at the latter station. Preliminary analyses indicate the overall survival rates (return to hatchery plus fishery contributions) of 1976 brood smolts through 5-year-old fish (1981) is 6.9 and 7.4 percent respectively, for Crystal Lake and Little Port Walter releases. Survival of the nine smolt groups at Little Port Walter ranged from 1.0 to 14.1 percent. An important factor concerning 1976 brood releases at both facilities was the relatively good fisheries contribution of 4-year-old immature chinook throughout northern southeast Alaska during 1980. Also noteworthy at Crystal Lake was the return of mature 4-year-old females along with males to the hatchery from the age 0 smolts (B. Zorich, personal communication 1981). At Little Port Walter, only males matured and returned as 4-year-olds from age 1 smolts.

All 1977 brood releases at Crystal Lake were again age 0 smolts (7.8 g), whereas releases at Snettisham and Deer Mountain were all age 1 smolts (7.4-10.1 g). Little Port Walter released eight groups of age 0 smolts (4.7-36.4 g) and six groups of age 1 smolts (11.2-37.1 g) from the 1977 brood. In general, adult returns and fishery contributions from 1977 brood releases through 4-year-old fish (1981) faired much poorer than comparable stages of the previous brood. Survivals at Crystal Lake, Deer Mountain, and Little Port Walter were all <0.5 percent of the smolts released (based on preliminary expansions of fishery contributions). No recoveries of 1977 brood releases at Snettisham have been documented through 1981. Two important factors associated with 1977 brood Deer Mountain releases include: (1) troll fishery catches along the outer coastline of southeastern Alaska of legal (>28 inch) immature chinook late during the 1981 season; and (2) recovery of a mature 4-year-old female in the hatchery stream (Ketchikan Creek) from an age 1 smolt release (C. Garber, personal communication 1981).

OTHER PROGRAMS

The ecological studies on wild populations by Kissner (1975, 1976, 1977, 1981, and 1982) continue to broaden the basic biological understanding of southeastern Alaskan chinook stocks. Through 1981, this program, in addition to many other data series, has tagged approximately 206,000 chinook juveniles from the Taku River system (36 tag groups) and 107,000 from the Stikine River system (18 tag groups). Some important biological factors regarding wild chinook populations spawning in southeastern Alaska, documented by Kissner's research, include the following:

1. Both adult scale age analysis and juvenile chinook rearing biology indicate most, if not all, southeastern smolts migrate at age 1.

2. Depending on the year, age 1 chinook smolts in the spring average from about 66 mm to 80 mm in fork length. Most of this growth is attained by October of the previous year.

3. Smolt emigration from the Taku River occurs in April, May, and June and usually peaks in mid-to-late May, a pattern consistent with that reported by Meehan and Siniff (1962).

4. Most females on the spawning grounds are 5 and 6 years old (age 1.3 and 1.4), whereas most males are 4 years old (age 1.2). Frequently, as high as 70 percent of the total spawning population is comprised of 3- and 4-year-old (age 1.1 and 1.2) males.

5. Of 88 coded-wire tags recovered from Taku River chinook, 87 have been from mature or maturing fish. Most are spawning ground recoveries. Data are most complete for the 1975 and 1976 broods after the 6- and 5-year-old fish returned in 1981.

During the joint ATA and ADF&G 1981 research troll fishery, nine of the chinook caught had been tagged as smolts with coded-wire tags. Of the nine, six originated from southeastern hatcheries, one from British Columbia and two from Oregon (Bethers 1981). Tags recovered from southeastern Alaska facilities included two from Andrews Creek stock released at Crystal Lake Hatchery and four from Cripple Creek stock released at Little Port Walter. Eight of the coded-wire tagged chinook were sublegal size (<28 inches) and would not have been retained during a regular troll fishery.

DISCUSSION

Although chinook hatchery programs in southeastern Alaska are still in early-development stages, data from three facilities (Crystal Lake, Little Port Walter, and Deer Mountain) show promise that meaningful contributions to ocean troll and urban area recreational fisheries can be derived from regional enhancement programs. Catches of immature chinook from these facilities in 1980 and 1981 suggest ocean migration patterns that allow harvest in southeastern ocean troll fisheries. Healey (1982) points out that ocean trolling is more effective in harvesting immature than mature chinook and that troll fisheries are dependent on ocean distribution and migratory patterns of specific stocks of fish. Geist (1978) and McGie (1980) review experimental releases of tagged chinook in Washington and Oregon that indicate ocean migration, offshore dispersal, and fishery contribution patterns relate to genetic factors associated with specific stocks. Similar relationships likely occur among chinook stocks within southeastern Alaska and must be taken into account with enhancement efforts directed at ocean troll fisheries. In addition to effects of stock genetics on ocean migrations, the effects of hatchery location and of specific hatchery treatments also are likely important factors for chinook enhancement in southeastern Alaska. All southeastern Alaska enhancement programs involve transplants stocks, and McGie (1980) presents data suggesting that transplanted chinook may have a somewhat different ocean distribution and fishery contribution potential from siblings released in natal streams.

Perhaps the most important recent finding regarding southeastern Alaska stocks is the absence of immature fish among recoveries of coded-wire tagged Taku River chinook and the small number of tags recovered from this stock in ocean troll fisheries (Kissner 1982). Recoveries of tagged Taku River chinook are confined to a narrow time and space corridor associated with the nearshore migration of mature fish returning to the natal river. This pattern differs from prior assumptions that the stock resided within regional marine waters as immature feeders and was an important contributor to regional troll fisheries. The emerging Taku stock pattern, however, is consistent with the thesis advanced by Healey (1982) that stream-type chinook (= age 1 smolts or spring-type stocks) migrate further seaward and make a smaller contribution to coastal-oriented troll fisheries than ocean-type chinook (= age 0 smolts or fall-type stocks).

The effects of basic genetics, stock transplants, hatchery treatment, and specific hatchery location will likely play overlapping roles in the success or failure of chinook enhancement in southeastern Alaska. For example, unlike wild Taku chinook, transplants of Cripple Creek (Unuk River) stock to Deer Mountain (60 miles) and Little Port Walter (300 miles) and cultured to age 1 smolts (spring type) are making good contributions to regional troll fisheries as immature fish. Andrews Creek (Stikine River) stock transplanted a shorter distance to Crystal Lake (30 miles) and cultured as age 0 smolts (ocean type) also appear to have a favorable marine distribution and fishery contribution pattern.

The five southeastern stocks presently involved in regional enhancement (Figure 2) all have stream-type biology is natal streams, but the effects of modifying this to an ocean-type age 0 smolt in a hatchery setting is unclear. One factor appears to be some earlier maturation of females as 4-year-old fish from age 0 smolts, maturation perhaps being triggered by ocean residency (Zorich 1981, personal communication). Uncertain is whether or not southeastern chinook cultured in a hatchery as an age 0 smolt might have different ocean distribution patterns and hence different troll fishery contribution potentials from the same fish as an age 1 smolt (either in the hatchery or natal stream). The genetic distinctiveness in ocean migration patterns of stream- and ocean-type chinook stocks indicated by Healey (1982) might suggest little initial difference in ocean distribution arising from various hatchery treatment effects (i.e. age 0 versus age 1 smolts). Adaptation of a hatchery stock over several generations of specific culture treatments, however, can certainly modify original wild natal stock characteristics (Hynes et al. 1981). And some hatchery treatments, such as delayed release timing, apparently have immediate effects on ocean distribution patterns of chinook (Moring 1976).

Healey (1982) presents data showing that stream- and ocean-type chinook stocks have respectively more oceanic and coastal marine distribution patterns. He further notes that stream-type stocks tend to originate from headwater portions of large rivers, whereas ocean-type stocks tend to originate from coastal stream systems. A subset of this relation may occur within southeastern Alaska stream-type chinook. The suggestion has been made that stock units in southeastern Alaska, a short distance upstream from tidewater, utilize coastal and protected inside marine nursery waters, whereas stock units from upriver mainstem and headwater tributary stock units utilize more distance, oceanic marine nurseries (D. Cantillion 1981, personal communication). Results to date with Andrews Creek stock located less than 10 miles above tidal influence on the Stikine River system support this contention.

A successful chinook enhancement program in southeastern Alaska must consider not only complex biological factors but equally complex coastwide social and political issues. Pressures to reduce Alaska troll harvest of depressed non-Alaska stocks can be neutralized to some extent by programs providing for more Alaska fish in this fishery. Although not explicitly defined as policy, both regional and coastwide issues suggest that chinook enhancement in southeastern Alaska should be directed primarily at the troll fishery and secondarily at marine urban area recreational fisheries. To survive and prosper, these fisheries must integrate many complex issues into effective management and enhancement programs.

LITERATURE CITED

Alaska Trollers Association. 1977. Southeast Alaska troll logbook program 1976 scientific report. Univ. Alaska Sea Grant Program Rept. 77-11. 61 p.

Bethers, M. 1981. Research troll fishery spring, 1981. Report to the Board of Fisheries, Alaska, Department of Fish and Game; Sport Fish Division, unpublished manuscript. 17 p.

Blackett, R.F. 1979. Establishment of sockeye (Oncorhynchus nerka) and chinook (O. tshawytscha) salmon runs at Frazer Lake, Kodiak Island, Alaska. J. Fish. Res. Bd. Can. 36:1265-1277.

Geist, R.W. 1978. Genetic effects on Dungeness, Cowlitz-Umpqua hybrid, and Ovillayute chinook released from Coleduk Hatchery. In Proceedings of the 1977 Northeast Pacific chinook coho salmon workshop. B.G. Shepherd and R.M.J. Ginetz (Rapporteurs) Fish. and Marine Serv. Tech. Rept. 759:126-132.

Hard, J.J. 1981. Chinook salmon lake-rearing study, Little Port Walter 1981-84. Unpublished manuscript. Natl. Mar. Fish. Serv. NWAFC, Auke Bay Laboratory, AK. 6 p.

Healey, M.C. 1982. Coastwide distribution and ocean migration patterns of stream and ocean type chinook (Oncorhynchus tshawytscha). Can. J. Fish. Aqua. Sci. In Press.

Heard, W.R. and A.C. Wertheimer. 1976. Progress Report No. 1. NMFS-ADF&G cooperative chinook salmon study in southeastern Alaska. Unpublished manuscript Natl. Mar. Fish. Serv. NWAFC, Auke Bay Laboratory, AK. 21 p.

Heard, W.R., A.C. Wertheimer, R.M. Martin, and B.E. Short. 1979. Culture of 1976-brood spring chinook salmon, Oncorhynchus tshawytscha, from two Behm Canal stocks in Little Port Walter, Baranof Island, Southeastern Alaska. Natl. Mar. Fish. Serv. NWAFC Processed Rept. 79-6. 47 p.

Hynes, J.D., E.H. Brown, J.H. Helle, N. Ryman, and D.A. Webster. 1981. Guidelines for the culture of fish stocks for resource management. Can. J. Fish. Aqua. Sci. 38:1867-1876.

Kissner, P.D. 1975. Study AFS-41-3: A study of chinook salmon in Southeast Alaska. Alaska Dept. Fish. Game Ann. Performance Rpt. Study AFS 41-3, 1 July 1974, Vol. 17, 37 p.

_____. 1976. A study of chinook salmon in Southeast Alaska. Alaska Dept. Fish Game Ann. Performance Rept. Study AFS 41-4, 1 July 1975 - 30 June 1976, Vol. 17, 37 p.

_____. 1977. A study of chinook salmon in Southeast Alaska. Alaska Dept. Fish. Game Completion Rpt. Study AFS 41-5, 1 July 1976. 63 p.

_____. 1981. A study of chinook salmon in southeast Alaska. Alaska Dept. Fish Game. Annual Rpt. 1979-1980, Project F 9 23, AFS 41-8. 35 p.

_____. 1982. A study of chinook salmon in southeast Alaska. Alaska Dept. Fish Game. Annual Rpt. 1980-81, AFS 41-9. 36 p.

McGie, A.M. 1980. Coastal fall chinook assessment project. Oreg. Dept. Fish Wildl. Annual Prog. Rept. 1 Oct. 1979 to 30 Sept. 1980. 13 p.

McMullen, J. and M.W. Kissel. 1981. Annual Report, Division of Fisheries Rehabilitation, Enhancement and Development (FRED) 1980. Alaska Dept. Fish Game, Juneau. 126 p.

McMullen, J and M.W. Kissel. 1982. Annual Report, Division of Fisheries Rehabilitation, Enhancement and Development (FRED) 1981. Alaska Dept. Fish Game, Juneau. 101 p.

Meehan, W.R. and D.B. Siniff. 1962. A study of the downstream migrations of anadromous fishes in the Taku River, Alaska. *Trans. Am. Fish. Soc.* 91:339-407.

Mills, M.J. 1979. Alaska statewide sportfish harvest studies. Alaska Dept. Fish and Game. Annual Performance Rpt. Study SW-1-A, Vol. 20. 78 p.

Moring, J.R. 1976. Contributions of delayed-released, pen-cultured chinook salmon to the sport fishing in Puget Sound, Washington. *Prog. Fish-Cult*. 38:36-39.

Novak, P. 1981. Deer Mountain Hatchery chinook salmon 1977-78 brood stock evaluations after first and second year "adult" returns. Alaska Dept. Fish Game; Division of Fisheries Rehabilitations, Enhancement and Development (FRED). Unpublished manuscript. 23 p.

Parker, R.R. and W. Kirkness. 1956. King salmon and the ocean troll fisheries of southeastern Alaska. Res. Rept. No. I. Alaska Dept Fish Game, Juneau. 64 p.

Southern Southeast Regional Aquaculture Association (SSRAA), Ketchikan and Northern Southeast Regional Aquaculture Association (NSRAA), Sitka. 1981. Comprehensive salmon plan for southern Alaska, Phase 1. Joint Southeast Alaska Regional Planning Teams. 219 p.

Wahle, R.J. and E. Chaney. 1981. Establishment of nonindigenous runs of spring chinook salmon, *Oncorhynchus tshawytscha*, in the Wind River drainage of the Columbia River, 1955-63. *Fish. Bull*. Vol. 79:3:507-516.

Wertheimer, A.C. and J.R. Winton. 1982. Differences in susceptibility among three stock chinook salmon, *Oncorhynchus tshawytscha*, to two isolates to infectious hematopoietic neurosis virus. NOAA Tech. Memo. NMFS F/NWC22. 11 p.

Wertheimer, A.C., W.R. Heard, R.E. Vallion, and R.M. Martin. 1981. Culture of 1977-brood Unuk River chinook salmon, *Oncorhynchus* tshawytscha, at Little Port Walter, Baranof Island, Southeastern Alaska. Unpublished manuscript Natl. Mar. Fish Serv. NWAFC, Auke Bay Laboratory, Alaska. 59 p.

_____. 1982. Culture of 1978-brood Unuk River and Situk River chinook salmon at Little Port Walter, Baranof Island, southeastern Alaska. Unpublished manuscript. Natl. Mar. Fish. Serv. NWAFC, Auke Bay Laboratory, AK. 37 p.

Zimmer, P.D., R.J. Wahle, and C.M. Maltzeff. 1963. Progress report spring chinook salmon transplantation study 1955-61. Spec. Sci. Rpt. Fish. No. 443. 24 p.

Zorich, B. 1978. Crystal Lake Hatchery chinook salmon data series report. Alaska Dept. Fish Game; Division of Fisheries Rehabilitation, Enhancement, and Development (FRED), unpublished manuscript. 23 p.

MIXED STOCK SALMON MANAGEMENT WITH ENHANCED AND NATURAL STOCKS

Steven Pennoyer, Director
Division of Commercial Fisheries
Alaska Department of Fish and Game
Juneau, Alaska

Mr. Chairman, thank you for the opportunity to speak to your group on harvest management of our salmon resources. I can see from the topics and speakers that your discussions have covered many aspects of seeking ways to increase production of salmon for our existing fisheries. You have, therefore, been talking about salmon management implications throughout, even if you have not been directly addressing them. This is certainly as it should be, since the charge to all of us is to produce from our available resource and salmon-producing habitat some form of optimal yield for our commercial, subsistence, and recreational users. It all comes back to allocation of harvests among users and gear types through the regulatory and public input process, while maintaining the reproductive potential of the resource. This holds true for both enhanced and natural stocks.

The ramifications of mixed-stock management on the productivity of Alaska's salmon is not a topic that I can completely cover in half an hour. I do have graphics produced by the Canadian Department of the Environment to show their users and staff to explain why the problems of mixed-stock management have led them to choose their present course of action regarding enhancement. Most of you are already interacting on fisheries management problems through the comprehensive planning-RPT process.

First, I'd like to make a few general statements about Alaskan salmon runs. There are few, if any, Alaskan salmon fisheries that are not perpetrated on mixed stocks, even without enhancement. Most managers do not have the luxury of counting a single stock through a weir and then allowing a harvest on the surplus. Chignik sockeye may come close to that but even there, where we are able to separate rearing areas fairly well by timing, there is a mix of spawning stocks involved. In addition, Chignik salmon are taken in other fisheries. Even in Bristol Bay, where we take great pains to point out the appropriateness of our river mouth fisheries, we may be keying on a single major river, but we are usually fishing on a multitude of rearing and spawning stocks of varying productivity.

Even if we could conduct fisheries right at the mouths of individual spawning streams--this is not physically possible because of the location of some of these spawning areas--it would not be economically feasible. The fishery demands quality fish and the quality generally improves as you move away from the freshwater streams of origin. This quality problem varies by species, but our management is a continual balance of trying to provide a quality, orderly fishery and at the same time manage for the reproductive requirements of the stocks.

A very large proportion of our funds are spent determining the reproductive requirements of various stocks and rearing units, trying to identify them in the fisheries, and designing management strategies to maintain brood stocks at the desired level by regulating time and area of harvest. Normally the mixture of stocks and species in our various fisheries will not allow management by individual stocks. We are required to pick a manageable unit, such as pink salmon districts in Prince William Sound and Southeast, or a major river system in Bristol Bay such as the Kvichak, and set an escapement goal. This goal is really an average escapement for the unit. We usually find that individual stocks within the unit may exceed these goals if very productive, or not meet the goals if from lower productivity stocks. There is usually some variation in this mix, but those stocks which are of consistently lower productivity will probably have consistently lower escapements and sooner or later will decline, often drastically, even with "good management."

This, of course, mirrors the historical pattern of most fisheries. As our knowledge of stock migration and timing increases, we can often improve our management to provide better protection for more stocks. We have, in recent years, moved from more unmanageable major cape fisheries along the migration route, to more discrete stock management. Nevertheless, the problem will not go away. Management for more productive stocks and species and for quality of harvest will always lead to overharvest of certain stocks.

We have identified some 145 manageable salmon stock units in Alaska for which we set escapement objectives and evaluate the success of our program on their achievement. There are perhaps 10,000 such units, plus individual reproductive stock units. Generally, the more complex a stock/species intermixture and the broader our management unit definitions, the worse the decline in stock status. I think Southeast is a fairly good example of this. The more mixed the stocks, the lower the exploitation rate you can afford in a particular fishery without significant declines. This is not to say that, as with the troll fishery, you can't have some form of sequential exploitation that takes advantage of certain socioeconomic characteristics of the fishery, perhaps allowing later exploitation more discreetly on higher productivity stocks. You do, however, have to reduce the exploitation rate dramatically to maintain the overall stock status in such highly mixed-stock fisheries.

What I'm getting at is that enhancement will add major, new, more productive stocks. We have problems managing just natural mixed stocks of varying production. New approaches will be required to take advantage of the potential while minimizing losses. The problems which may be engendered by enhancement and mixed stocks are not new. They are just a matter of degree, (caused by) adding major, new, more productive stocks on top of an already complicated situation.

We have common goals to increase and attempt to stabilize salmon harvests for the benefit of our various users, with a reasonable cost benefit to the public. Obviously, our current salmon run levels and the problems we are experiencing with marketing don't add fuel to the fire to produce more fish. However, I think we can assume that the runs will return to more average levels of productivity, and the industry will adjust to levels consistently achieved. We hope our improvements in management over the past decade will allow us to maintain natural run salmon harvest levels higher than in the '50s and '60s, but I think we can still assume there will be major fluctuations in annual harvest and that there will be a demand for more fish--particularly by species.

It is obvious that the mix of present natural stocks and enhancement opportunities may not fit our current capability to manage each to full capacity. We may not be able to fully develop some sites and stocks without declines in natural stocks or foregoing harvests of enhanced stocks unless we can modify our current way of managing. For example, we may have to modify our traditional views on where and how various gear types can operate to achieve fair benefit from our enhancement. This, in essence, is an allocation question. I think it's important that the Board of Fisheries, through the public hearing process, be brought into the fore in planning for this type of modification. Implications may even extend to our current limited entry program.

In certain cases it will be extremely difficult to ensure good management given the physical or gear characteristics of an area. Upper Cook Inlet is a good example. There are very few opportunities in the upper inlet that will not complicate management by introduction of a major, new productive stock into a mixed stock fishery and allowing for terminal harvest of surpluses.

Certainly, the RPT comprehensive regional planning efforts involving the department, the association, and the general public have made significant strides in this type of planning. The department must do a better job of providing you with an assessment of our management capability handling for various types and magnitude of production. The manager must give realistic assessments of how he would have to manage different types, levels, locations of production and what the allocation, quality of harvest, and potential effect on natural stocks may be. We must also do a better job of making known our needs in terms of data to manage for full benefits from this production.

Conscious trade-offs of weaker or smaller natural stocks may be justified by the magnitude of enhancement opportunity, but this cost must be carefully measured. Generally, I think we must cautiously approach the management of major enhancement on top of major natural stocks, but potential benefits may dictate that it is worth the risks. This brings me back to a comment I made previously: we must very carefully assess our data needs. Marking hatchery stocks may yield valuable information on timing and migration of stocks. Certainly data on their contribution to mixed stock fisheries will be absolutely essential if we are to manage for exploitation rates that will not decimate either the average or more productive of our natural stocks. To help defray the cost of further enhancement, we must find some way of harvesting enhanced stocks both in some segregated fishery by the common property users, and in a quality fishery by the associations.

Beyond that, I think we're going to have to upgrade our knowledge of natural stocks. This would be desirable even without enhancement, but I think if we're going to take full advantage of potential mixes of salmon production, we are going to need better information on the annual variation in abundance, migrations and timing of the natural stocks. We are achieving, I hope, such a blend of programs in southeastern Alaska where we have combined data requirements from U.S./Canada negotiations, our own inseason management, coastwide and Alaskan enhancement evaluation, and our needs for longer range escapement goal and forecasting procedures, to come up with a combined interdivisional and association program for harvest evaluation.

There are a lot of rough edges yet. While we are basically combining our fishery and escapement monitoring and sampling with the various marking and analysis projects, all are designed differently to accomplish different things. Nevertheless, it is a first step and I hope it's the type of thing that will lead to data expansion needed for appropriate management and planning.

I guess what I'm saying is that I'm not scared of this process. As a manager I simply want to make sure that we go into major enhancement with our eyes wide open. I believe properly planned and managed enhancement can improve our capability to manage for rehabilitation of natural stocks as well as to supplement harvest levels. I think the same yardstick of adequacy for manageability that we apply to the natural stocks must also be applied to the enhanced stocks. Then we hope to do a better job of managing both. I believe that we are well down the track in this process with regional comprehensive plans and basic and annual hatchery management plans. I hope we can sustain this level of interest and attention.

WORLD MARKET CONDITIONS AND THE EX VESSEL PRICES OF ALASKA SALMON

Richard S. Johnston
Department of Agricultural and Resource Economics
Oregon State University
Corvallis, Oregon

INTRODUCTION

In this paper I wish to make a point which, while seemingly obvious, is often overlooked. In the salmon market, as in many other markets, it often appears both to buyer and seller that prices depend primarily on local conditions. It is important to recognize that while local conditions are important, such conditions are themselves dependent on market conditions elsewhere. In Alaska you face circumstances this year which undoubtedly are alarming to many participants in the salmon industry. Concern had already been expressed over the likely effects of anticipated increases in salmon run on ex vessel prices, well before the current botulism crisis. With the recall and embargo of canned salmon products in various export markets, no one in Alaska needs to be told how important international conditions are to the Alaska fishery and, hence, to the Alaska economy.

But this is not a recent phenomenon. Alaska has always been a net exporter of seafoods. When these exports enter foreign markets directly, the dependence is obvious. But even where the major market is the rest of the United States, market conditions abroad are crucial to Alaska conditions because of the interdependence between the U.S. economy and economies in the rest of the world. I hope to present to you some results of recent and ongoing analyses which will generate discussion of just how interdependent worldwide economies are.

INTERNATIONAL TRADE IN SALMON PRODUCTS

Table 1 depicts the exports of fresh and frozen salmon from the United States to various important foreign markets. As this table reveals, since 1965 there have been substantial increases in the sales abroad of fresh or frozen salmon. It also reveals significant fluctuations in sales to particular markets over the period.

In 1981, the National Marine Fisheries Service began for the first time to collect data on Pacific salmon exports by species and product form. Table 2 reveals the destination of these various products. While 1981 was a peculiar year in many respects, it is nonetheless instructive to note the high percentage of sockeyes in fresh chilled and frozen salmon exports. In that year, Japan was the major consuming market. Japan was also a big importer of other salmon species in this form, with the exception of pinks. For the latter species, Canada and the European Economic Community (EEC) countries were the major importers of the United States' product. The EEC was also an important purchaser of fresh chilled and frozen chinook, chum, and coho salmon during 1981 as well as fillets, steaks, and portions. With respect to the canned product, note that once again the EEC countries, most notably the United Kingdom, were important purchasers of United States' Pacific salmon.

Table 1. U.S. exports of fresh/frozen salmon

	Country of Destination														
	Japan			France			Sweden			United Kingdom			Total		
Year	Q	V	V/Q	Q	V	V/Q	Q	V	V/Q	Q	V	V/Q	Q	V	V/Q
1965	1,205,995	587	0.49	2,612,184	1,449	0.5546	757,050	430	5.68	2,078,974	1,206	0.58	10,558,902	5,330	0.505
1966	2,243,218	920	0.41	4,781,710	2,978	0.6228	1,485,251	888	0.60	4,669,448	3,175	0.68	19,845,429	10,626	0.535
1967	2,016,465	885	0.44	5,216,491	3,724	0.7139	1,473,898	889	0.60	4,213,804	3,161	0.75	18,910,706	11,846	0.626
1968	2,638,634	1,130	0.43	4,031,061	3,095	0.7677	1,641,472	931	0.57	3,963,196	2,893	0.73	16,233,747	10,076	0.621
1969	12,851,989	7,345	0.57	4,269,721	3,552	0.8318	2,151,506	1,387	0.64	3,633,404	2,870	0.79	30,552,825	19,060	0.624
1970	6,977,932	3,826	0.55	5,605,484	4,946	0.8823	2,737,951	1,869	0.68	3,836,819	3,338	0.87	28,200,620	18,145	0.643
1971	8,629,265	4,961	0.58	6,954,777	5,064	0.7282	3,080,852	2,057	0.67	4,429,220	3,543	0.80	32,891,301	21,258	0.646
1972	3,167,729	1,728	0.55	10,608,369	10,064	0.9487	5,728,670	4,703	0.82	5,665,505	5,666	1.00	34,684,977	28,451	0.820
1973	25,061,343	26,776	1.07	9,476,680	9,880	1.0341	3,732,563	4,067	1.09	6,002,456	7,683	1.28	60,742,430	59,641	0.982
1974	3,824,058	4,885	1.28	7,288,729	10,043	1.3779	3,889,169	4,690	1.21	3,224,714	4,063	1.26	28,066,709	34,924	1.244
1975	9,225,148	14,085	1.53	15,242,934	22,328	1.4648	4,788,105	6,572	1.37	5,460,389	7,207	1.32	48,229,186	66,863	1.386
1976	4,679,375	8,535	1.82	15,054,550	29,352	1,9497	3,653,953	6,334	1.73	5,050,256	8.686	1.72	41,921,495	75,645	1.804
1977	30,602,924	60,593	1.98	14,050,083	30,375	2.1619	3,746,459	6,068	1.62	3,439,972	5,367	1.56	69,844,105	125,396	1.795
1978	87,679,657	197,008	2.25	12,029,811	30,829	2.56	4,103,400	6,331	1.54	5,950,209	10,082	1.69	122,179,945	268,582	2.198
1979	93,457,824	191,803	2.05	17,122,876	48,448	2.83	5,972,244	9,421	1.58	6,497,020	13,941	2.15	140,159,766	302,324	2.157
1980	67,332,208	105,576	1.57	13,931,150	30,533	2.19	4,912,698	7,793	1.59	5,740,498	9,898	1.72	122,112,160	198,397	1.625

Source: U.S. Bureau of the Census. U.S. Exports - Schedule B, Commodity and Country, Report RT 410. Monthly, various issues.

Q = pounds
V = thousand $

Table 2. Disposition of U.S. Pacific salmon exports, by species and product form, 1981

	% of Pounds Exported					
	Canada	EEC	Other Europe	Japan	Other	Total (lbs)
Fresh, Chilled, or Frozen						
Chinook	5	28.3	1.2	64.6	1	8,698,251
Chum	7.5	30.6	5.5	55.2	1.2	25,440,482
Pink	57.2	21.9	8.4	9.3	3.2	24,581,636
Sockeye	3.9	1.9	*	89.7	4.4	103,504,711
Other (including Coho)	9.8	42.8	1.2	42	4.2	38,332,353
Fillets, Steaks, Portions: Fresh or Frozen	15.6	52.6	8.1	12.4	11.3	3,572,732
Canned						
Chum	24.9	46.2	*	12.6	16.3	3,362,800
Pink	17.8	59.3	0.4	0.2	22.2	27,231,039
Sockeye	15.1	70.3	*	2.3	12.3	26,174,913
Other	25.1	49.4	0.3	2.3	22.8	6,724,616

Source: National Marine Fisheries Service computer printouts.

*Less than 0.1%

The point I wish to make with Table 2 is that at least for one calendar year there are significant differences among regions in the form and species of salmon purchased. While this table is instructive, it is also potentially misleading. One may be tempted to look at the data and conclude that there are separate markets for each of the salmon species and product forms. In one respect, this may be accurate. But I submit that, because of the substantial interdependencies among these various products in both supply and demand, factors influencing the price of one species undoubtedly have an impact on prices of the others.

Before addressing this issue, however, consider Table 3. While its data pertains only to frozen salmon exported from Canada, it does permit a re-cap of the point made earlier: market conditions vary over time and species, and across geographic regions. Consider the United Kingdom and Sweden. Both countries are relatively important importers of Canadian frozen chum salmon. But, at least over the 1974-80 period, they have played a relatively minor role as frozen coho buyers. Even this situation has changed since 1978, when the United Kingdom's coho imports started to increase.

Tables 4 and 5 provide data on Japanese and EEC salmon imports, respectively. On the import and export sides of the salmon market, it is clear that circumstances change over time and across markets.

What is happening here? Once again, I would hypothesize that these are not random events. They are the results of responses to market signals such as prices of substitute species, changes in foreign exchange rates, and so on.

SALMON AND MARKET FORM

Salmon is marketed in many forms: fresh, frozen, smoked, and canned, to name a few. What factors affect the allocation among market forms across species? Table 6 provides data comparing the percentages of United States non-canned salmon marketed between 1948 and 1980.[1]

While there have been variations over time, it is clear that for all species these percentages are considerably higher than their levels 30 years ago. A number of hypotheses have been advanced by industry sources to explain this trend:

---

[1] These estimates were made by assuming that the amount of salmon required to produce a 48 lb (standard) case of canned salmon depends on the species of fish being canned, as follows: chinook, 68 lbs; coho and chum, 72 lbs; sockeye, 70 lbs; and pink, 78 lbs. A difficulty with using such averages is that they may not reflect the true conversions in any one year. Another difficulty is the assumption that salmon canned in any given calendar year are harvested that same year. Furthermore, it is assumed that only United States-caught salmon are canned, whereas substantial volumes enter the United States from abroad, especially Canada, and may be canned. Similarly, some of the United States harvest may be exported for canning abroad.

Table 3. Canadian exports of frozen salmon

Frozen Salmon	Country of Destination	1974		1975		1976		1977		1978		1979		1980	
		Q	V	Q	V	Q	V	Q	V	Q	V	Q	V	Q	V
Coho	Belgium-Luxembourg	230	668	238	713	161	658	448	2,227	283	1,770	369	2,998	443	2,635
	France	2,357	6,949	3,131	10,159	2,409	10,077	3,211	15,165	3,283	20,199	3,231	27,017	3,333	21,547
	Germany	102	324	177	655	162	750					75	580	95	691
	Netherlands	61	177	146	527	100	452	120	530	107	760	130	1,032	211	1,377
	U.S.	477	1,259	274	747	241	818	246	898	92	493	191	1,319	157	830
	U.K.							92	370	181	1,078	120	852	330	2,298
	Italy							163	768	101	599	212	1,736	51	368
	Japan							785	3,119	1,935	11,117	185	1,152	874	4,833
	Other	460	1,403	497	1,538	565	2,294					120	854	182	1,263
	Total	3,687	10,780	4,463	14,339	3,638	15,049	5,250	23,894	6,141	36,971	4,633	37,540	5,676	35,842
Chum	U.K.	771	1,870	394	1,087	526	1,896	331	1,300	534	2,604	582	3,175	289	1,694
	Denmark	749	1,716	518	1,399	557	2,011	738	2,782	1,071	5,317	880	4,758	938	5,421
	France	270	623	205	599	151	540	206	770	472	2,372	514	3,139	222	1,237
	Germany	484	1,055	274	772	585	2,017	592	2,196	625	3,066	606	3,367	710	4,120
	Sweden	1,709	3,917	1,127	3,146	1,197	4,250	732	2,715	1,284	6,031	1,250	6,451	1,074	6,308
	Switzerland							165	657	240	1,255	159	1,001	278	1,716
	Japan							334	985	918	4,588	454	1,904	61	286
	U.S.	1,877	3,914	439	1,155	633	2,082	355	1,222	341	1,431	372	1,686	165	780
	Other	655	1,477	287	733	274	997					560	3,044	305	1,965
	Total	6,515	14,572	3,244	8,891	3,923	13,793	3,645	13,415	5,721	27,852	5,377	28,525	4,042	23,527
Spring	France	847	3,062	1,647	6,099	1,145	6,027	1,120	7,728	1,246	9,327	1,592	13,172	1,377	12,012
	Germany	168	541	323	1,163	274	1,532	198	1,342	298	2,033	228	2,123	292	2,385
	Italy	207	724	230	884	354	1,943	247	1,722	227	1,881	401	3,356	358	2,973
	Sweden	58	159	200	532	132	465					109	507	228	1,049
	U.S.	1,402	4,295	1,821	5,659	1,388	6,135	1,079	5,395	1,040	6,143	951	5,529	1,298	8,911
	U.K.							7	29	129	733	116	662	78	532
	Netherlands							48	292	85	525	210	1,448	173	1,386
	Japan							502	1,933	561	3,464	134	661	136	958
	Other	325	1,395	561	2,044	540	2,663					233	1,765	267	2,202
	Total	3,007	10,176	4,782	16,381	3,833	18,765	3,429	19,857	3,823	25,472	3,974	29,223	4,207	32,408
Salmon, n.e.s.	France	76	182	547	1,512	73	264	419	1,731	210	906	452	2,533	340	1,476
	Sweden	134	283	230	585	182	532	742	2,175	241	781	1,115	4,267	854	3,321
	Japan	142	400	350	1,064	169	597	1,504	6,090	5,963	38,820	3,721	23,066	1,112	6,067
	Denmark							290	788	135	428	337	1,290	95	416
	U.S.							260	886	450	787	379	1,760	191	743
	Other	639	1,613	502	1,524	561	1,860					1,009	5,295	822	4,234
	Total	991	2,478	1,629	4,685	985	3,253	3,516	12,833	7,266	42,727	7,013	38,211	3,414	16,257

Source: Annual Statistical Review of Canadian Fisheries, Volumes 10 and 11.
Statistics Canada, Domestic Exports By Commodities and Countries, 1979 and 1980.

Q = metric tons

V = thousand dollars, Canadian

Table 4. Japanese imports of salmon (fresh and frozen)

Country of Origin	1976 Q	1976 V	1977 Q	1977 V	1978 Q	1978 V	1979 Q	1979 V	1980 Q	1980 V
Republic of Korea	30,356	11.44	12,387	13.20	6,947	20.08	25,380	142.202	11,577	54.95
North Korea	536,228	462.75	661,890	1,012.73	1,807,760	3,070.48	1,382,085	3,046.788	1,673,891	2,385.00
Taiwan			30,508	95.60	5,194	4.52				
Iceland					27,960	52.11				
Norway	1,354	6.08	560	1.38	1,186	6.40	8,335	31.742	1,735	23.28
Sweden					11,702	47.47				
France					181	1.01				
Spain					2,300	1.80				
Canada	321,769	1,331.85	3,705,891	16,981.45	7,052,744	44,500.84	4,726,911	27,264.380	2,641,538	14,792.11
USA	2,378,979	8,942.18	14,883,496	70,757.40	40,860,648	221,026.72	48,103,159	234,829.755	33,024,771	135,449.53
Trinidad					997	1.69				
Canary	1,980	0.75			2,360	1.36				
West Germany			27	0.89						
China	5,000	6.41	37,719	57.55						
United Kingdom			34	0.55						
Brazil			1,021	1.30						
USSR	404,910	499.05					439,174	1,055.781	1,990,644	4,204.50
Morocco									1,260	1.33
Panama	3,410	1.27								
Finland							50	1.378		
Mexico							12,811	109.827		
Totals	3,683,986	11,261.79	19,333,533	88,922.05	49,779,979	268,734.48	54,697,905	266,481.853	39,345,416	156,910.69

Source: Imports of Japan, Commodity by Country, various issues.

Q = kilograms
V = thousand $ US

Table 5. EEC: imports of frozen salmon

Country of Origin	1976		1977		1978		1979		1980	
	thsd. kg	thsd. ECU	thsd. kg	thsd. ECU	thsd. kg	thsd. ECU	thsd. kg	thsd. ECU	thsd. kg	thsd. ECU
France	346	1,362	200	848	267	1,167	346	1,905	118	528
Belgium-Luxembourg	-	-	75	660	132	1,036	97	665	108	729
Netherlands	87	376	104	480	134	565	65	348	93	358
Germany	-	-	84	223	87	309	70	258	95	309
Italy	-	-	-	-	-	-	-	-	-	1
U.K.	63	310	162	913	164	753	88	539	103	549
Ireland	646	4,035	666	3,593	536	3,066	378	3,510	311	2,410
Denmark	475	2,727	446	2,844	726	3,657	714	4,682	805	5,394
Iceland	23	147	-	-	47	268	17	138	2	25
Faroe Islands	57	250	45	270	34	172	22	125	452	3,046
Norway	1,075	7,929	1,022	7,623	1,309	7,718	1,358	10,784	1,185	11,109
Sweden	166	754	182	974	172	878	209	1,174	288	1,538
Finland	-	-	-	-	-	-	-	-	15	68
Switzerland	-	-	-	-	-	-	-	-	1	3
Soviet Union	-	-	-	-	-	-	-	-	3	9
USA	12,723	51,020	10,400	42,729	11,765	48,228	14,992	68,545	14,075	56,522
Canada	8,177	35,449	9,193	39,247	9,618	40,211	11,287	52,614	11,473	52,363
Greenland	1,067	3,638	1,320	4,899	939	3,537	1,288	5,913	1,060	5,232
St. Pierre-Miquelon	-	-	-	-	-	-	-	-	1	13
Venezuela	-	-	-	-	-	-	-	-	23	89
Japan	1,147	3,474	495	1,591	236	774	312	1,173	921	3,124
Total	26,179	111,796	24,422	107,041	26,268	112,549	31,271	152,503	31,132	143,419

Source: EEC Trade Offices, Brussels.

Table 6. Estimated percentages of total salmon landings not marketed as canned product

	1948 (%)	1980 (%)
Chinook	50	96
Coho	37	87
Chum	3	62
Sockeye	2	37
Pink	10	34

- Demand has increased for fresh, smoked, and frozen salmon, especially in European and Japanese markets. This may be associated with rising real incomes, exchange rates which favor importing United States goods, increasing populations, and, until recently, declines in the availability of Atlantic salmon.

- Because of unfavorable economic conditions in some areas which have traditionally been major importers of canned salmon (such as the United Kingdom), there has been a switch away from the higher priced canned salmon products (including sockeye) to the less expensive species (chum and pink).

- Active competition from products such as canned tuna has dampened the domestic demand for canned salmon.

- The costs of canning salmon, including labor and materials, have risen dramatically over the past few years.

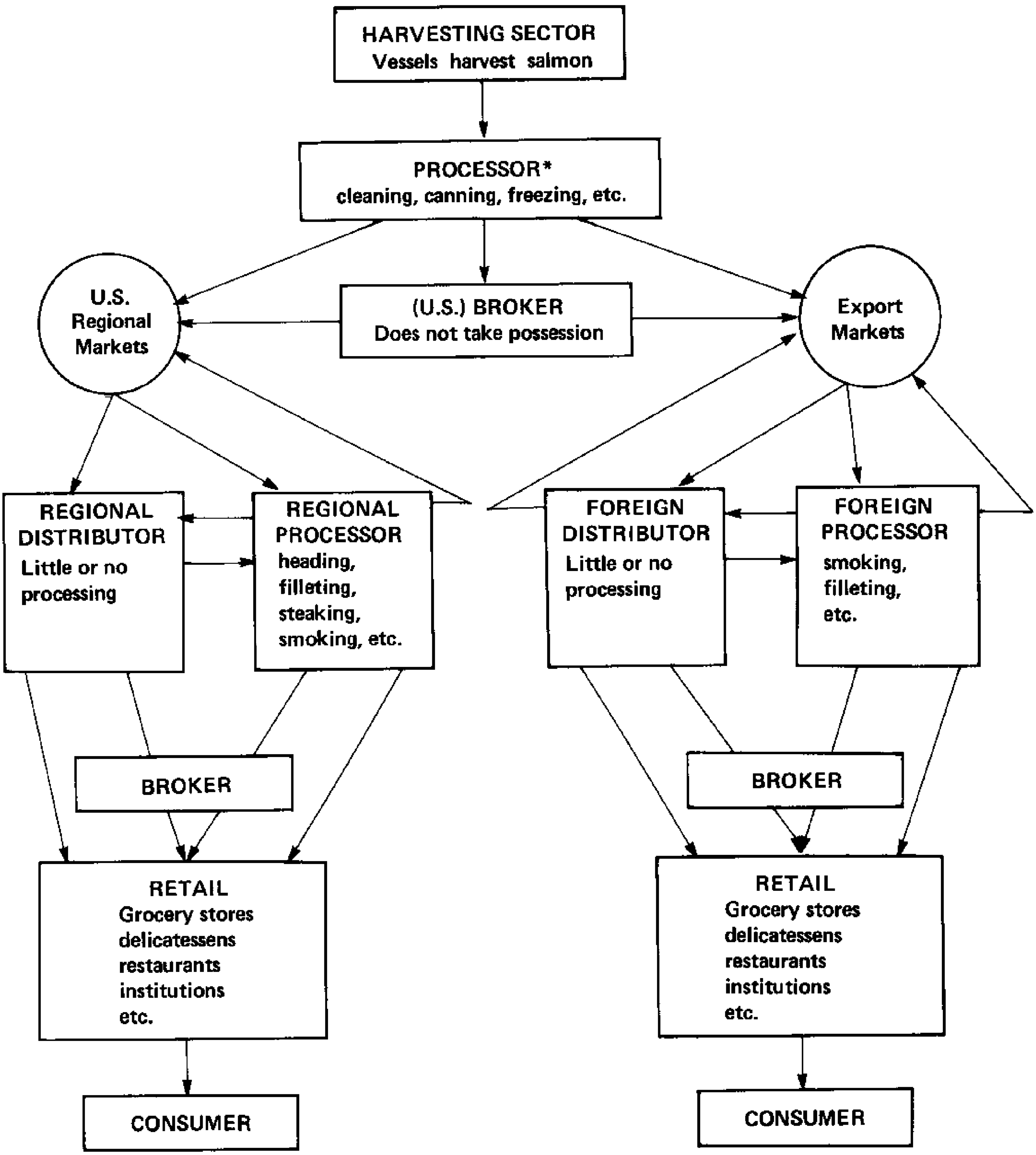
- Technological advances enable less expensive and more convenient storage and transport of frozen seafood products.

It is instructive to compare the events of 1979 with those of 1980. U.S. landings of pink and sockeye salmon in those years were considerably higher than in previous years. The 1980 chum run was also relatively high. Between 1979 and 1980, the percentage of salmon entering non-canned outlets declined for all species but pinks. For sockeye and coho there was a drop in absolute terms. This may have been a short-term response to market conditions peculiar to those years, or it may be an indication of coming events. Perhaps, if salmon enhancement programs around the world lead to increased availability of salmon (both Pacific and Atlantic), the trend away from canned salmon (in relative terms) will reverse. What factors affect these markets abroad? This is the topic of the next section.

PRICES AND PRICE MOVEMENTS

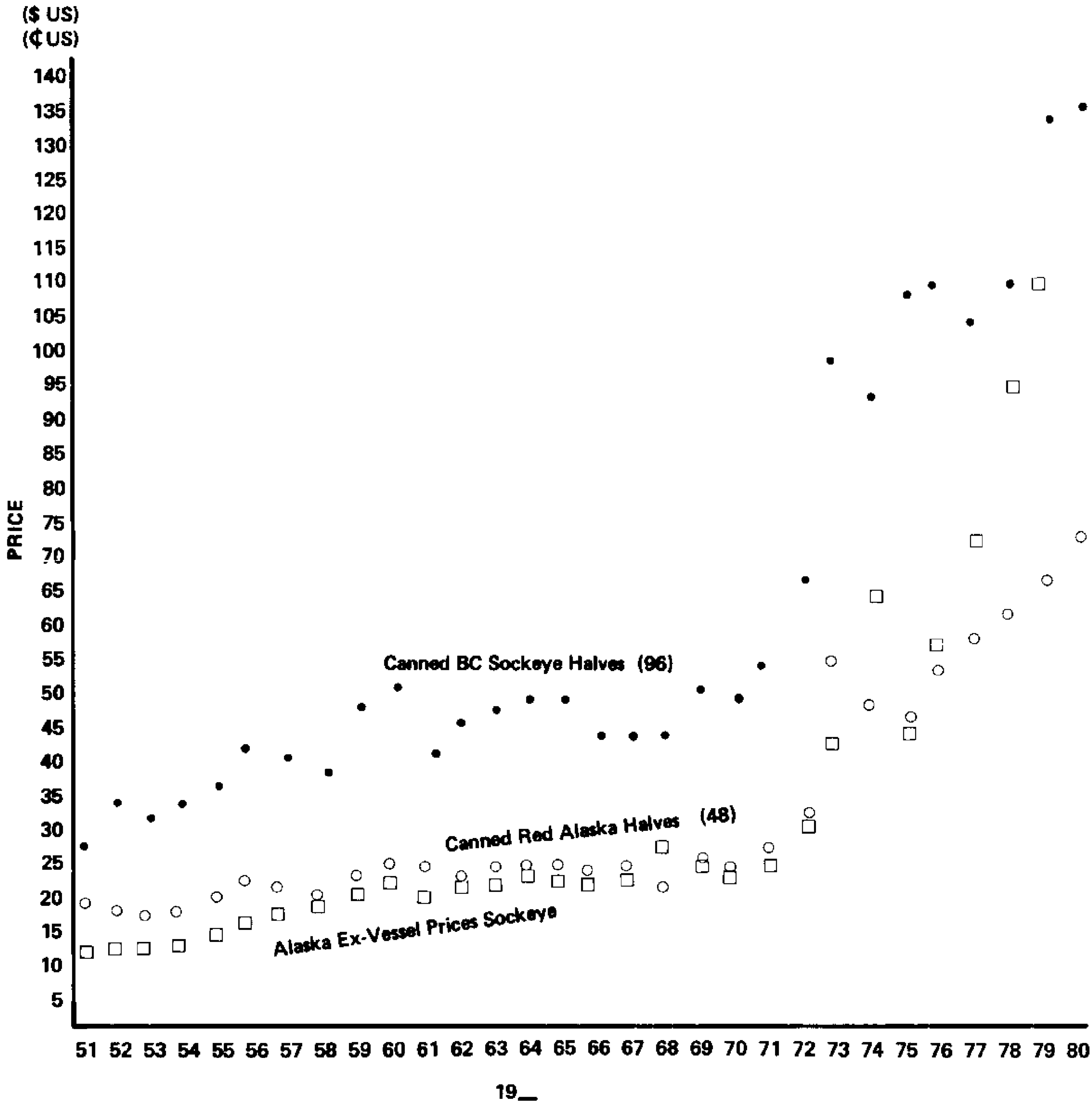
So far I have argued that, despite substantial differences over time among species, regions, and geographical areas, interdependencies result in prices tending to move in similar patterns. This is also true among prices at different levels of the marketing channels, despite the rather complex nature of these channels. Figure 1 is a simplified version of these channels. Figure 2 depicts three different price series of sockeye salmon for 1950 to 1980: ex vessel, all Alaska; Alaska wholesale (canned); and Canadian export (canned). Over the period these prices have all moved together. The relationship is not exact but does suggest that factors affecting one price affect others as well. Let's consider some of these factors.

Several studies of the canned salmon markets suggest that, at least at the wholesale level, and for particular species, purchasers are relatively sensitive to price changes. That is, as the wholesale price of canned sockeye salmon increases, buyers tend to cut back their purchases appreciably. This appears to be the case in both the United States and Canada, and may be because of the availability of substitutes, such as other salmon species or tuna. Interestingly, the demand for canned salmon in Italy was found to be influenced primarily by its own price and the price of Danish salmon.



*There is also an undetermined volume of salmon traded between processors.

Figure 1. Marketing channels of Pacific Northwest salmon.



Sources: Seafood Business Report, Spring 1982
NMFS, Fishery Statistics of the U.S., various issues

Figure 2. Ex vessel (¢/lb) and canned ($/case of 48 halves) prices of Alaska sockeye salmon; canned ($ U.S./case of 96 halves, FOB Vancouver), prices of B.C. exports of sockeye salmon.

The United Kingdom has long been an important market for Pacific salmon, particularly canned. While Japanese canned salmon once dominated the United Kingdom market, the United States and Canada now account for a growing share. Sockeye is the preferred species in the United Kingdom canned salmon market, due to its color and oil content. However, as sockeye prices rose in the late 70s, consumers in the United Kingdom substituted lower-priced canned pink and chum salmon. Thus, the current embargo is especially painful to both American suppliers and British consumers. In any event, there is evidence to suggest that, for a given species of canned salmon, consumers will substitute other salmon species, or even other protein sources in response to price increases.

For frozen salmon, the situation is a little different. Little work has been done to estimate demand relationships in this country. However, in Germany and Sweden, consumers appear to be relatively insensitive to price changes for frozen chum salmon. Similar results have been uncovered in other countries, along with the finding that consumption tends to increase with increases in real per capita income.

This suggests that if the availability of salmon increases, sellers will have an incentive to sell increasing shares in the canned markets. If the above findings are correct, this is because prices will decline less precipitiously in the canned salmon market than in the frozen salmon market. This is one of several hypotheses we are currently exploring in some detail in a model of international salmon markets.

The market for salmon is affected by many factors, including the roles of substitute goods, real incomes, and population levels, both here and abroad. The exchange rate is also a crucial variable to be considered (See Table 7). A strong Japanese yen in the late 70s undoubtedly had an impact on Japan's demand for Pacific salmon. In fact, in some periods export prices in United States dollars rose, while the price in yen fell. A weak dollar also appeared to make EEC imports of Pacific salmon less expensive in the late 70s. Recent increases in the value of the United States dollar against the Japanese yen and EEC currencies will undoubtedly affect these markets as Pacific salmon import prices in local currencies rise. Tariff and non-tariff barriers (See Tables 8 and 9), as well as transportation costs, in general play important roles in the international flow of seafoods.

SOME RECENT ANALYSES

A recent exploratory study, using data for the period 1868 to 1977, indicates that, for the Columbia River and Puget Sound, there appears to be no relationship between the size of the canned salmon pack there and its wholesale price. This is not the case for Alaska, however. Indeed, it should come as a surprise to no one here that increased landings tend to depress the price of canned Alaskan salmon. Price decreases do not necessarily mean lower revenues, however. Indeed, with a highly price-elastic demand for salmon, increased supplies would be expected to increase total industry revenues (The impact on net revenues would depend on how costs change). This statement says nothing about the distribution of these revenues, however. If a given fisherman, region, or country does not share in the increased landings, or experiences only a slight increase, revenues to this fisherman, region, or country could decline while revenues elsewhere in the industry are rising.

Table 7. Exchange rates[1]

Date	French Franc	Japanese Yen	U.K. Pound	Swedish Kr.
1960	4.903	359.6	2.803	5.180
1961	4.900	361.8	2.808	5.185
1962	4.900	359.6	2.802	5.188
1963	4.902	362.0	2.796	5.200
1964	4.900	358.3	2.789	5.148
1965	4.902	360.9	2.802	5.180
1966	4.952	362.5	2.789	5.180
1967	4.908	361.9	2.406	5.165
1968	4.948	357.7	2.384	5.180
1969	5.558	357.8	2.401	5.170
1970	5.520	357.6	2.394	5.163
1971	5.224	314.8	2.553	4.858
1972	5.125	302.0	2.348	4.743
1973	4.708	280.0	2.323	4.588
1974	4.445	301.0	2.349	4.081
1975	4.486	305.2	2.024	4.386
1976	4.970	292.8	1.702	4.127
1977	4.705	240.0	1.906	4.670
1978	4.180	194.6	2.035	4.296
1979	4.020	239.7	2.224	4.147
1980	4.516	203.0	2.385	4.373
January 1981	4.879	204.7	2.386	4.572
February 1981	5.006	208.8	2.205	4.641
March 1981	4.958	211.0	2.244	4.593
April 1981	5.254	215.0	2.140	4.763
May 1981	5.543	224.1	2.070	4.936
June 1981	5.718	225.8	1.943	5.085
July 1981	5.852	239.5	1.856	5.229

Source: International Monetary Fund Monthly Bulletin, various issues.

[1]Foreign currency per $ U.S., except U.K. pound, which is $/pound.

NOTE: Additional figures for fall of 1981-82 as follows:

November 1981	5.555	214.0	1.97	5.425
February 1982	6.080	237.0	1.857	5.791

Table 8. Japanese import tariffs on fresh and frozen salmon

Date	General	Advalorem Duty GATT	Preferential	Temporary[1/]
April 1, 1966	10			
April 1, 1969	10			8
December 31, 1969	10	8		7
March 31, 1970	10	8		7
December 31, 1970	10	7		
April 1, 1974	10	5		5
March 1979	10	5		5

Source: International Customs Journal, No. 28, various editions; International Customs Tariff Bureau, Brussels.

[1/] "For the purpose of assessment of duty, a 'GATT' rate shall be applied before a 'temporary' rate and a 'temporary' rate shall be applied before a 'general' rate. If, however, a 'GATT' rate is higher than the other rates, the rate applicable shall be the 'temporary' rate, or if no 'temporary' rate is specified, the 'general' rate. (International Customs Journal).

Table 9. EEC tariffs on fresh, chilled and frozen salmon[1]

Date	Advalorem Duty Autonomous	Advalorem Duty Conventional
1 January 1971	16	8.4
1 January 1972	16	8
1 January 1973	16	8
1 January 1974	16	8
24 November 1975	16	4
15 November 1976	16	4
14 November 1977	16	4
1 December 1978	16	4
31 December 1979	16	3.8
24 November 1980	16	3.5

Source: Official Journal of the European Communities, various issues, 1970-71.

1/ This tariff had been suspended until early 1981 for several years.

However, it has been suggested in this paper that Alaska landings are not the only factors affecting prices paid to Alaska fishermen. More than 50 percent of the variation in (real) ex vessel sockeye prices can be explained by variations in real per capita income levels in the United Kingdom, Japan, or the United States. Unfortunately, because these income levels are themselves interrelated, it is difficult to separate the effects of each. Nonetheless, it appears that ex vessel sockeye salmon prices and income levels move together in consuming countries.

One surprising result of the analysis to date is that while there is a relatively strong inverse relationship between ex vessel sockeye prices and sockeye landings, a rather weak relationship was uncovered between ex vessel sockeye prices and world landings of all salmon. The analysis suggests that when world landings of all salmon increase, sockeye prices to Alaska fishermen decline--but the relationship is a weak one, if it exists at all. If correct, this suggests that the various salmon enhancement programs around the world, to the extent that they are successful, may have little impact on Alaska fishermen, at least for the sockeye fishery. Clearly this result needs further examination.

In this preliminary investigation, an attempt was made to examine the relationship between exchange rates and ex vessel prices. The reasoning is as follows: if the U.S. dollar were to strengthen relative to, say, the British pound, this would, even with no change in the United Kingdom demand, effectively decrease the number of dollars United Kingdom importers are willing to pay for Alaska salmon products. This, in turn, should filter down to the fisherman in the form of lower prices. Indeed, statistical analysis suggests this is the case, although the evidence is weak.

Interestingly, the relationship to the Japanese yen is much stronger. This may be because Japan is both an importer of United States salmon and a competitor with the United States in other, notably European, markets. When a competitor's currency depreciates, the export demand, expressed in the competitor's currency, increases. Thus, the effective demand in the United States decreases, as does the ex vessel price. This phenomenon was further explored with the Canadian-United States exchange rate and the hypothesis held. When Canada, a competing sockeye salmon seller, experiences a decline in the value of its currency, this is associated with a lower price to United States fishermen.

CONCLUSIONS

Prices of competing goods tend to move in similar directions. Prices at different levels of the marketing channels tend, also, to move in similar directions. Because of the interdependencies among salmon markets, on both the demand and supply sides, factors affecting one price affect others.

In this paper, emphasis has been on sockeye prices and their influencing factors, including sockeye landings, landings of other species, conditions in world markets (represented here by real per capita income levels), and exchange rates. Other factors, not explored here, include tariffs, quotas, role of other protein sources, and non-tariff barriers. These are being examined in ongoing research at Oregon State University and elsewhere.

ACKNOWLEDGMENT

Department of Agricultural and Resource Economics, Oregon State University. Support for the research reported here was provided, in part, by the OSU Sea Grant College Program supported by NOAA, Office of Sea Grant, U.S. Department of Commerce, under Grant Number NA-81-AA-D-00086. The author wishes to acknowledge the assistance of Mr. Jim Earley, Mr. Biing-Hwan Lin and Ms. Rebecca Lent for data collection and analysis. The paper draws heavily on a presentation made last fall at a meeting of the Humboldt County, California, chapter of the American Fisheries Society.

REFERENCE

Lent, Rebecca J. and Richard S. Johnston. 1980. The marketing of Pacific northwest salmon. Unpublished manuscripts. Oregon State University. 15 pp.

BIBLIOGRAPHY

Abraham, Gideon. 1979. Canadian chum salmon export market study. Unpublished M.S. thesis. Corvallis: Oregon State University. 54 pp.

DeVoretz, D. 1980. An econometric demand model for Canadian salmon. Unpublished manuscript. Burnaby, British Columbia: Department of Economics, Simon Fraser University. 39 pp. and Appendix.

Johnston, Richard S. and W. Robert Wood. 1974. Demand analysis for canned red (sockeye) salmon at wholesale. Oregon State University Sea Grant College Program Publication Number ORESU-T-74-001. 36 pp.

Lent, Rebecca, Gerald Whittaker, and Richard Johnston. 1981. The economic response of increased salmon landings. In Proceedings of salmonid enhancement symposium, 1981. Arcata, California: In press.

Onuorah, Michael C. 1973. Foreign and domestic trade in canned salmon of the United States and Canada: the effect on the derived demand of the fisherman. Unpublished M.S. thesis. Corvallis: Oregon State University. 112 pp.

Oregon State University, Department of Agricultural and Resource Economics. 1978. Socio-Economics of the Idaho, Washington, Oregon and California coho and chinook salmon industry: Volume B. Final report to the Pacific Fishery Management Council. Corvallis, Oregon. 380 pp.

O'Rourke, Andrew Desmond. 1970. The California fresh and frozen fish trade. Unpublished Ph.D. dissertation. University of California, Davis. VIII and 167 pp.

Swartz, A. Nelson. 1979. The Pacific coho salmon fishery: An intraseasonal and interregional economic analysis of the ex vessel market. Unpublished Ph.D. dissertation. Corvallis: Oregon State University. 189 pp.

Wang, Der Hsiung. 1976. An econometric study of the Canadian sockeye salmon market. Unpublished Ph.D. dissertation. Corvallis: Oregon State University. 54 pp.

LIST OF REGISTRANTS

Brian J. Allee
Prince William Sound Aquaculture
Corporation
P.O. Box 1110
Cordova, AK 99574

Jerry Bellezza
UFDA
P.O. Box 294
Valdez, AK 99686

Bill Allender
Fisherman
P.O. Box 1136
Cordova, AK 99574

Dan P. Bilderback
Commercial Fisherman
P.O. Box 723
Cordova, AK 99574

G. R. (Bob) Andersen
Chugach Alaska Fisheries
P.O. Box 120
Cordova, AK 99574

Nancy Bird
The Cordova Times
P.O. Box 200
Cordova, AK 99574

Fred Arbogast
Chugach National Forest
P.O. Box 380
Cordova, AK 99574

Margaret C. Blake
Blake's Fancy Smoked Salmon
P.O. Box 94
Cordova, AK 99574

Bruce Bachen
Northern Southwest Regional
Aquaculture Association
P.O. Box 786
Sitka, AK 99835

Robert Blake
Cordova Aquatic Marketing
Association
P.O. Box 359
Cordova, AK 99574

John Ball
Marine Advisory Program
P.O. Box 521
Cordova, AK 99574

Garvan Bucaria
U.S. Forest Service
P.O. Box 1204
Cordova, AK 99574

Dave Barjo
Prince William Sound Aquaculture
Corporation
P.O. Box 1503
Cordova, AK 99574

Jane Buchhof
Alaska Native Foundation
411 W. 4th Avenue
Anchorage, AK 99501

Bob Calman
State of Alaska
Pouch AM
Juneau, AK 99801

Jerry Felton
Alaska Native Foundation
411 W. 4th Avenue
Anchorage, AK 99501

J. R. Philip Chung
Prince William Sound Community College
P.O. Box 590
Valdez, AK 99686

Ken Florey
Alaska Dept. of Fish and Game
333 Raspberry Road
Anchorage, AK 99502

Lauren R. Donaldson
Professor Emeritus of Fisheries
University of Washington
School of Fisheries
Seattle, WA 98195

Gale Foode
P.O. Box 1454
Cordova, AK 99574

Lisa Dundas
Fisherman's Daughter
P.O. Box 241
Cordova, AK 99574

Robert H. Ford
Northern Southeast Regional Aquaculture Association
Box 1181
Sitka, AK 99835

Dennis Eames
Northern Southeast Regional Aquaculture Association
Angoon, AK 99820

Janet A. Fries
Alaska Resource Consultants
P.O. Box 244
Anchorage, AK 99510

Tracy Estes
Fisherman
P.O. Box 242
Cordova, AK 99574

Dennis Haanpaa
Alaska Dept. of Fish and Game
333 Raspberry Road
Anchorage, AK 99502

Brad Evans
Fisherman
P.O. Box 1314
Cordova, AK 99574

William Heard
National Marine Fisheries Service
Auke Bay Laboratory
P.O. Box 155
Auke Bay, AK 99821

Christine Honkola
Prince William Sound Aquaculture Association/Cordova Aquatic Marketing Association
P.O. Box 174
Cordova, AK 99574

J. P. Hopkins
Commercial Fisherman
P.O. Box 343
Cordova, AK 99574

Dail Hurdlow
Prince William Sound Aquaculture Corporation
Port San Juan
Cordova, AK 99574

Jeff Jackman
Chugach School District
Box 638
Whittier, AK 99693

Jack P. Jacobsen
Southern Southeast Regional Aquaculture Association
P.O. Box 8794
Ketchikan, AK 99901

Richard S. Johnston
Department of Agricultural and Resource Economics
Oregon State University
Corvallis, OR 97331

Byron L. Jones
Cordova Aquatic Marketing Association
Cordova, AK 99574

Bob Kellar
UFDA
P.O. Box 36
Valdez, AK 99686

Curt Kerns
University of Alaska-Juneau
11120 Glacier Highway
Juneau, AK 99801

Armin Koernig
Prince William Sound Aquaculture Corporation
P.O. Box 191
Cordova, AK 99574

Donald M. Kramer
University of Alaska
Marine Advisory Program
2651 Providence Avenue
Anchorage, AK 99504

Sue Kramer
Fisherman (North Pacific)
P.O. Box 367
Cordova, AK 99574

Carly Kritchen
Cordova Aquatic Marketing Association
P.O. Box 1255
Cordova, AK 99574

Ken Kritchen
Cordova Aquatic Marketing Association
P.O. Box 1255
Cordova, AK 99574

Lynn Kritchen
Commercial Fisherman
P.O. Box 1173
Cordova, AK 99574

Walter Larrick
Southern Southeast Regional
Aquaculture Association
P.O. Box 6916
Ketchikan, AK 99901

Chester R. Mattson
Mossback - Retired
P.O. Box 314
Douglas, AK 99824

Paul McCollum
Valdez Fisheries Development
Association
P.O. Box 125
Valdez, AK 99686

Michael L. McCurdy
Alaska Dept. of Fish and Game
P.O. Box 669
Cordova, AK 99574

Jean McDaniel
Alaska Dept. of Fish and Game
FRED Division
P.O. Box 669
Cordova, AK 99574

Tim McDaniel
Alaska Dept. of Fish and Game
P.O. Box 669
Cordova, AK 99574

John McMullen
Alaska Dept. of Fish and Game
P.O. Box 3-2000
Juneau, AK 99802

William J. McNeil
General Manager
Oregon Aqua-Foods, Inc.
88700 Marcola Road
Springfield, OR 97477

Charles P. Meacham
Alaska Dept. of Fish and Game
333 Raspberry Road
Anchorage, AK 99502

Brenda R. Melteff
Alaska Sea Grant Program
University of Alaska
3 Bunnell, 303 Tanana
Fairbanks, AK 99701

Tom Namtvedt
Prince William Sound Aquaculture
Corporation
P.O. Box 2202
Cordova, AK 99574

Bob Palmer
Coordinator, Special Projects
Office of the Governor
Pouch AN
Juneau, AK 99811

Rene' F. Pellissier
Prince William Sound Aquaculture
Corporation
P.O. Box 1541
Cordova, AK 99574

Steve Pennoyer
Director
Alaska Dept. of Fish and Game
Division of Commercial Fisheries
P.O. Box 3-2000
Juneau, AK 99802

Gary Raymond
Prince William Sound Aquaculture
Corporation
P.O. Box 596
Cordova, AK 99574

Dan Romey
Metlakatla Indian Community
P.O. Box 416
Metlakatla, AK 99926

Pat Roppel
Southern Southeast Regional
Aquaculture Association
435 Washington
Ketchikan, AK 99901

Donald H. Rosenberg
University of Alaska
Alaska Sea Grant College Program
3 Bunnell, 303 Tanana
Fairbanks, AK 99701

Robert S. Roys
Aquaculture Consultant
306 7th Street
Juneau, AK 99801

Christine Sager
Commercial Fisherman
P.O. Box 723
Cordova, AK 99574

F. Keith Sandercock
Fisheries & Oceans, Canada
1090 West Pender Street
Vancouver, British Columbia
CANADA V6E 2P1

Debbie Seymour
Alaska Sea Grant Program
P.O. Box 1613
Cordova, AK 99574

Charles B. Simpler
Cordova Aquatic Marketing
Association
P.O. Box 159
Cordova, AK 99574

William W. Smoker
University of Alaska-Juneau
11120 Glacier Highway
Juneau, AK 99801

Joseph R. Sullivan
Alaska Dept. of Fish and Game
333 Raspberry Road
Anchorage, AK 99502

John F. Thomas
P.O. Box 284
Cordova, AK 99574

Ken Thompson
Chugach National Forest
2221 E. Northern Lights Blvd.
Anchorage, AK 99508

William F. Webber
Vice President
Prince William Sound Aquaculture
Corporation
P.O. Box 876
Cordova, AK 99574

Jason C. Wells
Valdez Fisheries Development
Association
P.O. Box 125
Valdez, AK 99686

Craig Wiese
University of Alaska
Marine Advisory Program
2651 Providence Avenue
Anchorage, AK 99508-4670

Kathleen Wiese
Cordova High School
P.O. Box 1153
Cordova, AK 99574

Harold H. Zenger, Sr.
NOPAD Company
P.O. Box 713
Juneau, AK 99802