University of Alaska

Alaska Sea Grant College Program

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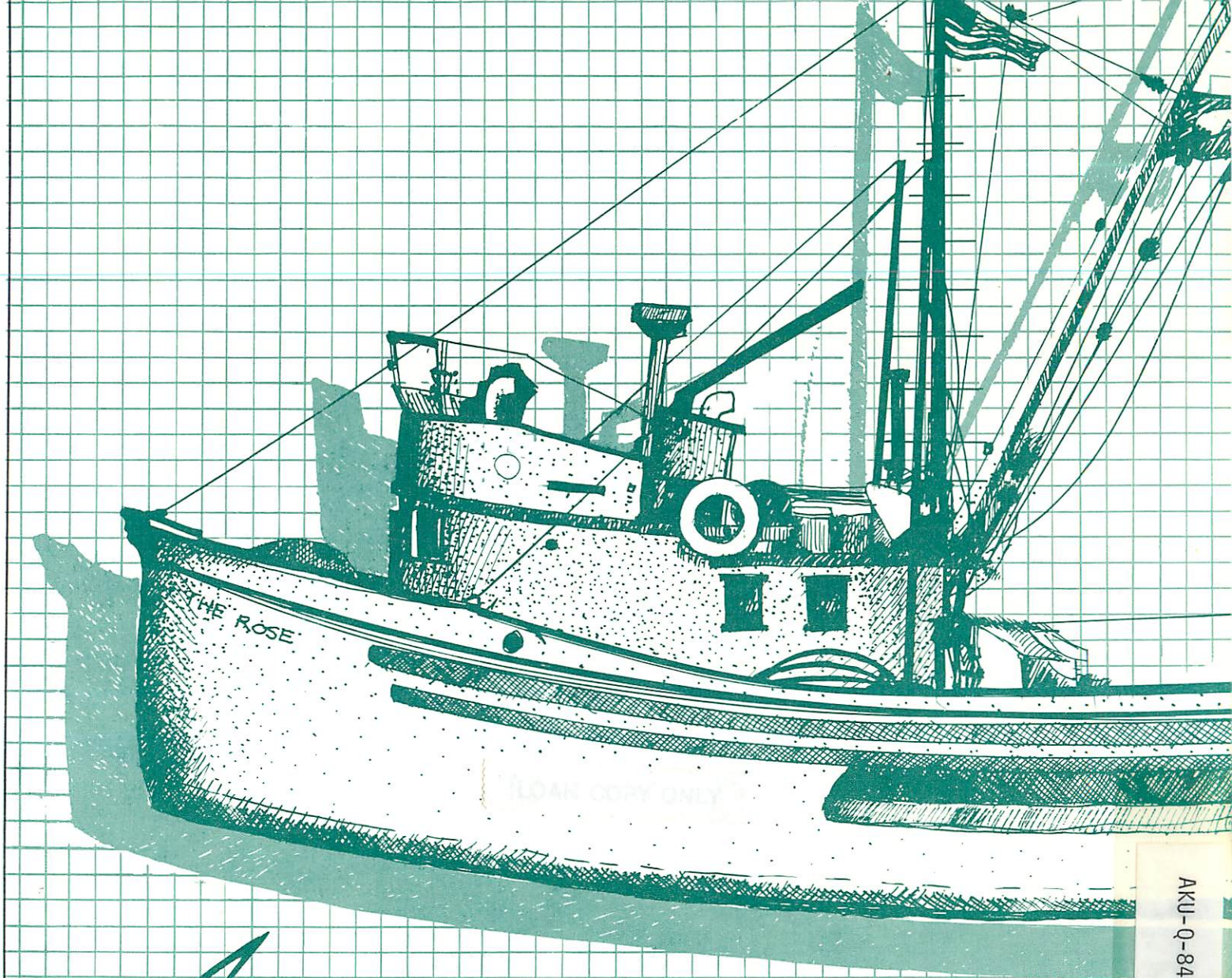
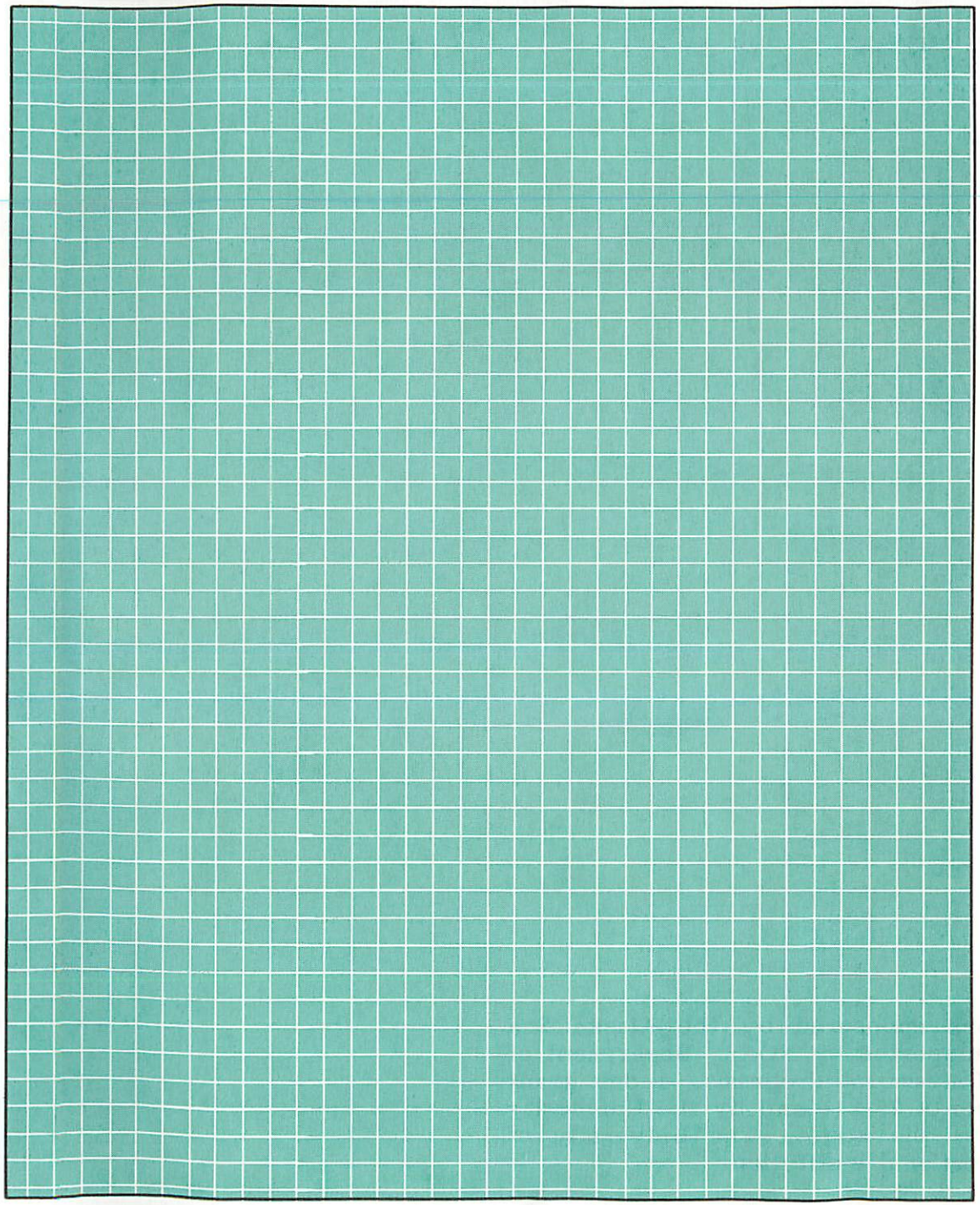


Annual Report

AK-SG-85-8
July, 1985



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Annual Report

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Alaska's economy is bound together by the state's natural resources. Currently, the oil and commercial fishing industries predominate both in terms of employment and of dollars generated. While government remains the largest employer, fishing is second and the state's largest private employer. The world's largest oil field, Prudhoe Bay, continues to make oil the top dollar-value industry, producing 1.6 million barrels per day. Fishing generates the second highest industrial income, around $600 million in 1983, representing the top-value catch among U.S. states.

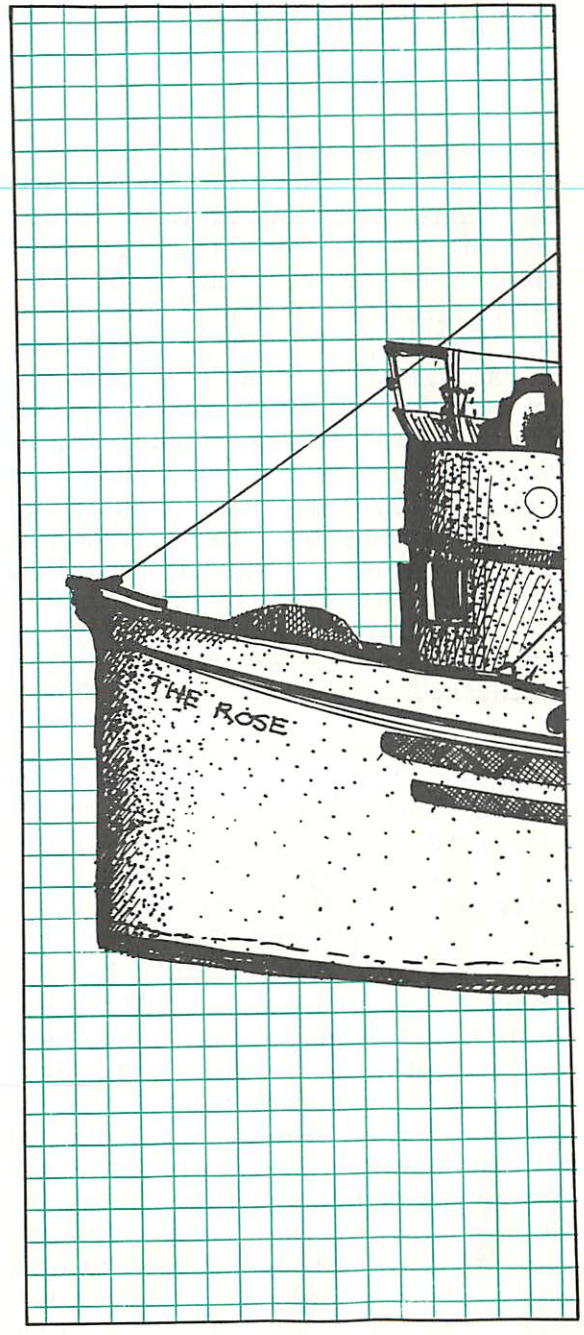
The fishing industry is growing both in size and sophistication. Once dependent on salmon, crab and shrimp, fishermen and processors are looking at lesser used species for possible development. Processors are diversifying, freezing various salmon cuts rather than canning all the catch. An altogether new product, surimi, is being produced in Kodiak from Alaskan pollock, and there are plans to build two more surimi plants in Alaska in the next few years.

Alaska Sea Grant's research, education and public service projects reflect these changes and the major management problems that will be tackled as Alaskans enter a multi-species industry.

West Coast chinook salmon fisheries will live or die by the Pacific salmon treaty recently negotiated between the United States and Canada. Sea Grant genetic tagging research may tell where Alaskan-caught chinooks originate, providing a key to allocation of this highly-valued and dangerously depressed species.

Alaska pollock are the most heavily exploited fishes in the immense groundfish complex found off Alaska. They are also the basis for surimi, a multi-use fish paste with primary markets in Japan. Alaska Sea Grant research is detailing the feeding energetics of these fish, information vital to good management for this potential "bread-and-butter" species.

Tanner and Dungeness crab in Alaska have come under increased fishing pressure since the decline of Alaskan king crab and West Coast Dungeness crab stocks. Research is investigating the tanner crab's molting frequency and a natural tag, both of which would result in better management and decreased mortality. Dungeness crab fisheries in central California were devastated by parasitic infestation by a nemertean worm. Sea Grant research is examining nemertean incidence in Alaskan Dungeness crab as well as some of that species' other



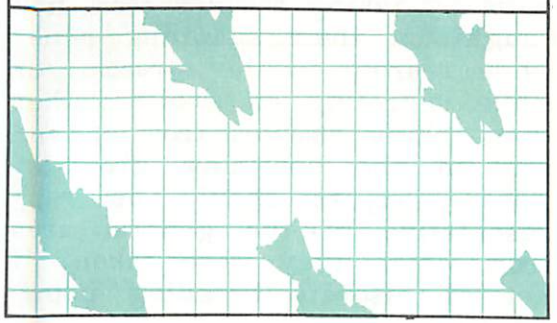
biological traits, information which will add greatly to better management of this species.

Sea Grant advisory and information services have fulfilled both immediate and longer-term information needs of the growing fishing industry. Marine Advisory Program staff have been active in training fishermen to take advantage of the sablefish fishery opened in the Gulf of Alaska, in training processing workers in a labor intensive but cost effective hand filleting method for pollock, in developing new fish packaging for Southeast Alaska rockfish marketed air fresh, and in continued efforts to make safety a top concern of everyone in the industry.

With the Fishery Conservation and Management Act up for reauthorization and management agencies attempting to control the burgeoning halibut fishery as well as the international fishing effort off Alaska, Sea Grant helped sponsor a major conference, Fisheries Management: Issues and Options. This meeting brought together fishermen, processors, top management figures, and well-known fisheries experts to discuss the successes and failures in U.S. fishery management and possible solutions to current problems. Sea Grant also organized meetings to discuss the state's port and harbor system and its development, and to determine research needs for managing the Dungeness crab fisheries in Alaska.

Alaska Sea Grant continues to provide an important bridge between the state's vital marine industries and the technical expertise available through universities for solving marine resource problems.

Aquaculture and Salmon Genetics



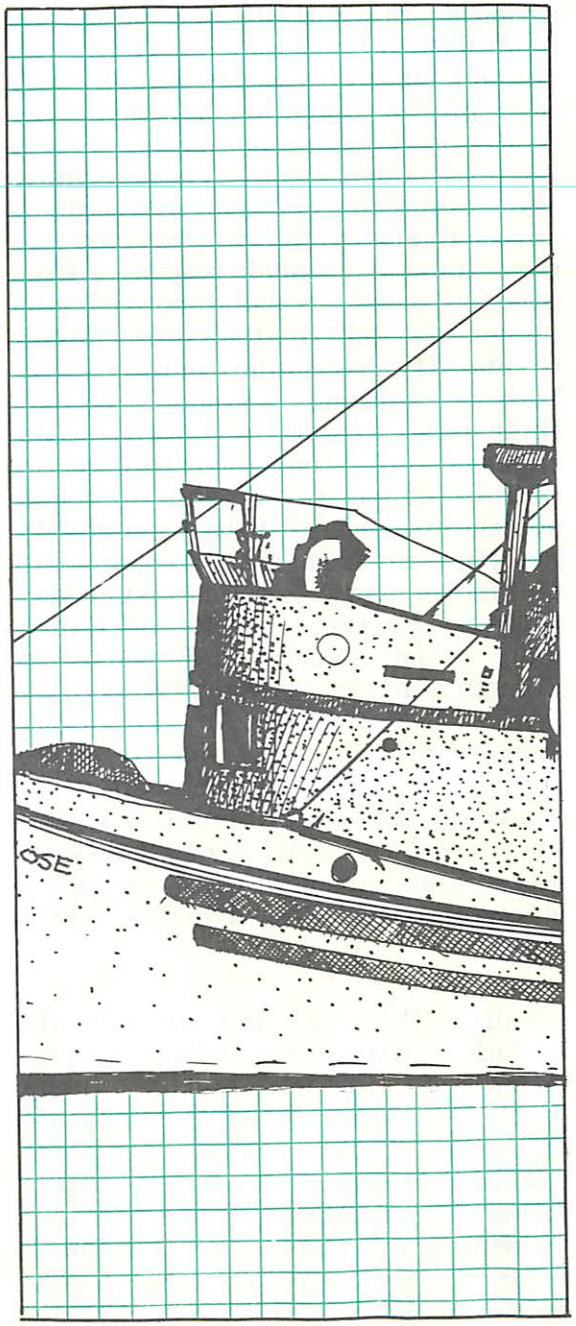
Alaska made a commitment to fisheries enhancement in 1971 by establishing a separate unit of the Department of Fish and Game to oversee such activities. In 1974, the state created the private non-profit hatcheries, and beginning in 1975, launched a major enhancement effort.

By 1981, the capacity of state hatcheries had grown from zero to 650 million eggs. Prince William Sound hatchery at Port San Juan has a return approaching 2.5 million adults, one of the largest returns ever to a hatchery in the western world. Crooked Creek king salmon increased from 38 fish to approximately 5,000 kings annually returning through the hatchery wire.

Alaska Sea Grant has funded four major salmon genetics projects, beginning in 1977. These variously attempted to detect the effects of transplanted fish and hatchery fish on wild stocks, to learn more about the heritability of important genetic characteristics such as those that govern homing, to use genetic information for stock separation, and to breed salmon for desirable flesh and survival traits. Two projects funded in this period examine specific questions: genetic separation to identify chinook stocks and the potential for using breeding methods to improve salmon strains in hatcheries.

Project **R/06-17 Genetic Study of Some Alaskan Chinook Populations and the Potential for Use of This Information on Stock Separation Problems** was funded in response to a crisis in west coast chinook stocks. The question of ownership and allocation of these highly valued sport and commercial fish became increasingly important as stocks declined and the fish's value increased.

Chinooks are the most far-ranging Pacific salmon in their migration seaward, meaning that effective management can be accomplished only through international agreements. Chinooks caught in the Alaskan fishery, at the far reaches of the migration, may actually be fish from natal



streams in British Columbia or Washington. The question of chinook origin is a pivotal one for most of the allocation schemes.

Alaska Sea Grant researchers chose starch gel electrophoresis as a likely way to provide information on chinook origin. This process uses several biochemically detectable genetic traits or "tags" to identify particular populations. Like all salmon, chinooks return their natal stream to spawn. The success of the electrophoretic method depends on each of these population groups being genetically different from the others. The technique has been used successfully to separate stocks of Canadian chum salmon and those of Columbia River chinooks.

Sea Grant's project was to characterize the genetic composition of Alaskan chinook populations and determine whether enough diversity exists among them to make electrophoretic identification possible.

Ideally, this baseline data would include many spawning populations. Unfortunately, very little is known about Alaska's chinooks. They spawn in remote, turbid streams. Accurate population estimations are rare. Spawning grounds have not been located for many of the larger systems such as the Yukon River.

King salmon like this one will be covered by the new U.S.-Canada Pacific salmon treaty. Photo by John P. Doyle.

"The success of the electrophoretic method depends on each of these population groups being genetically different from the other."

The major problem facing researchers was obtaining good quality chinook tissue samples from major Alaskan spawning stocks. Some samples were provided by state and federal agencies. Some compromise was made by taking samples from fish caught on their spawning runs, while rearing in the streams, or while migrating as smolts rather than taking samples from spawners on the spawning grounds. These samples should be representative of the general area from which they were taken, if not of discrete breeding populations.

Forty collections of young chinook or tissue samples from adults were taken from or near 14 Alaskan river systems. (See Figure 1.) Adult samples included heart, eye, liver and skeletal muscle tissue.

The cells of each tissue sample were broken down to release soluble enzymes.

All chinook samples were analyzed electrophoretically. Approximately 40 loci representing 16 enzyme activities routinely stained, but only 29 were considered reliable. Data for some loci were not collected in some samples because of low enzyme activity in fry or loss of activity during storing and shipping. Collections from

each drainage were examined for heterogeneity. Data for collections within a drainage were pooled if the collections were homogenous.

Heterogeneity was displayed in three of the drainages: the Yukon, Taku and Stikine. In the Yukon system, the Tanana tributaries are homogeneous, but generally different from the gill net fishery collections taken near the mouth. Heterogeneity also appeared among the collections from the mouth of the river, probably reflecting the movement of many different populations. In both the Taku and the Stikine rivers, there appears to be a difference between upper river and lower river samples. The pooled data was analyzed several ways to quantify the divergence among collections and infer relationships between them. This divergence gives an idea of the extent to which biochemical data can be used for stock identification.

Direct plotting of allelic frequencies revealed that southeastern Alaskan pooled collections can be separated from western Alaska pooled collections. (Collections from the Chilkat and Tanana drainages were the exception, possibly because they are both distant from the other points of collection in their region.)

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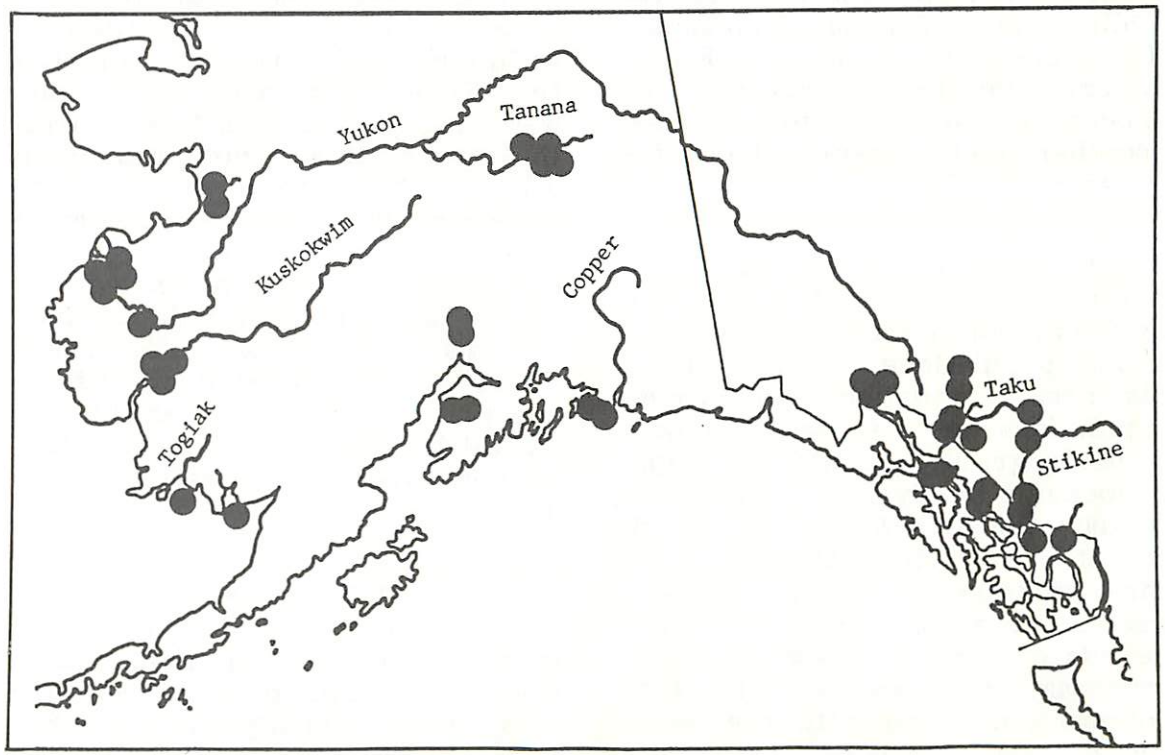

Figure 1. Sites where chinook were sampled for tissue specimens used in Project R/06-17.

Alaskan collections are also distinct from collections made on the Fraser River, Washington coast and Deschutes River.

In principal component analysis, data from several loci is used to graphically portray variability among populations. This is limited to the number of loci for which all samples have been measured. Again, southeastern collections clustered together as did the western Alaskan collections (except those from the Chilkat and Tanana drainages). The collections from the Fraser River, Deschutes River, and Washington state clustered closer together and separate from the Alaskan samples.

Genetic distances are used to measure the extent of divergence in biochemical genetic compositions among populations. From genetic distances, relationships among populations can be visualized with a dendrogram. As with principal components analysis, there must be data for each loci used in each collection. Using this method, three distinct groups were noted: western Alaskan collections that lie close together; some of the southeastern Alaskan collections (others clustering with the western or southern collections); and the most southerly collections with which Chilkat samples clustered.

Researchers have concluded that there are differences in the genetic composition of most Alaskan chinook and chinook from British Columbia, Washington and Oregon. There are also differences between western and southeastern Alaskan chinooks. The Alaskan fish display lower biochemical genetic variability than other populations that have been studied.

While collections made within a drainage are generally similar, genetic distances indicate discrete, identifiable populations within river drainages. Although the Tanana drainage collections were significantly different from the others, it was not possible to sample other Yukon River populations so the extent of population divergence is not known. Upstream and downstream collections within the Taku and Stikine River systems also show differences. These may be related to differences in the rearing habitat and should be taken into consideration during brood stock selection for hatcheries.

Once hatcheries have started to produce more fish, the next step is to produce better fish. More than 50 million pink salmon are harvested annually in Alaska, with hatcheries increasing the naturally occurring number with good success. Genetic variation among pink salmon stocks is the key to breeding hatchery fish with desirable characteristics.

Genetic trait heritabilities predict response to selection. Genetic correlations measure the degree of association among traits. Using estimates of these factors, managers could select against undesirable fish and alter the genetic composition of a population. Selection can be made by regulating when the harvest is made and the gear used. High fertility, large phenotypic variation and short generation time of pink salmon indicate potential for rapid gains using artificial selection. However, any selection program must be based on a thorough knowledge of the population's genetic variation and the effect of the artificial selection on correlated traits.

Project **R/02-11 Potential for Genetically Improving Salmon** documents genetic variation in Alaskan pink salmon. In the process, the scientists are developing an efficient way to collect and analyze useful genetic data.

The experiment is designed to estimate the covariances of several traits of pink salmon in groups of related individuals: siblings, half-siblings, or parents and offspring. Traits analyzed include a range of biologically and

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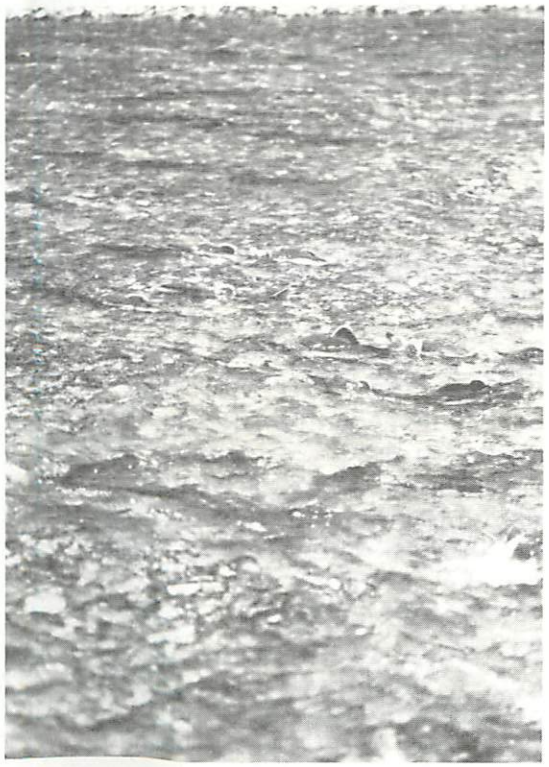


Returning pink salmon stretch from stream bank to stream bank. Photo by UAJ.

economically important traits. Test fish were from temporally separated populations in Auke Creek. These populations are reproductively distinct with peak runs separated by approximately 30 days in August and September. Other studies have found no gene frequency differences between the runs and no evidence of straying between the runs (over two generations). These other studies concluded that although the two populations are temporally separate, there is enough migration to eliminate genetic differences at the genetic loci observed in one study and that the separation is strong enough that no gene flow has been observed between the stocks.

In each experiment 60 females and 30 males were chosen at random and used in a hierarchical mating design which paired each male with two females. Both spawners and tagged returning adults were studied intensively in order to characterize the populations phenotypically and genotypically.

Electrophoretic analysis of protein isozymes in samples of eye, liver, heart, and white muscle provided characterization of the brood year (BY) 84 parents and returning offspring of the BY82 experiment at 30 different gene loci. These data are on file and will be analyzed along with quantitative data in a search for correlations.

Biochemical characters of Auke Creek pink salmon measured in BY82 spawners vary considerably. Moisture content of muscle varied from 70 to 90 percent, moisture content of liver from 76 to 81 percent. Protein in both liver and white muscle varied from 450 to 600 mg/g dry weight of tissues. Protein content did not vary between sexes. Glycogen content varied abnormally. Males had more glycogen in their livers than females, indicating that females are using liver glycogen as an energy source and/or as a carbon source for egg production. Glycogen content in both sexes declined over the spawning season.

Analyses of the offspring of these fish, collected in 1984, are not yet available. Preliminary data show that males differed from females in muscle glycogen, but the amounts are three times that of the parents. Rather than a decrease in muscle glycogen during spawning, the offspring show an increase. It is not clear how starving salmon can increase muscle glycogen.

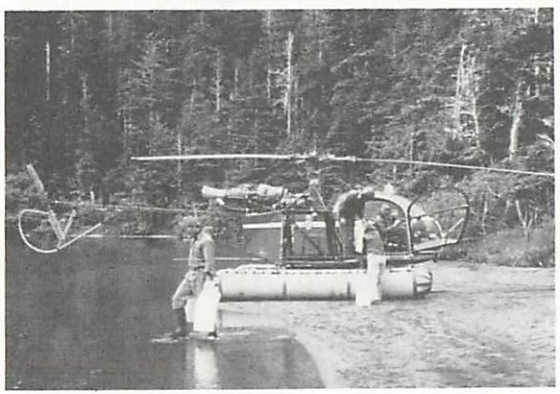
Emergent fry from each sibling group were tagged with 1/2 mm coded-wire tags. Of the 141 BY84 sibling groups, 139 families

survived to be tagged. No remarkable mortality was noted from the tagging process, but about 10 percent of the early run tagged fish were lost to a plumbing/water-quality accident before release. Short term tag retention was more than 95 percent.

Embryonic development of an organism depends on the action of many gene loci. It is a quantitative rather than a qualitative genetic trait. The annual unimodal distribution of outmigrating fry at Auke Creek suggests a difference in embryonic development rate between the early and late runs which compensates for the difference of run timing.

Using populations that are spatially and temporally separated, it is possible to describe the relative contributions of environmental and genetic variability to total phenotype variability. Observations made on Auke Creek pink salmon cannot be applied universally, but will predict the response to selection for this trait and may reflect the selective history of the population.

A master's thesis experiment associated with the project is measuring the amount of variation in embryonic development rate within and between the two runs of pink salmon in Auke Creek. The breeding experiment design was hierarchical and used 20 females and 10 males from each run of BY83. An attempt was made to perform a cross between the early and late runs, but prolonged gamete storage was not successful.



Coho salmon fry are released into Rostislaf lake. Photo by R.A. Crone, NSRAA.

"If the results continue to show that only 20 percent of the stocked coho succumb to predation in the initial four months of life, barriered lakes probably can be used to rear coho from fry to smolts."

Development rate was measured first by calculating temperature units from fertilization to 50 percent hatch. Eggs were sampled from each cross during development and have been preserved. This information on variability between populations and between parents within populations will permit tests of hypotheses about how genetic factors affect development rates.

Preliminary data from this hatching experiment suggest a significant difference in development rate between runs. On average, the late run eggs hatched after accumulating 536 temperature units, and early run eggs hatched after accumulating 608 temperature units. In spite of this functional difference between development rate of embryos at hatching, there is apparently no difference between the runs at earlier stages of development. There is no evidence of significant genetic variability of development rate in either late or early run Auke Creek pink salmon.

The genotypes of each parent

have been observed at 30 loci. In these observations, there are no correlations between individual heterozygosity and developmental variance in offspring.

A second master's thesis project is looking at the use of energy reserves in developing pink salmon embryos up to the hatching stage. These embryos have three potential sources of energy: proteins, carbohydrates, and lipids. Preliminary results show that the pink salmon embryo consists of 18 percent lipid (dry weight basis). However, the major component of the eggs' dry weight is protein. The amount of carbohydrate in developing pink salmon is small. There appear to be significant reserves of free amino acids in the developing eggs.

Respiration increases from fertilization until hatching. The respiratory quotient for developing eggs is lower than would be predicted under the assumption that complete oxidation of fats is the main means of energy production. It is possible that fats or other molecules are only partially oxidized by the developing salmon.

In Project **R/02-10 Potential for Using a Barriered Southeastern Alaska Lake Containing Rainbow Trout for Producing Coho Salmon Smolts**, Rostislaf Lake's native trout and introduced coho smolt populations are studied to see if the smolts can be successfully raised in the lake and how the introduced coho affect the resident rainbow trout.

Various lake conditions were documented before the coho were introduced and salmon broodstock was taken from a nearby stream for stocking the lake. In this, the project's second year, limnology sampling continued and selected physical and chemical measurements were made. Lake water was collected to determine nutrient concentrations. Densities of the lake's various zooplankton populations were also estimated from monthly surveys. Primary productivity studies were cancelled because of recent government restrictions on the radioactive isotope technique used. Seasonal variation in phytoplankton is also being estimated. Quantities and types of invertebrates present will be estimated from benthic samples taken during the ice-free period.

In June 1984, 186,000 coho salmon fry were planted in Lower Rostislaf Lake. The juvenile fry averaged 46 mm in fork length and weighed about 1 g each. They were transplanted in two similar lots from the hatchery to the lake by float plane. Mortality during transportation was negligible and the young salmon entered the lake in good condition.

Funnel traps baited with salmon eggs were used to collect coho for size, food habits and intralake distribution data. The fish grew rapidly for the first two months, with fastest growth during the first 6 weeks then slowing from late August through October as water temperature and the abundance of preferred foods declined. The final size measurements were taken in October, with fish averaging 99 mm in fork length and 9.6 g wet weight. Size sample data indicated that 95 percent of the surviving coho will be large enough to emigrate as age I smolt in spring 1985.

Samples were taken at various depths, distances from shores and habitats during the summer work. Juveniles remained close to shore for the first six weeks, and were first observed feeding at the surface offshore at the end of July when mean size was estimated at 74 mm and 4 g.

Seven samples of 13 to 20 coho each were taken between June and October. Stomach content examinations indicated that the most important food item was Diaptomus through August 21, with few appearing after that. Zooplankters remain abundant in

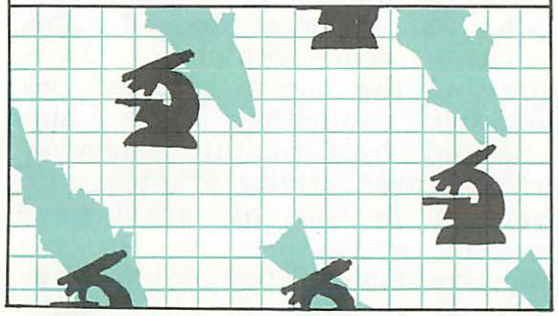
nearly all fishes in all samples. Preliminary results of studies using tagged coho indicate that approximately 80 percent of the fish survived the first summer and fall of lake life with approximately 150,000 in the lake by mid-October. If the results continue to show that only 20 percent of stocked coho succumb to predation in the initial four months of life, barriered lakes probably can be used to rear coho from fry to smolts. A migrant trap set on the lake outlet stream will be used to determine emigration of age I smolts in spring 1985.

Such a trap was not used in spring 1984, so the actual number of emigrants was not determined. Funnel traps fished in pools of the outlet stream in August 1984 caught only a few coho, indicating that little emigration had occurred.

Fifty trout were collected between June and August. Nine had coho in their stomachs. The rest had only invertebrates or empty stomachs. The only other coho predators observed were the mew gull, the kingfisher, the common merganser, and the common loon. No birds were taken for gut analysis.

All trout captured in 1984 were examined for fin clips applied in 1983 as a way to estimate that population. Only one definite marked fish was found. Based on that assumption, the population is estimated at 1,950. Other evidence also suggests that the trout population of Lower Rostislaf Lake is small.

Commercial Fisheries Biology



The world's largest red salmon run; two commercially important crab species; pollock, Alaska's fish of the future; and Prince William Sound's valuable herring stocks are the subjects of current Alaska Sea Grant biological research.

Hundreds of boats from the west coast pack into Bristol Bay every year to cash in on the world's largest red salmon run. Determining what triggers migration of returning salmon would be a big help to managers and fishermen waiting for the season to begin.

Project **R/07-10 Factors Affecting Migration Timing of Bristol Bay Sockeye Salmon** attempts to document changes in oceanographic factors that trigger salmon migration toward the major Bristol Bay rivers toward their spawning grounds. Air temperatures may hold the key to predicting peak return dates and this study indicates that return timing can be predicted from readings at particular weather stations.

Work continued analyzing return timing, expanding to include four rivers in northwestern Bristol Bay in addition to the four already studied in the southeastern bay (See Figure 2). Work relating sea surface temperatures and the peak return dates of those rivers, and determining any relationship between Bering Sea Sea surface temperatures and the air temperature also continued. Scientists began to suspect that the photoperiod may also be a significant factor. In years with more cloudy days, the aggregation of prey organisms and maturation of the fish could be slowed. To test this hypothesis, data on cloudiness was gathered and analyzed. Zooplankton samples were collected in the Gulf of Alaska and Bering Sea, then

processed, weighed, sorted, and numbered.

The interrelationships of peak return dates among the eight rivers of Bristol Bay were analyzed based on time series data available for the years 1963 to 1981. Generally, the correlation coefficient is very high for geographically adjacent rivers, and low as the distance between rivers increases. Each pair of two rivers showed a high correlation within the southeastern rivers and within the northwestern rivers, except for a pair between Igushik River and Togiak River. Kvichak, Naknek, and Egegik rivers revealed a high correlation with Wood River, a distant river in the northwestern area. Togiak correlated only with its neighboring rivers, Nuyakuk and Wood.

Correlation analysis therefore suggests that the rivers be placed in one of three groups by affinity rather than by geography: Kvichak, Naknek and Egegik; Igushik, Nuyakuk and Wood; and Ugashik, which did not correlate with any rivers in the northwestern area. Togiak River also does not correlate with any others. These results suggest that the extent of distribution and the migratory route of maturing sockeye in the ocean will differ among these groups. The

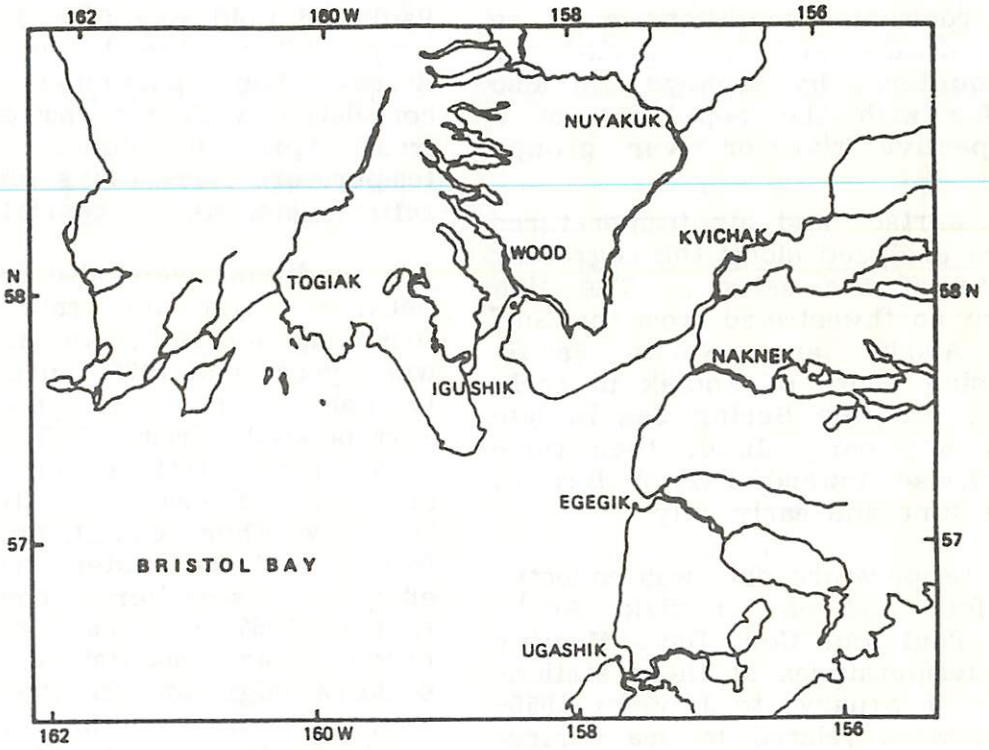


Figure 2. Location of eight major rivers in the Bristol Bay area.

"Correlation analysis therefore suggests that the rivers be placed in one of three groups by affinity rather than by geography: Kvichak, Naknek and Egegik; Igushik, Nuyakuk and Wood; and Ugashik, which did not correlate with any rivers in the northwestern area."

environmental conditions such as temperature and food availability encountered by sockeye will also differ with the population of a respective river or river group.

Sea surface and air temperatures were analyzed along the migratory route of the salmon. The fish move northwestward from the Gulf of Alaska and North Pacific passing south of Kodiak in early May, into the Bering Sea in late May and early June, then move clockwise toward Bristol Bay in late June and early July.

Air temperature data was collected at four stations: Kodiak, Adak, St. Paul and Cold Bay. Monthly air temperatures at these stations from February to July for 1955-1963 were related to sea surface temperatures of the Bering Sea and the peak return dates.

Bering Sea basin temperatures correlated highly with the air temperatures at all stations but Adak. The shelf temperatures showed high correlations with Kodiak in May and July, with St. Paul from February to June, and with Cold Bay from March to June. No temperatures correlated with the Adak air temperature of any month.

Only Togiak River's peak return dates failed to correlated highly with the air temperature in St. Paul and Cold Bay from March to June. The Egegik and Wood Rivers had particularly high correlation with air temperatures from April to June. Kodiak temperature correlations with peak return dates were inconsistent.

Sea conditions were also compared between warm and cold years, focussing on 1967, an unusually warm year; and 1971, an unusually cold year. Data used was extrapolated from T/S Oshoro Maru cruise statistics on vertical structure of sea water temperature, weather conditions, wind force, and sea water transparency. Researchers concluded that in 1967 very calm sea conditions were maintained during sockeye migration in the Bering Sea. The fine weather and calm wind resulted in a stratified water column, warm temperatures in the upper water layer and high transparency. In 1971, windy conditions caused mixing in the upper water column, cold temperatures and low transparency.

Scientists have also hypothesized that in cold years, rough weather and cloudy conditions reduce the penetration of sunlight into the deeper water layers. Under these conditions, with accompanying vague photoperiods, prey organisms will not be strongly aggregated in particular layers of depth in the water column. Feeding conditions will be less efficient for salmon and maturation is therefore delayed as is the return migration.

To test this hypothesis, project leaders began to examine the relationships among cloudiness, sea surface temperatures, and depth distribution of salmon and zooplankton. Cloudiness data for May through July of 1982-1984 were obtained from NOAA satellites. Daily cloudiness was then estimated for 5x5 degree latitude and longitude blocks. The data is still under analysis.

Zooplankton biomass data used was collected from samples taken with a Norpac net. This net does not primarily sample for the larger zooplankton that make up salmon diets, so this data may not provide the appropriate parameters to represent actual prey abundance for salmon.

Samples were also made using larger mesh-sized nets. These samples were taken one hour after sunset in the Bering Sea and Gulf of Alaska in June and July of 1980-1983. Species composition, wet and dry weights were determined for each sample. Samples were not taken in the same places each year, but annual variation in mean biomass was apparent.

While salmon remain the staple of Alaska's commercial fisheries, more fishermen are considering a lesser-valued but year-round fishery in pollock.

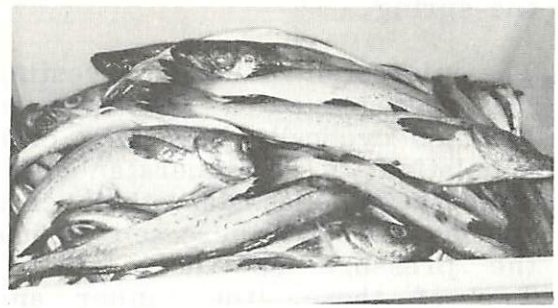
Pollock has been the target of large foreign fishing operations in the Alaska region and the total catch in those waters exceeds one million mt annually.

Management decisions about optimum and allowable yields are based on information about population dynamics. To work population dynamics models however, much needs to be known about the relationships between food ingestion, fish weight and ambient temperature. Very little information was available on the bioenergetic requirements of pollock so a variety of values for food intake, food elimination and caloric requirements for other species of gadids from the North Atlantic were used for simulations.

Project R/06-19 **Alaska Pollock Feeding Functions** attempts to fill this information gap. In particular, food intake and its effect on growth, conversion efficiency and condition factor have been studied using immature pollock held in captivity.

The problem of obtaining live, healthy, adult pollock was solved by culturing a supply of adults from juveniles caught in pots during 1983. Experiments on adult fish will use these 18 specimens, limiting the number of test individuals will limit the amount of information obtained. Experiments were delayed by an unusually warm fall and winter in Seward. Data analysis has also been delayed although investigators have conferred with National Marine Fisheries Service personnel about results to date and expected results, as well as on NMFS stomach fullness and food transit data. The captive population of adult pollock is quite uniform in size. Feeding experiments at 7°C indicate that the average adult has a maximum food intake of about 12,000 calories per day resulting in a maximum growth of 0.6 percent body weight per day. Maintenance ration is estimated at 5,000 calories for this temperature. Starvation results in a loss of 0.4 percent body weight per day.

"Interest in pollock harvesting has accompanied a downturn in Alaska's cyclically lush king crab population."



Pollock ready for filleting.

At 5°C, adult pollock have a maximum food intake of about 7,000 calories per day, with a maximum growth of 0.4 percent body weight per day. Maintenance ration at 5°C is about 3,000 calories per day and starvation results in a daily 0.3 percent body weight loss.

Observations made at 3° and 7.5°C (the approximate range of

temperatures pollock encounter in the Bering Sea), maximum food consumption and maximum growth are linear, negative functions of pollock weight and inverse, linear functions of pollock length. Maximum consumption in calories per day was a power function of pollock weight.

In 30 to 60 g pollock growth was a linear function of food consumed. Maximum growth at 3° and 7.5°C was 0.93 percent and 2.12 percent of body weight per day, respectively. Maintenance ration at this size was 225 calories per day at 3°C and 382 calories at 7.5°C.

Change in condition factor was a direct, linear function of food intake, allowing calculation of the ration required to maintain constant condition factor. Those required rations are three to four times higher than maintenance rations, suggesting that juveniles, unlike adults, preferentially grow in length at low levels of food consumption. During starvation, pollock lose weight at a constant rate and therefore condition factor declines linearly with the length of starvation. Death from starvation occurs in juveniles at a condition factor of about 0.44.

Between 3° and 7.5° C, both maximum food intake and growth were linearly related to temperature. Maximum conversion efficiency was an inverse, linear function of temperature, suggesting that at low levels of food availability, growth is more rapid at colder temperatures, perhaps relating to juvenile movement into colder Bering Sea water during the spring.

The interest in pollock harvesting has accompanied a downturn in Alaska's cyclically lush king crab population. Understandably, interest in Alaska's other crab species has also increased as has the pressure on these stocks. Two of these, the tanner and Dungeness crabs, are the subject of Sea Grant work in Alaska.

Project **R/06-18 Molting Frequency of Tanner Crab** has two objectives: to determine molting frequency and test a new way to estimate it.

A major problem of tanner crab management is the inability to predict molting frequency. The carapace is totally replaced during a molt, precluding ageable structures. Molting frequencies are estimated to determine the rate at which sublegal-sized crab are recruited to the fishery. Carapace grading is one method used, although it is somewhat subjective.

Two barnacle species of the northeast Gulf of Alaska are often found attached to tanner crab carapaces. These species are common to the region and are easily identified. In both species, larva are released from early spring through fall. Thus, for more than 50 percent of the year, barnacle larvae can settle on newly molted crabs. Aging the barnacles found on crabs delivered to processors could be an easy and inexpensive way to estimate molting periods. A portion of the work in this project was to describe size at age relationships for these two barnacle species.

During these studies both species were found to have five-year life spans and similar growth rates. Depending on the geographic site of collection, between zero and 90 percent of the crabs had barnacles on their carapace.

Earlier work had suggested an intermolt period of approximately 18 months for tanner crab of harvestable size. The prevalence of newly settled barnacles and barnacles that had settled the previous year on commercially harvested tanner crab suggests that most of those examined had molted within a period similar to that expected. However, in some areas around Kodiak Island and Sand Point, between 9 and 32

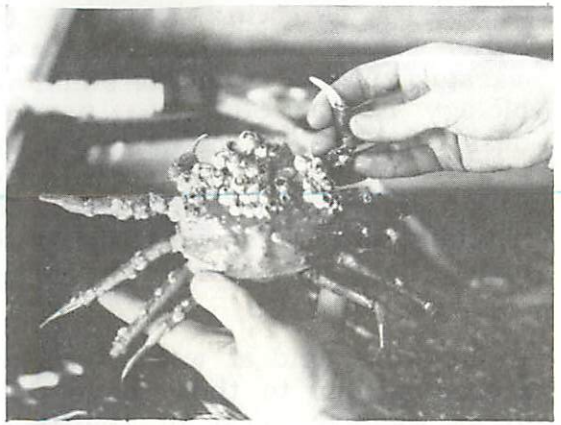


Photo by Tricia Olsen.

"Aging the barnacles found on crabs delivered to processors could be an easy and inexpensive way to estimate molting periods."

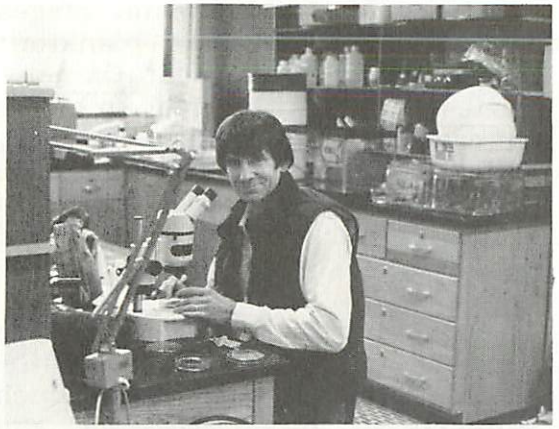
percent of the crab carried barnacles at least 27 months old. The results of this study suggest that for some areas of the Gulf of Alaska, barnacle age can aid in estimating the intermolt period for tanner crabs.

The Dungeness crab, Cancer magister, has traditionally been fished commercially off California, Oregon, Washington and British Columbia. In recent years, these stocks have declined. From 1980 to 1983, however, the number of vessels in the Alaska fishery increased by 347 percent, and the catch by 263 percent. This tremendous increase, coupled with the lack of concrete biological knowledge about Dungeness in Alaskan waters, has led many to question the way this species has been managed in Alaska. This study, Project **R/06-20 Alaska Dungeness Crab Biology and Parasitology** investigates the life history, and diseases and parasites of the Dungeness. Scientists seek to determine the year-class structure and sex ratios of a representative population; to determine molting and mating periods; to measure recapture rates, handling stress, and mortality of soft-shell and sub-legal-sized crabs; to derive fecundity-crab size relationships and percentages of ovigerous females in selected populations; to measure temporal variation in density and developmental stages of Dungeness larvae in plankton; to assess the density of Carcinomertes errans and other epibionts on crabs and their egg clutches, and to conduct gross anatomical and histological examination of crabs for parasites and pathological conditions.

The major area of investigation is adjacent to Icy Strait in southeastern Alaska, an area which supports an active commercial and subsistence fishery. Additional samples for comparison came from bays adjacent to Lynn Canal, on Chichagof Island, and from sites adjacent to the road system of the Juneau Borough.

Crab were collected with otter trawls or caught in pots baited with fresh or frozen herring. The captured crab were weighed, measured, and described, then returned to the lab for detailed examination. Hydrological data were measured at the surface and bottom at all sample stations.

During April of 1984, only a few adult crabs were collected on sampling trips, indicating that the animals were still restricted to deeper waters. In May, 1984 segregation of sexes by depth was evident, with males found primarily in shallow water. The greatest percentage of males were in 45 ft and shallower depths.



Tom Shirley investigates Dungeness crab parasitology in University of Alaska, Juneau fisheries lab under Project R/60-20. Photo by Amy Richards.

"From 1980 to 1983 . . .the number of vessels in the Alaska (Dungeness crab) fishery have increased by 347 percent and the catch by 263 percent. This tremendous increase, coupled with the lack of concrete biological knowledge about Dungeness in Alaskan waters, has led many to question the ways this species has been managed. . ."

C. errans, the nemertean egg-predator, has been reported as the dominant biological control of Dungeness crab abundance in the depressed central California fishery. Approximately 83 percent of the female Dungeness captured in Icy Strait had the worm in their egg clutches, with an average of 21.6 worms per crab. In view of this preliminary data, researchers concluded that the worm intensities should be monitored closely as fishing pressure on the stock increases.

The biology of the nemertean in Alaska should also be investigated and compared with the results of studies completed along the lower west coast of the U.S. Significant differences between males and females in both prevalence and intensity of infestation may change seasonally and with ontogeny of the crab.

Histological slides of various tissues from the crabs collected in the Pleasant Island area have been processed and will be examined. Twenty-three more crabs were collected for necropsy from Freshwater Bay in Chatham Strait and their tissues were preserved for histological examination.

Clutch release time for Dungeness from Icy Strait was estimated to be in late March of 1984. No ovigerous females were collected in April. Knowing the time of clutch release is important both to management and to understanding biology of the Southeast Dungeness crab. A detailed laboratory experiment was conducted to more fully understand variations in hatching and their relationship to incubation temperature.

Crabs were held at water temperatures similar to those along the lower western coast of the U.S. and to those of southeastern Alaska. These animals hatched their broods at times similar to wild animals at these locations.

The temperature-incubation experiment results will also be used to explain the significant morphological differences in spination of Dungeness zoea from southeastern Alaska observed in plankton. This information is vital to understanding life history and for predicting recruitment success. Larvae collected at each temperature will be compared with those collected during plankton sampling, those obtained from the California coast, and to published descriptions.

Prince William Sound supports two herring fisheries: a spring roe harvest and a winter bait fishery. The roe fishery brought $650 to $800 per ton of eggs in 1985. The bait fishery is a much lower-

Boat load of herring roe on kelp ready for delivery in Prince William Sound.

"Herring in this area have always been managed as two distinct stocks although there is no evidence to support the assumption that there are indeed two stocks."

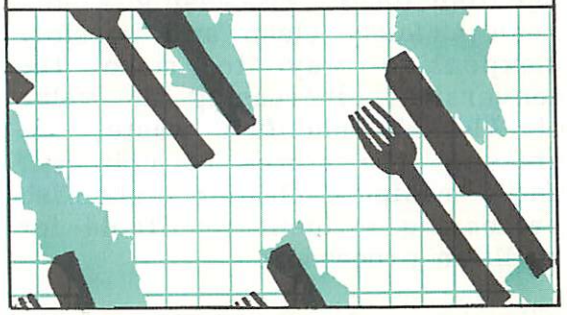
valued pursuit. However, herring in this area have always been managed as two distinct stocks although there is no good biological data to support the assumption that there are indeed two stocks.

Project **R/06-15, Herring Stocks in Prince William Sound** seeks biological evidence of what stocks are involved using various methods. Neither scale pattern analysis nor biochemical genetic data have differentiated between fish from the roe and bait fisheries. This could mean that the same stock is exploited in both fisheries or that the methods are simply inadequate to make a distinction. To further evaluate these alternatives, investigators pursued proof that the bait fishery stock might actually spawn in some other area. Available information on timing and year-class strength of other Alaskan herring populations was gathered and examined along with biochemical genetic data already collected.

Research uncovered no indication that the bait fishery herring spawn elsewhere. Herring caught in both of the Prince William Sound fisheries, for example, had very distinct year-class composition not apparent in herring stocks from areas outside Prince William Sound. The biochemical genetic composition of herring in northern southeast Alaska and Kodiak is different from that of Prince William Sound herring.

There still appears to be no reason to assume that the roe and bait fisheries are conducted on different stocks.

Seafood Science and Technology



Refining Alaska's shellfish waste and improving seafood product quality topped the list of Alaska Sea Grant seafood technology projects. The problems of shellfish processing waste disposal are enduring in a state with remote processing facilities. And, as our fishing industry matures, the quality as well as the quantity of traditional products has received more attention than in past years.

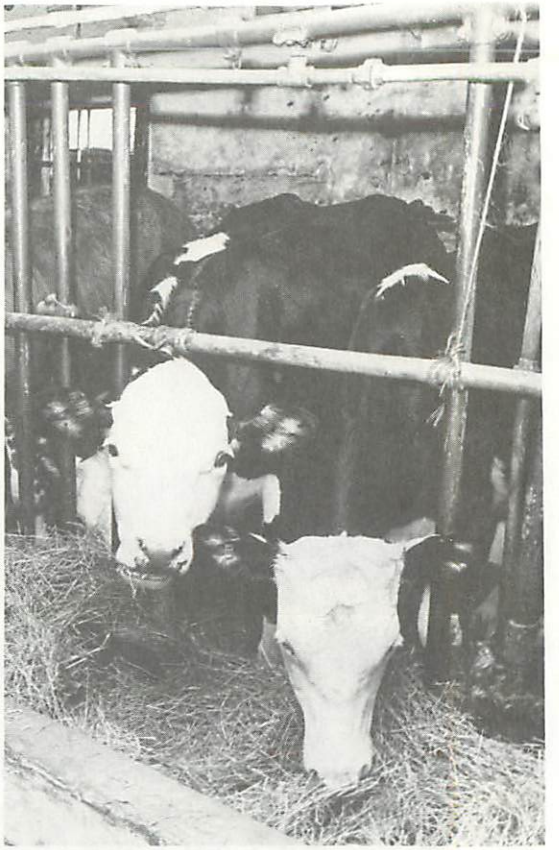
Alaska Sea Grant has already sponsored a string of projects on the possible uses of shellfish meals as protein supplements in livestock rations. Funding was also provided to find ways of removing more of the shell component from processing wastewaters and refining the matter reclaimed for fish meals.

Following this line of research, a project was funded that attempts to develop a biochemical process for converting the chitin found in shells into its industrially valuable cousin, chitosan. Success in Project **R/35-05 Biotechnology of Shellfish Waste Processing** would mean a fairly clean and possibly inexpensive way to make the conversion, increasing the value of Alaska's shellfish waste, increasing the stores of chitosan, and making cleaner shellfish processing effluent profitable for shellfish processors.

Scientists planned to use an enzyme to modify the chitin and produce chitosan. The first step was to purify and characterize that enzyme, in this case chitin deacetylase which cleaves the acetyl group from chitin and creates chitosan. The commercial viability of this process depends on an easily cultured source of the enzyme used. Researchers chose a common fungus, Mucor rouxii, as a likely source of the enzyme. The results of this and other studies indicate that that substrate of M. rouxii chitin deacetylase is not intact chitin, but prechitin which is present only during wall formation in the growing fungi. Recent studies show that 67 percent of intact chitin from shellfish wastes can be deacetylated by nonchitinolytic bacterial isolates.

Taken together, these results led Sea Grant researchers to conclude that single enzyme bioconversion of chitin to chitosan is not feasible at this time. Therefore, focus shifted from increased production of the enzyme to studies of the cellular functions of chitin deacetylase in M. rouxii and to the uses of crab wastes in animal nutrition.

Tests showed that chitin deacetylase activity increased prior to increases in cellular concentration of cAMP (cyclic adenosine monophosphate, an important molecule in controlling cellular functions). Chitin deacetylase forms chitosan in new cell walls of germinating sporangiospores. Researchers hypothesized that polycationic chitosan, which is known to depolarize cell walls, will stimulate the production of cAMP by activating membrane-bound adenal cyclase. Because cAMP activates the proteins that regulate apical growth in M. rouxii, chitin de-



Dairy cattle at Palmer Agricultural Station. Photo by Sabra McCracken.

"A third focus of this project was to extend work on nutritional values of chitin in livestock diets, focussing on the digestibility of tanner crab meal..."

acetylase and chitosan may have a function in starting sporangiospore germination.

A master's thesis project investigated this possibility. Aerobically grown M. rouxii produced the highest deacetylase activity during late logorithmic and early stationary stages of growth. An isolate of M. rouxii resistant to detergent produced eight times more chitin deacetylase activity than did a wild type strain. Work continued to purify the deacetylase obtained from M. rouxii. Mycelia in the log phase were harvested by filtration and suspended in buffer. The cells were later disrupted with a high-speed stirrer and centrifugation. The supernatant containing deacetylase was removed and fractionated using ammonium sulfate, gel chromotography, and ion exchange. A major activity peak was observed at an elution volume corresponding to a molecular weight of 20 kilodaltons.

A third focus of this project was to extend work on nutritional values of chitin in livestock diets, focussing on the digestability of tanner crab meal and how chitin is degraded while passing through a ruminant digestive tract. Isolation of chitinolytic enzymes from the digestive tract will show a possible mechanism of chitin deacetylase in the ruminant.

The substrate for the enzyme was synthesized and experiments were performed using commercially available chitinase enzyme. A radioactive type enzyme assay was preferred because it was not affected by the highly-colored rumen fluid.

A feeding trial using four fistulated beef cattle also began. The animals were fed constant intakes of brome hay for eight weeks. Chromium oxide was administered for 15 of the days and feces samples were collected at 12 hour intervals. Crab meal was introduced to the diets. Two cows received 25 percent of their diet in crab meal. When all animals reached a constant intake, chromium oxide was administered and feces samples were taken. Results of this experiment are under analysis. In Project **R/35-07, Alaska Seafood Microbiological Profiling,** the microbial load and composition of fish landed in Alaska are examined. Of particular interest are finfish and shellfish of commercial importance. In addition, the environments in which they live, are transported, and are stored are important sources of microbial flora for fish. These environments often cause differing microbial loads and compositions for similar species landed and processed in different areas.

Two recent developments in the Alaska fishing industry led to this project. First, salmon fishermen and tenders have become more quality conscious in the wake of botulism scares, expressing particular interest in alternatives to traditional ice chilling methods. While the Alaska Marine Advisory Program was testing the promising seawater and ice mix with constant air bubbling, commonly known as "champagne ice", researchers used the experiment to develop microbiological support data establishing the protocol for studying the microbiological profile of Alaska seafoods.

The second development was an attempt to produce top-grade surimi at a Kodiak plant. Researchers addressed the question of how the Kodiak-produced surimi would compare with the quality of imported surimi.

The microbiological research laboratory began operation in September 1984. The first experiment undertaken was to enumerate the microbial content of seawater and ice mixtures used to chill salmon in the champagne ice system.

Pour plating and spread plating methods were used to determine the optimum enumeration process. On average, spread plating on a

special recovery medium yielded 10 times the number of isolates as pour plating. The seawater and ice mixture contained concentrations as high as 1.5 x 10 (6) microorganisms/ml. Inadequate fish hold cleaning was evidenced by the initial microbial load of 3.2 x 10 (4) organisms/ml. Identification of the microbial isolates from this experiment continues.

To assist the surimi operation, nine imported surimi samples were examined for their microbial content. They were then compared to Kodiak-produced samples. The Kodiak surimi compared favorably with the highest-quality imports.

Microbiological profiling of halibut landed in Kodiak is in progress. This will be followed by microbial study of Pacific salmon.

Researchers in Project R/35-06 **Pacific Salmon Postmortem Biochemical Changes During Partially-Frozen Storage** have been pinpointing the best temperature for storing salmon in the partial freezing temperature range, that which minimizes the biochemical changes that cause spoilage. After that is determined, the usefulness of partial freezing to extend chill storage times for salmon can be evaluated.

Work in the second year of this project has examined the changes in proteins, amino acids and other amines. Some of the lipid work done in the first year was repeated. This data is being calculated and tabulated. The total soluble protein in coho salmon muscle was found to slowly decrease during holding for 20 days at -2°C. A more pronounced drop in soluble protein during storage at -3°C was noted, one that parallels the drop seen in frozen storage. After 10 days however, protein solubilizes at both the lower temperatures, reversing this trend of less total soluble protein.

"A sensory panel scored cooked muscle samples of coho and chum salmon held at several temperatures for flavor and odor. . . data indicated that holding at -2°C for 10 days gives acceptable quality."

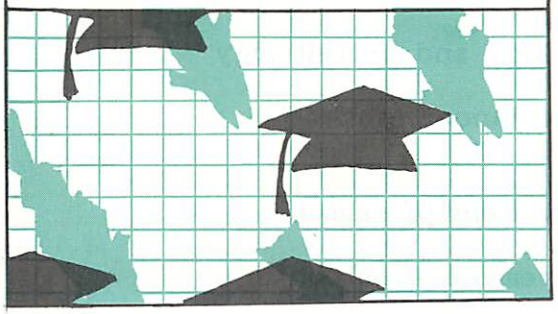
Chris Bublitz, Fishery Industrial Technology Center staff member, samples test fish for project R/35-05. Photo by Jong S. Lee.

Electrophoresis was used to obtain a more detailed analysis of protein changes at various temperatures for three test fish. In the future, a scanning densitometer will be used to quantitate actual rates of change.

A sensory panel scored cooked muscle samples of coho and chum salmon held at several temperatures for flavor and odor. Scores reflected an average of eight tastings for a particular fish. The sockeye data indicated that holding at -2°C for 10 days gives acceptable quality. The sockeye and coho data shows holding at 0°C for 15 days gives acceptable quality. After this, quality loss is rapid and in another 5 days, the samples were unacceptable or spoiled.

At partial freezing temperatures of -1°to -4°C, samples held as long as 25 days were of acceptable quality.

Marine Education



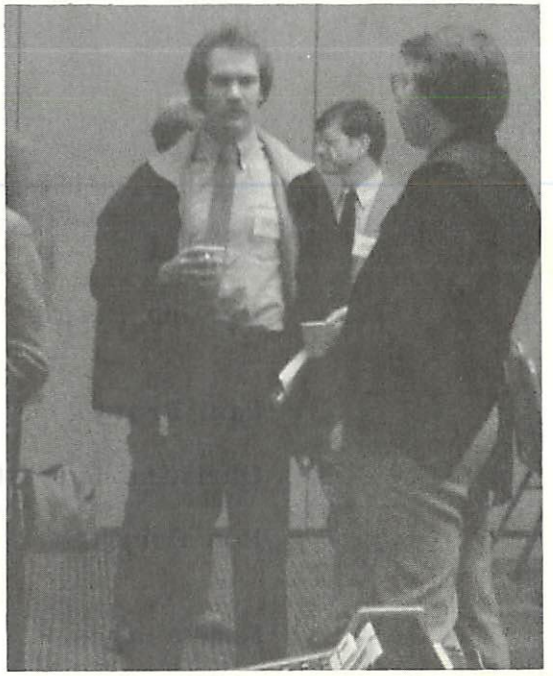
Alaska Sea Grant continued its commitment to advanced fisheries education by supporting interns and graduate students during 1984.

Project E/70-10 Sea Grant Traineeships supported all Sea Grant graduate research assistantships, rather than having each supported through a specific research project. Eleven trainees received Sea Grant funding in this year (See Table 1.) At the beginning of the project, information was gathered on all graduate assistantships provided by Alaska Sea Grant since 1976. (See Table 2.)

In March 1984 Project E/70-11, **the Sea Grant Fisheries Intern Program** was established in cooperation with the North Pacific Fishery Management Council using Rapid Response funds. Two student interns were hired by the university and housed in the council office. Work direction was provided by the council staff. One of these students was extended during the fall semester, returning to the university for the spring semester.

Two students were selected for the 1984 summer program: Steve Brooks and Ronald Rogness. Brooks has a B.S. in fishery management and is working toward an M.S. in resource economics. He worked three months for the council. Rogness has a B.S. degree in economics and is working toward an M.S. in resource economics. He worked six months for the council.

Both students received outstanding reviews from the council staff. Brooks redrafted and updated the Gulf of Alaska groundfish fisheries management plan (FMP). Rogness focussed on updating the tanner crab FMP; analyzing allocation, conservation and enforcement effects of pot limits and exclusive areas in tanner crab management; and examining the economic issues associated with Pacific halibut management.



Sea Grant graduate students Pete Hagen (center) and Steve Brooks (left) attended the Fisheries Management: Issue and Options conference in Anchorage, November, 1984. Photo by T. Frady.

"Both students received outstanding reviews from the council staff. Brooks redrafted and updated the Gulf of Alaska FMP... Rogness focussed on analyzing...pot limits and exclusive areas in tanner crab management."

Table 1. 1984 Sea Grant graduate assistantships

Student	Project	
Cynthia Beegle	R/06-24	Temperature as a predictor of fishery success in the northern Gulf of Alaska
Paul Drury	R/02-11	Potential for genetic improvement of salmon
Christine Forrest	R/06-20	Alaska Dungeness crab biology and parasitology
Ron Heintz	R/06-10	Reproductive biology of the tanner crab Chionoecetes bairdii
James James	R/02-11	Potential for genetic improvement of salmon
John Joyce	R/02-11	Potential for genetic improvement of salmon
Greg McNeill	R/35-06	Pacific salmon postmortem biochemical changes during partially frozen storage
Cynthia Morrow	R/35-05	Biotechnology of shellfish waste processing
Barbara Plonski	R/35-05	Biotechnology of shellfish waste processing
Paul Schwartz	R/35-06	Pacific salmon postmortem biochemical changes during partially frozen storage
Mark Willette	R/06-24	Temperature as a predictor of fishery success in the Northern Gulf of Alaska

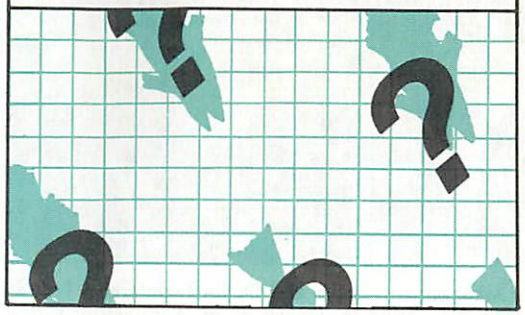
Table 2. Graduate students funded by Alaska Sea Grant College Program, 1976-1984

Year Funded	Name	Degree Completed	Current Known Employment
1976-79	Erickson, Susan	M.S.	
1976-77	Hall, Sherwood	Ph.D.	Woods Hole Oceanographic Institution
1976-77	McDaniel, Michael		
1976-77	Root, Michael		
1977-80	Barnard, David	M.S.	Wyoming Fish & Game
1977-80	Ippolito, Andrew	M.S.	Florida MAS
1977-78	Thorsteinson, Lyman	M.S.	NOAA/OCSEAP
1977-79	Urquhart, David	M.S.	Family business
1977-80	Weingartner, Thomas	M.S.	Ph.D. program at Univ. of S. Florida
1978-80	Lindley, Kerry	M.S.	Alaska Industry
1978-81	McGregor, Andrew	M.S.	Alaska Department of Fish & Game
1978-80	Schwartz, Jack	Ph.D.	
1979-82	Burkey, Charles		
1979-82	Lane, Sandro		
1979-81	Nunes, Pepsi	Ph.D.	
1979	Rowell, Kathy		Alaska Department of Fish & Game
1979-84	Thayer, Jill	M.S.	CES Agent
1979-80	White, Roberta	M.S.	Icicle Seafood Consultant; Northern Institute

Table 2. (Continued)

Year Funded	Name	Degree Completed	Current Known Employment
1980-83	Adams, Al	M.S.	
1980-82	Gallanger, Susan	M.S.	Alaska Department of Environmental Conservation, Anchorage
1980	VanAlen, Ben	M.S.	
1981-84	Plonski, Barbara	M.S.	Research Assoc. at Cornell University
1981-83	Thrower, Frank		National Marine Fisheries Service
1981-83	Tromble, Galen		
1982-	Joyce, John		
1983-84	Drury, Paul		
1983-	Heintz, Ron		
1983-84	McNeil, Gregg		
1983	Rogness, Ronald		
1983-84	Schwarz, Paul		
1984-	Beegle, Cynthia		
1984-	Hawkes, Clayton		
1984-	Morrow, Cynthia		
1984-	Willette, Mark		
1984-	Forrest, Christine		
1984-	James, James		
1984-	Walter, Mark		

Information and Advisory



Project A/75-01 is Alaska Sea Grant's Public Information Service. It is responsible for getting Sea Grant work into the hands of those who can use it, for keeping in contact with those Sea Grant serves, and providing a forum for professional discourse among the many groups involved in Alaska's marine industries.

In 1984, Sea Grant helped sponsor three large conferences: the Symposium on Dungeness Crab Biology and Management, Fisheries Management: Issues and Options, and Maritime Alaska '84. Planning for four more conferences continued or was initiated: International King Crab Symposium, Oceanography of the North Pacific and the Bering Sea and its Effects on Fisheries Distribution, Western Groundfish Conference; and the International Symposium on Seafood Quality Determination.

The Symposium on Dungeness Crab Biology and Management was the third in the Lowell Wakefield Symposia, held in Anchorage October 9-11. Technical papers were presented and workshops conducted on future research needs. Approximately 60 persons attended. The meeting was also sponsored by the Pacific Sea Grant College Program, the Alaska Department of Fish and Game, and the Crustacean Society.

Fisheries Management: Issues and Options was held in Anchorage November 13-16 and was attended by approximately 180 people. Most major figures involved with national fisheries policy attended including prominent fisherman's leaders as well as government and regulatory staff. Seventeen agencies, organizations and individuals helped sponsor the conference.

Maritime Alaska '84 was held in November of 1984 and was attended by 128 people. In preparation for this conference, Alaska Sea Grant guided a summer internship to develop material on how other countries handle port and ocean supply services to rural areas. The conference was primarily

Sea Week coordinator Margaret Cowan conducts a freshwater field trip.

sponsored by the Alaska Department of Transportation and Public Facilities. Co-sponsors included the U.S. Coast Guard, the Army Corps of Engineers, the U.S. Maritime Administration, and the Alaska Department of Commerce and Economic Development.

Nine technical reports and six journal articles were produced during this period. A complete list begins on page 36. The most requested publications for this period were a revised version of Marine Advisory Bulletin #7, Artificial Salmon Spawning; the Alaska Sea Week curriculum guides; Marine Advisory Bulletin #14, Business Calculations and Financial Statements for Commercial Fishermen, and Alaska Sea Grant Report 84-7, A Bibliography of References on the genus Chionoecetes.

Production time was heavily consumed by production of the Sea Week curriculum series. During this period, the 402-page sixth grade guide and the 240-page second grade guide were finished. Four conference proceedings also figured prominently in editorial and layout time. These should be available in early 1985.

Increased capacities have been added to our word processing system with purchase of communications software. The staff has been directed to learn the new functions which allow us to transfer information across the main university computer to the many varieties of personal computers used by advisory staff and principle investigators.

Panel discussion on fisheries management problems at the Fisheries Management: Issues and Options conference held in Anchorage November, 13-16, 1984. Panel members, left to right are: Alan Millikan, University of Washington; Daniel Huppert, National Marine Fisheries Service; E.C. Fullerton, National Marine Fisheries Service; Donald Bevan (moderator), University of Washington; Douglas Marshall, New England Fishery Management Council; Michael Sissenwine, National Marine Fisheries Service. Photo by T. Frady.

Communications staff continued to provide publicity and media coverage for conferences, and helped with promotion of Oregon State Sea Grant's Nova program "Farmers of the Sea" aired on PBS in the fall. Promotional materials were sent to state film libraries and science teachers across the state.

The staff also participated in the Alaska State Fair and the AlaskaMar trade show in Anchorage. Approximately 130,000 persons attended the fair and Sea Grant contests drew over 1,000 entrants each. The booth was co-sponsored by the NOAA Ocean Service Center in Anchorage and the Alaska Seafood Marketing Institute (ASMI). NOAA provided publications and a staff member to help run the booth. ASMI donated recipe cards and pamphlets, Alaska Seafood shoestrings, and two sweat suits for winners of a Fun Run associated with fair week.

The AlaskaMar Trade show booth was co-sponsored by the Alaska Department of Fish and Game and the Alaska Fisheries Development

"Alaska Sea Grant shared a booth with the National Marine Fisheries Service and the Alaska Department of Fish and Game at the AlaskaMar Trade Show held in Anchorage. The booth highlighted surimi development and trawl training in Alaska."

Photo by T. Frady.

Foundation (AFDF). The booth displays highlighted surimi, a possible product of the future for the Alaskan seafood industry. AFDF materials concentrated on the surimi project it supports in Kodiak. The Sea Grant materials focussed on trawl fishing training courses and on surimi quality research conducted by the university's Fishery Industrial Technology Center (FITC) of Kodiak. Planning continues for participation in Fish Expo '85 to be held in Seattle in October 1985.

Project A/71-01, **Alaska Marine Advisory Program**, is an extension education and support network for Alaska's commercial marine industries. It is jointly supported by the Alaska Sea Grant College Program and the University of Alaska Cooperative Extension Service (CES). The administrative unit is located in Anchorage and field office are found in six other Alaskan communities: Kotzebue, Dillingham, Kodiak, Cordova, Juneau, and Petersburg.

The program is divided into six missions, reflecting the priorities established in the university's fisheries plan and the six-year Cooperative Extension Service plan developed under the leadership of CES director Dr. James Matthews. These missions are: management, response, commercial fisheries development, marine safety, fisheries business management, seafood technology and aquaculture. Table 3 lists teaching and professional activities for this period. See the Publications Section for miscellaneous Advisory publications.

The management mission coordinates all Marine Advisory Program (MAP) missions, provides guidance to the staff and assures coordination between the university's formal research and education activities and those of MAP. Specialists with the program are funded through the Fishery Industrial Technology Center (FITC), a unit of the university located in Kodiak. Field agents are funded through CES. Because MAP staff is assigned to two different administrative units, a uniform management agreement was worked out during this period. Time has also been devoted to developing an evaluation system that appraises both individual staff performance and MAP activities. Also under this project, a needs assessment for all parts of MAP was initiated.

Decreasing travel budgets and the university's strong commitment to rural education are among the factors that have made telecommunications vital to delivering MAP services across the nation's

Table 3. MAP workshop, teaching, professional activities, 1984

MISSION/ date	Title (type of activity)	Location	Attendees	Staff
MISSION B - Rapid Response				
3/84	Fish Processing School (invited instructor)	China	56	Pennington
4/84	Biology 104 (taught audio-conference course)	Kotzebue	15	Garza
4/13/84	Fisherman's convention (attendee)	Kotzebue	60	Garza
5/10/84	Marine Environment of PWS (taught)	Cordova	11	Steiner
5/10-11/84	Ocean Edibles (for CES conference)	Homer	30	Steiner
5/13-16/84	Ocean Biology (taught for Whittier, Tatitlek students)	PWS	50	Steiner
5/17/84	Forest Service naturalist training (taught)	Seward	9	Steiner/MacDonald
6/1-3/84	Inboard/Outboard Gasoline Engine Repair (organized workshop)	Cordova	40	Steiner
7/84	Classroom by the Sea (taught)	Seward	12	Pennington/MacDonald
10/84	Fisheries Oceanography (taught)	Dillingham		Coughenower
MISSION C - Commercial Fisheries Development and Assistance				
4/27/84	Longline Workshop (taught)	Kodiak	17	Pennington
4/28/84	Alaska Marine Research (lecture to Alaska Shellfish Grower's Association)	Wrangell	26	Kerns
4/15-16/84	Underutilized Fishery Resources (taught)	Homer	8	Steiner
4/18/85	Underutilized Fishery Resources (taught)	Seward	15	Steiner
4/22/84	Underutilized Fishery Resources (taught)	Anchorage	25	Steiner
5/8/84	Underutilized Fishery Resources (taught)	Fairbanks	10	Steiner
4/30/84	Fishing Rules and Regulations (taught)	Naknek	15	Coughenower
9/24/84	Fisheries Development (taught)	Selawik	10	Garza
10/12/84	Marine Mammals (lecture)	Nome	20	Garza
10/17/84	Marine Mammal Management (lecture)	Pt. Hope	22	Garza
10/84	Marine Mammal Management (audio-conference class)	Kotzebue	12	Garza
10/84	Introduction to Oceanography (audio-conference class)	Dillingham		
11/15/84	Rockfish Marketing (taught)	Cordova	35	Steiner

Table 3. (Continued)

MISSION/ date	Title (type of activity)	Location	Attendees	Staff
MISSION D - Marine Safety				
5/15/84	Sea Survival Workshop (taught)	Whittier	24	MacDonald/Steiner
5/20/84	Sea Safety and Marine Survival (taught)	Chiniak	35	Pennington
5/21/84	Marine Science class (taught)	Chiniak	35	Pennington
5/23/84	Survival suit races (organized) (300 observers)	Kodiak	44	Pennington
6/7-10/84	Marine Science Camp (organized)	Glacier Spit	26	Pennington/MacDonald
6/14/84	Survival suit races (organized) (20 observers)	Naknek	12	Coughenower
6/15-19/84	Marine Science Camp (taught)	Kodiak	63	Pennington/MacDonald
7/5/84	Marine safety (lecture/demonstration)	Gulf of Alaska	29	Doyle
9/15/84	Safety training for public safety and ADF&G employees (taught)	Kodiak	32	Pennington
10/3/84	USCG safety training (taught)	Kodiak	14	Pennington
10/11/84	Survival suit training (taught)	Kodiak	11	Pennington
10/12/84	Fisheries safety training (taught)	Kodiak	11	Pennington
MISSION E - Fisheries Business Management				
2/23/84	Fisheries Management (lecture/demonstration)	New Orleans	75	Wiese
10/30/84	Can You Afford a Boat (taught workshop)	Dillingham	4	Coughenower/Wiese
11/1/84	Can You Afford a Boat (taught workshop)	Aleknagik	10	Coughenower/Wiese
11/5/84	Commercial Fishery Financing (organized, assisted)	Cordova	6	Steiner
11/29/84	Tax Practitioner's Institute	Fairbanks	75	Wiese

largest state. A course on marine mammal management was taught to students in nine different locations in Western Alaska using the university's instructional telecommunications service. A marine biology course was similarly taught for Dillingham students and students in 12 other Bristol Bay communities. The MAP staff also takes advantage of the teleconferencing system for a bi-weekly staff meeting involving all seven offices.

All MAP staff spend an estimated 30 percent of their time responding to individual requests from the public for information and advice. During this period, an attempt was made to evaluate the success of these efforts and as expected, it proved to be difficult. One-on-one delivery is time consuming, and so is not efficient from that standpoint. However, it does tailor the response to individual needs, building credibility for and goodwill toward MAP in the marine community.

MAP staff members hold volunteer positions of community and professional interest on education committees, in professional organizations, on citizen's advisory councils, and even have served as visiting technical advisors to foreign nations, as in Kodiak agent Hank Pennington's case. Pennington was asked to travel to the People's Republic of China to demonstrate his hand filleting method for cod and pollock. MAP staff also attend training programs designed specifically for the west coast advisory services, such as that held in Hawaii in 1984. All faculty attended at least one professional conference. One result of this work is a conference on sharks planned for Oregon and a seafood retailing workshop. Both are joint projects involving Alaska with other west coast advisory services.

The commercial fisheries development mission provides assistance with fishing gear and techniques useful in Alaska waters.

Eliminating foreign sablefish efforts in the Gulf of Alaska has increased the opportunities in this fishery for Alaskan fishermen. Sablefish harvesting workshops were conducted in Homer, Seldovia and Kodiak during this period. MAP agent Rick Steiner also demonstrated longline techniques on three vessels recently converted for the fishery. A number of small vessels now target sablefish during the offseason.

Loran-C is used by state fisheries regulatory and management teams for navigational purposes and to pinpoint boundaries. Its use is not common among small vessels however, and this handicapped the western Alaska fleet in particular. A 30-minute videotape on Loran-C and how to use it was developed by Dillingham agent Doug Coughenower and used throughout Bristol Bay at workshops and in school rooms.

Two projects in support of the processing sector have been pursued. Two staff members worked with a salmon processor and exporter to develop a cooked, flaked meat that was frozen and sold on the Japanese market. This product is sold at a price that gives the producer a substantially higher rate of return than whole frozen fish.

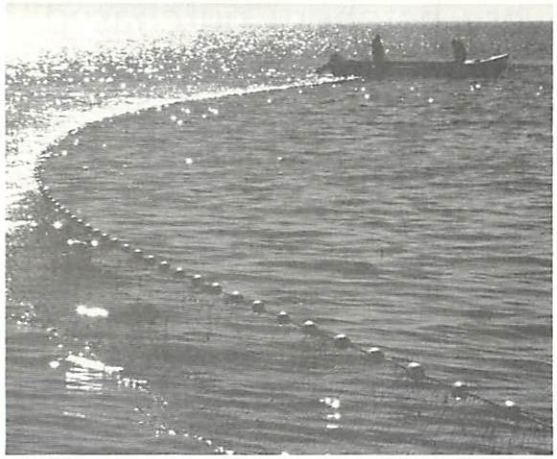
One of the barriers to Alaska's entry into the ocean white fish market has been the high cost of processing. Those who did enter used highly mechanized methods that have not proved profitable. Kodiak agent Hank Pennington developed a more labor intensive hand-filleting method for cod. A local plant using the method expects to profitably produce frozen shatterpacks by spring, 1985.

With the National Fisheries Institute, MAP co-sponsored a conference on seafood packaging and shipping. The southeastern Alaska rockfish fleet depends on air delivery of its products to

direct marketing customers. The sharp spines of these fish punctured traditional packaging, causing leakage and damaging both the product and the aircraft. A series of meetings on this problem developed after the conference, under the leadership of agent Brian Paust. As a result, several new air freight containers were developed that eliminated the leakage problem. Many fishermen now also remove the points of the dorsal fins.

Also in the southeastern fisheries, agent Paust has helped fishermen find direct marketing customers for non-traditional species. Approximately 200 fishermen now regularly and profitably market rockfish, white king salmon, and ling cod to buyers throughout the western U.S.

Chum salmon from Kotzebue usually fetched a price well below that received for chums from other Alaskan regions, a price that was not set until the day before the fishery opens. Kotzebue agent Dolly Garza studied the market structure and marketing potential for this fish in her area. By identifying the niche Kotzebue chums fit in the Japanese market, fishermen have been able to use the study in price negotiating. The price range offered is now announced well in advance of the fishery.



Inupiaq Eskimos fish for Kotzebue chums. Photo by John Creed.

"Kotzebue agent Dolly Garza studied the market structure and market potential for (Kotzebue chum)...fisherman have been able to use the study in price negotiation."

The study has also encouraged buyers, processors, and fishermen improve handling methods, reducing the number of lower graded fish.

Cordova agent Rick Steiner has been looking for new herring markets. These fish are normally destined for roe or bait fisheries. Steiner arranged for test shipment of the fish to zoos and aquariums for use as animal feed. The Prince William Sound herring season has been adjusted to accommodate this fishery.

Alaska's commercial fisheries are some of the most dangerous in the nation in part because of the heavier gauge equipment required in the North Pacific, but also because of the unpredictable weather and the distance between many fishing grounds and emergency assistance.

Development of local training and information sources on marine safety is a part of MAP that hits close to home all too often. MAP has instituted a series of survival suit races in conjunction with local community fairs to encourage familiarity with these indispensable safety devices. The races and their accompanying life raft/sea safety demonstrations attracted 158 participants and more than 2,300 spectators in 1984, including the state's governor

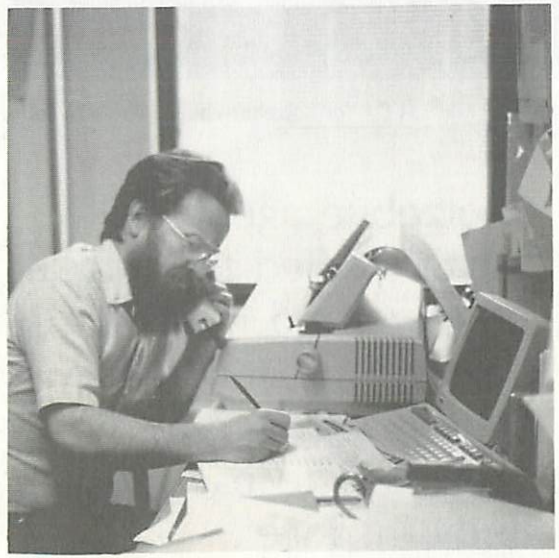
who was M.C. for the Cordova race. The four-part sea survival videotape series developed during last proposal period has been widely distributed and acclaimed. The series is being used extensively both in Alaska and throughout the coastal U.S. in various training and education programs.

Fifteen Sea Grams were added to the series when articles from Pacific Fishing magazine on fishing injuries and first aid were reprinted in that format. These have been used in various MAP marine safety activities.

Workshops on recordkeeping and break-even analysis were presented in Alegnagik and Dillingham. Attendees from the Bristol Bay Native Association learned the break-even analysis procedure and taught it to fishermen around the region, using the MAP bulletin, "Fisherman's Recordkeeping System for Income Taxes", a biligual guide published in English and Yupik.

A comprehensive income tax workshop was conducted for regional staff of the Bering Sea Fisherman's Association. This workshop was also videotaped for later reference. Staff from nine village corporations attended, and returned to their villages to help local commercial fishermen with tax procedures and questions.

"A workshop was conducted on using microcomputers in salmonid research and production facilities... after the meeting, nearly every hatchery purchased a microcomputer and has used it to increase productivity."



Juneau MAP aquaculture specialist Curt Kerns conducted the microcomputer workshop. Photo by Amy Richards.

Some time was spent developing computerized recordkeeping and data base management for processors, building on recordkeeping, report preparation, and management requirements of a Kenai processor. The attempt revealed that considerable programming would be involved and that MAP equipment (Apple II computer with "dBaseII") was not sufficiently powerful or sophisticated to handle the project. A major accounting firm with larger machines and more programming talent has shown an interest in picking up the project.

A break-even procedure applicable to salmon processing operations was developed for the Alaska Commercial Fishing and Agriculture Bank (ACFAB). The bank uses the procedure to evaluate the feasibility of new processor loans as well as to demonstrate the procedure to existing clients.

The seafood technology mission provides the Alaska seafood industry with information on the latest research developments and new gear and technology that may improve operations. It also focuses on development of new products and introduction of new species as commercial fisheries.

A literature search has been conducted through the National Technical Information Service for publications on retort pouches, controlled atmosphere storage of food, frozen seafood storage, and packaging for shipping fish. Extending seafood shelf life was also investigated, with the most promising possibilities being modified or controlled atmosphere storage and holding at partial-freezing temperatures. One Kenai Peninsula smoking company is using the retort packages and the information on shelf life extension was used to prepare a three-hour workshop on the topic.

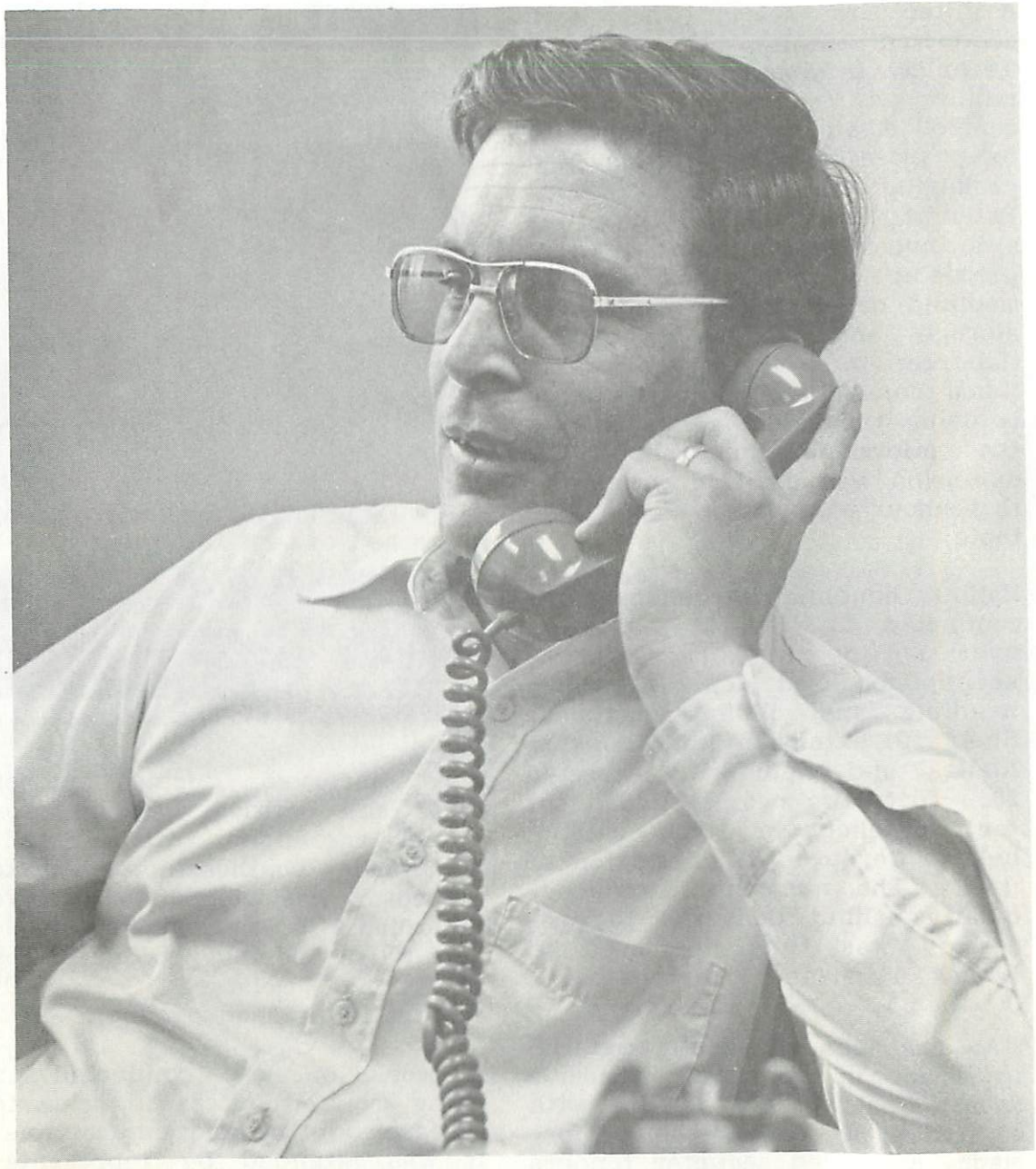
Halibut handling workshops were conducted in May 1984, drawing over 140 people. These workshops focussed on dressing, handling and chilling methods. Shelf life extension workshops in Kodiak and Ketchikan attracted 20. Forty-two people turned out for workshops on fish chilling held in Cordova, Sitka and Ketchikan. The number of reduced-quality halibut delivered to processors was thus decreased in Kodiak, according to processors.

MAP has been developing material to assist in upgrading Alaska's salmon quality. By working with a Kodiak processor, the performance of chilled seawater tenders has been improved. Four vessels were observed during summer 1984 and critical factors for proper operations were outlined. A small southeastern Alaska processor was helped to improve the quality of smoked fish products by developing procedures for monitoring moisture and salt content in finished products.

Kodiak shooting session for an instructional videotape on halibut handling. MAP assisted in production. Photo by Grant Sims.

A workshop was conducted on using microcomputers in salmonid research and production facilities. It was attended by representatives from virtually every Alaska hatchery corporation, the National Marine Fisheries Service, the Alaska Department of Fish and Game, and the University of Alaska School of Fisheries and Science. After the meeting, nearly every hatchery purchased a microcomputer and has used it to increase productivity. The University of Alaska computer system has made USERIDs available to all private non-profit hatcheries in the state, allowing them access to specialized software and a fast mail system.

"The administrative unit also directs a cohesive interdisciplinary group within the statewide higher education system and is responsible for coordinating the University's statewide fisheries programs."



Alaska Sea Grant College Program Director Donald H. Rosenberg. Photo by Tricia Olsen.

Project **M/79-01, Program Administration,** coordinates and directs the three major program areas of Alaska Sea Grant that include education, research and extension activities. The administrative unit also directs a cohesive interdisciplinary group within the statewide higher education system and is responsible for coordinating the university's statewide fisheries programs. Thus, this unit is housed in the university president's office.

In addition to providing normal functions, there were four achievements specific to this year.

Program development and administrative procedures were updated, partially in preparation for a new director.

Program records were brought up to date. All active projects have been entered into the Sea Grant management information system, a national database connecting the nation's Sea Grant programs.

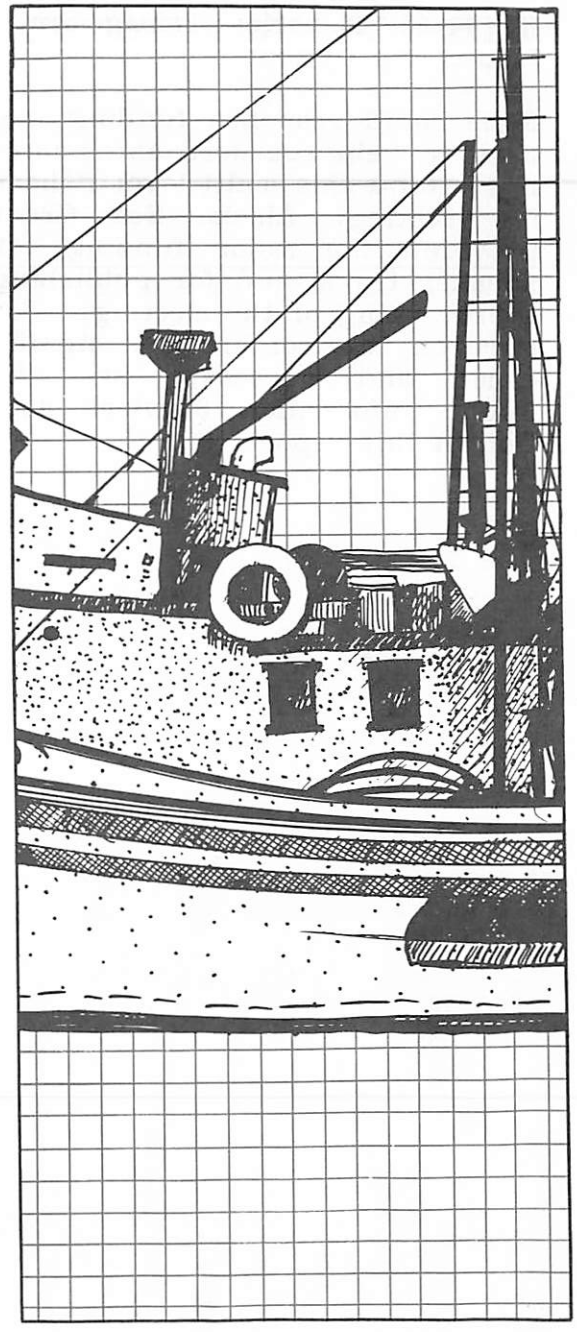
The Fishery Industrial Technology Center and the Cooperative Extension Service, with the assistance of Alaska Sea Grant have agreed on a procedure for consolidated management of the Alaska Marine Advisory Program. For more detail, see the Marine Advisory section of this report.

Alaska Sea Grant also continues to provide technical assistance to the North Pacific Fishery Management Council. Through Sea Grant, other university staff and faculty have become involved with council activities.

Project **M/81-01, Program Planing and Rapid Response,** allows Sea Grant to respond to short-term and unexpected needs during a grant cycle. During this year, three projects were funded.

RR/84-01 Alaska Trawl Training Program

During April 1984, ten Kodiak fishermen paid their own way to the British Sea Fish Industry Authority (BSFIA) facilities in Hull, England in order to participate in a two-week course supported by Alaska Sea Grant through the Fishery Industrial Technology Center. The fishermen were able to program the computer-linked trawl simulator at that facility for any specific bottom type, vessel horsepower, net design, trawl rigging, or fish behavior. They tested their own trawls and compared their performance with those typically used in the Atlantic fisheries. Well-known U.S. gear authority Duncan Amos conducted the lecture portion of the course in classrooms adjoining the BSFIA trawl simulator and flume tank.



RR/84-03 Fisheries Management: Issues and Options

Some rapid response funding was used to help speakers and panelists attend this multi-level fisheries meeting. Alaska Sea Grant provided the major funding for speaker travel and for publishing a proceeding of the meeting. For more on this conference's significance and success, see the Public Information Services section in this report.

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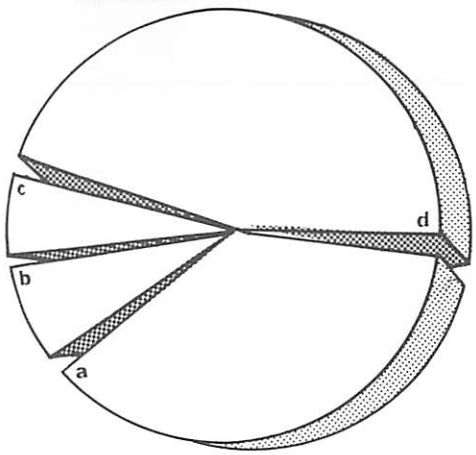
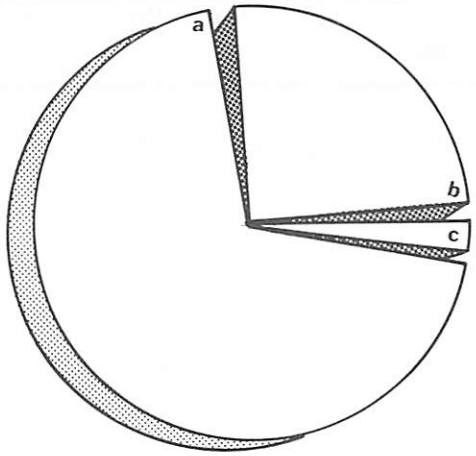


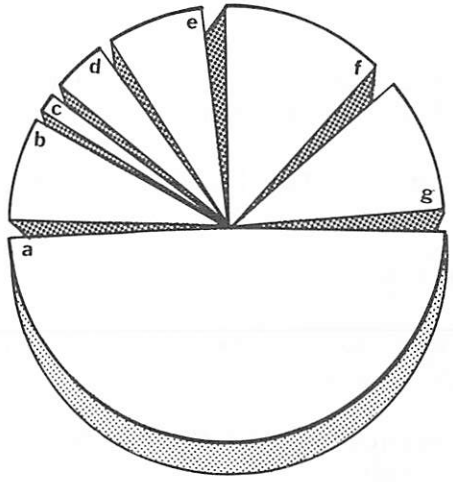
Federal Funds



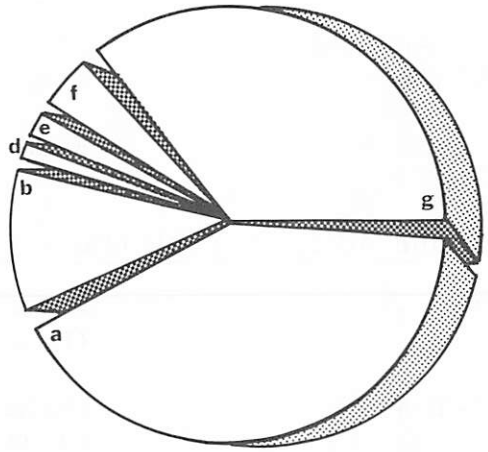
Matching Funds

Activity	Federal Funds	Matching Funds
a. Extension	$ 404,386	$ 954,547
b. Administration and rapid response	79,049	349,691
c. Education and training	64,692	30,998
d. Research	480,328	-0-
	$1,028,455	$1,335,236

Category	Federal Funds	Matching Funds
a. Salaries	$ 515,001	$ 568,903
b. Staff benefits	101,058	164,045
c. Permanent equipment	5,101	-0-
d. Expendible supply	50,447	15,337
e. Travel	85,309	28,976
f. Contract	141,122	62,088
g. Indirect	130,417	495,887
	$1,028,455	$1,335,236



Federal Funds



Matching Funds

Technical reports/Project

AK-SG-84-1 A/75-01	Proceedings of the Workshop on Biological Interactions Among Marine Mammals and Commercial Fisheries in the Southeastern Bering Sea
AK-SG-84-2 M/81-01 RR/83-02	Reproduction and Gonad Yield in Green Sea Urchin of Lower Cook Inlet, Alaska
AK-SG-84-3 M/81-01 RR/83-08	An Economic Profile of the Southeast Alaska Salmon Fishery
AK-SG-84-4 E/70-08	Alaska Sea Week, Vol III, Grade 2: Shells and Insects
AK-SG-84-5 M/79-01	Alaska Sea Grant Annual Report, 1980-1982
AK-SG-84-6 R/06-13	Cold Temperature Limitation on Growth of Pink Salmon Fry
AK-SG-84-7 A/75-01	A Bibliography of References on the Genus Chionoecetes
AK-SG-84-8 E/70-08	Alaska Sea Week, Vol. VII, Grade 6: Marine Mammals and Marine Issues
AK-SG-84-9 A/75-01	Final Report of the 1983 Troll Logbook Program

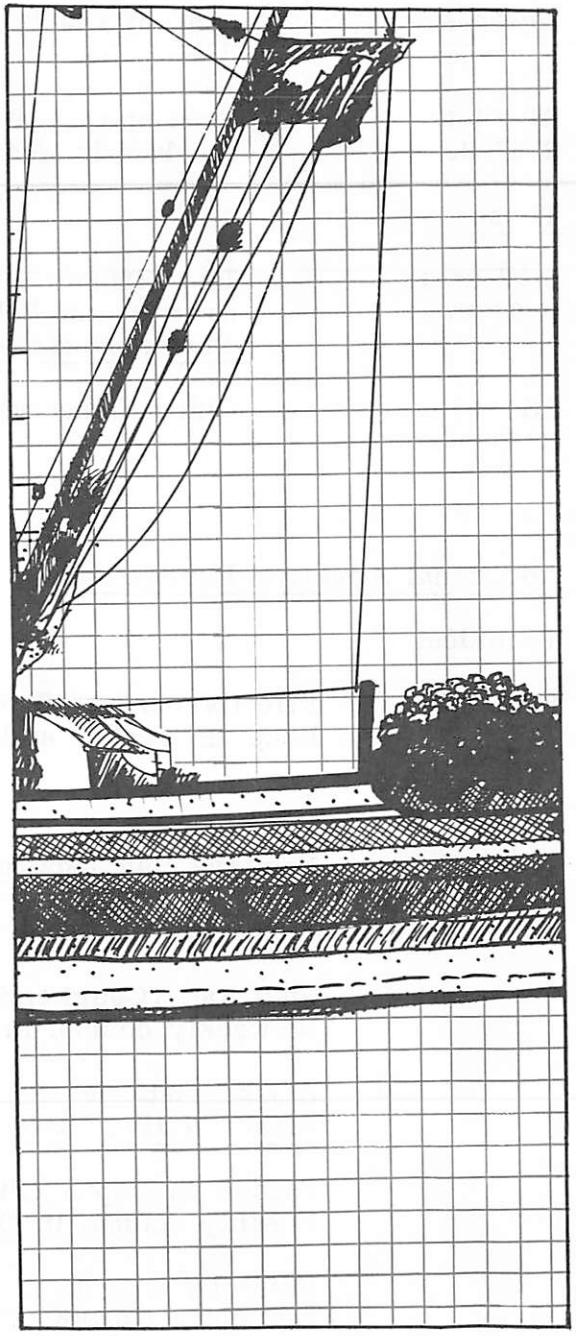
Marine Advisory Publications (A/71-01)

MAB #15	Fisherman's Record-keeping System for Income Taxes (In English and Yupik)
MAB #16	Market Structure and Market Potential for Kotzebue Chum Salmon
Sea Gram #9	"Hooked"

Sea Gram #10	"Bleeding"
Sea Gram #11	"Hypothermia"
Sea Gram #12	"Man Overboard"
Sea Gram #13	"Fish Poisoning"
Sea Gram #14	"Stress"
Sea Gram #15	"Heart Attack"
Sea Gram #16	"CPR"
Sea Gram #17	"Stroke"
Sea Gram #18	"Hearing Loss"
Sea Gram #19	"Keep Breathing"
Sea Gram #20	"Broken Bones"
Sea Gram #21	"Evacuation"
Sea Gram #22	"First Aid Kits"
Sea Gram #23	"Burns"

Reprints/Project

RP-84-1 R/35-03	Use of Coagulants to Treat Seafood Processing Wastewaters
RP-84-2 R/35-04	Acceptability of Tanner Crab in Concentrates for Lactation
RP-84-3 R/06-04	Cryptic Paralytic Shellfish Toxins
RP-84-4 R/02-1	Genetic Effect on the Dynamics of a Model of Pink and Chum Salmon



RP-84-5 R/07-02	Food of the Pacific Walrus in Winter and Spring in the Bering Sea
RP-84-6 R/07-02	Time and Location of Mating and Associated Behavior of the Pacific Walrus

Theses

SGT-84-1 R/02-07	The Effects of Oil-Contaminated Prey on the Feeding, Growth and Related Energetics of Pink Salmon, Oncorhynchus gorbuscha Walbaum, Fry
SGT-84-2 R/35-05	Chitin Deacetylase Production by Mucor rouxii

Additional Advisory Publications

Technical

FITC 84/T-1	Effectiveness of Ozone-Treated Wash Water and Ice on Keeping Quality and Stability of Sockeye Salmon

Brochures

Kasitsna Bay Laboratory

Columns and Articles in Periodicals

Fish Rap (Coughenower)
Bi-weekly column in Bristol Bay Times

Alaska Fisheries Policy Impacts on Southeast Fishermen (Garza)
Alaska Native News

Fathom in Depth (Steiner)
Monthly column in Ocean Wave

Halibut Management Options (Steiner)
Article in Cordova Times

Salmon Quality (Steiner)
in Copper River Fisherman's Co-op News

Occasional Papers

Alaska Marine Resources Handbook (Steiner)
Compiled for Alaska Marine Resources course held in July 1984

Economic Analysis of the Copper River Salmon Fishery
Briefing paper for Cordova District Fishermen United

Fish Chilling Techniques (Crapo, Kramer)
Copied for distribution at a workshop and to interested fishermen

Sleep Deprivation (Steiner)
Copied and distributed to interested fishermen

News Releases (Sims)

Selling the Seafood Concept to the American Consumer

Development of Surimi-Based Seafood Products

New Developments in Fish Chilling Techniques

Recent Advances in Shelf-Life Extension Methods

Secondary Processing and Value-Added Product Development News Releases

Paralytic Shellfish Poisoning Hazard in Alaska

Electronic Fish Finding

Wiring and Electrical Systems for Small Boats

Hydraulics in the Fishing Industry

Net Mending

Video Products

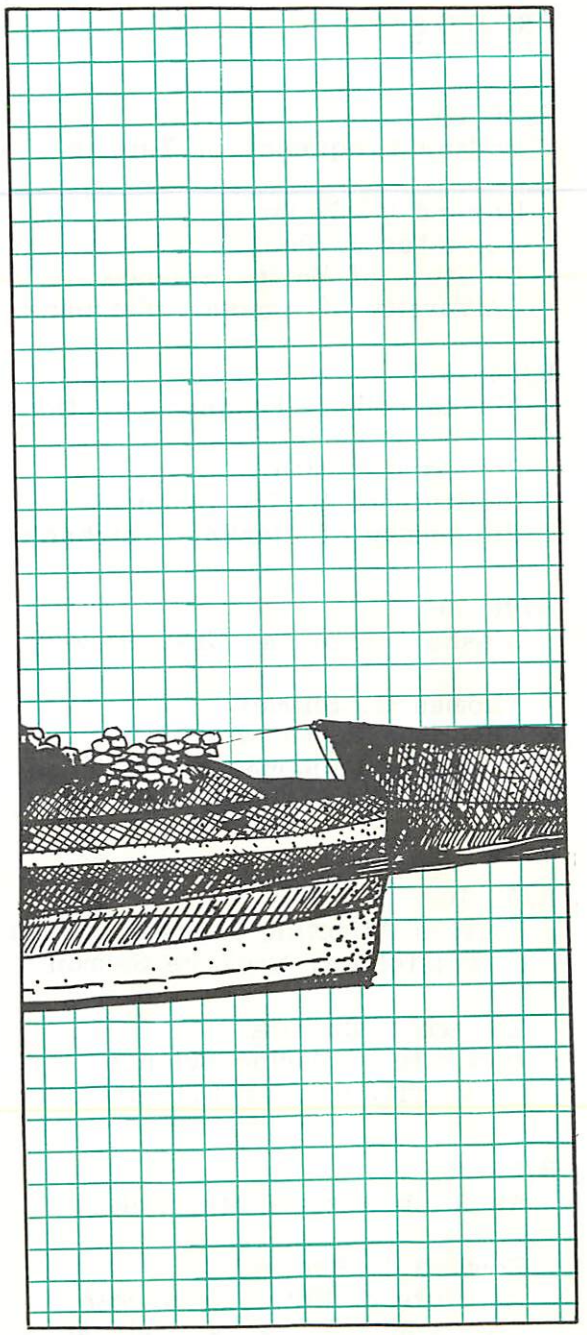
Loran-C Navigation

Slide Presentations

Salmon Quality (revised)

PROJECT	STATUS 1984
R/02-10 Potential of a Barriered Southeast Alaska Lake Containing Rainbow Trout for Production of Coho Salmon Smolt Richard A. Crone Northern Southeast Regional Aquaculture Association Sitka, Alaska	CG
R/02-11 Potential for Genetically Improving Salmon Willam W. Smoker Anthony J. Gharrett Michael S. Stekoll School of Fisheries and Science University of Alaska, Juneau	CG
R/06-15 Herring Stocks in Prince William Sound, Alaska Anthony J. Gharrett C.E. Burkey School of Fisheries and Science University of Alaska, Juneau	EX
R/06-17 Genetic Separation of Chinook Salmon Anthony J. Gharrett School of Fisheries and Science University of Alaska, Juneau	CG

NS-New Start; CG-Continuing Project; EX-Extended Project (to provide time for completion); CP-Completed Project



PROJECT	STATUS 1984
R/06-18 Molting Frequency of Tanner Crab Howard M. Feder Augustus J. Paul Institute of Marine Science University of Alaska, Fairbanks	CG
R/06-19 Alaska Pollock Feeding Functions Ronald L. Smith Institute of Marine Science University of Alaska, Fairbanks	CG
R/06-20 Alaska Dungeness Crab Biology and Parasitology Thomas C. Shirley Theodore R. Meyers School of Fisheries and Science University of Alaska, Juneau	NS
R/07-10 Factors Affecting Migration Timing of Bristol Bay Sockeye Salmon Tsuneo Nishiyama Institute of Marine Science University of Alaska, Fairbanks	CG
R/35-05 Shellfish Waste Biotechnology Edward J. Brown Institute of Water Resources University of Alaska, Fairbanks	NS

PROJECT	STATUS 1984
R/35-06 Postmortem Biochemical Changes in Pacific Salmon During Partially-Frozen Storage Donald E. Kramer Alaska Marine Advisory Program University of Alaska, CCREE John S. French John M. Kennish Chemistry Department University of Alaska, Anchorage	CG
R/35-07 Alaska Seafood Microbiological Profiling Jong S. Lee Fishery Industrial Technology Center Kodiak	NS
E/70-10 Sea Grant Traineeships Donald H. Rosenberg Alaska Sea Grant College Program University of Alaska	NS
A/70-01 Alaska Marine Advisory Program John P. Doyle Alaska Marine Advisory Program University of Alaska, CCREE	CG

PROJECT	STATUS 1984
A/75-01 Public Information Services Brenda R. Melteff Teri L. Frady Alaska Sea Grant College Program University of Alaska	CG
M/79-01 Program Management Donald H. Rosenberg Alaska Sea Grant College Program University of Alaska	CG
M/81-01 Program Planning and Rapid Response Donald H. Rosenberg Alaska Sea Grant Program University of Alaska	CG

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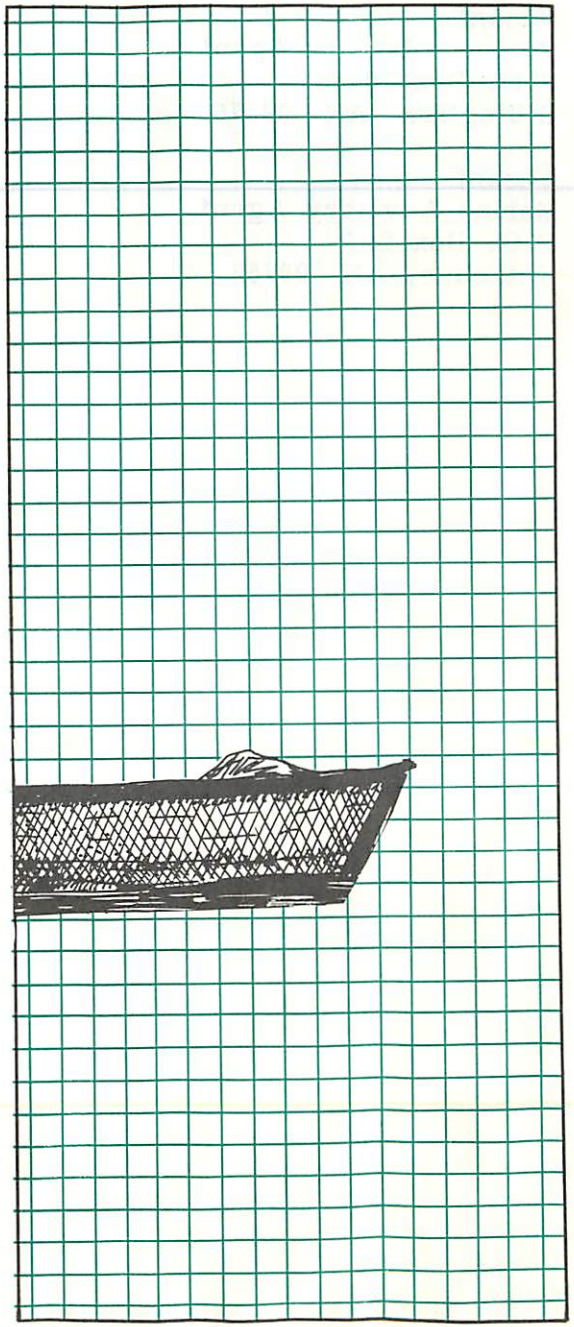

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