Whither Arctic Ocean Transportation?

Charles E. Behlke has long been an advocate of the commercial use of the Arctic seas. He has suggested the use of the North Passage (the North Passage lies to the west of the Canadian archipelago and to the north of Greenland) as well as the Northwest Passage. He attended the maiden cruise of the tanker MANHATTAN and has been involved in other coastal Arctic experiments. Since this issue is devoted primarily to nautical things it seems appropriate that Charles E. Behlke should comment on ocean engineering, in particular the use of tankers in the Arctic.

At the present time Behlke is Dean of the College of Mathematics, Physical Sciences and Engineering and Director of the Institute of Arctic Environmental Engineering at the University of Alaska.

The recent announcement by Humble Oil and Refining Company indicating its abandonment, at least for the present, of further work on tanker transportation of Alaska crude oil to the East Coast market has been disappointing to most coastal engineers and marine architects interested in Arctic development.

There can be no doubt that eventually sea transportation will be implemented for the movement to market of a large segment of the North American Arctic's energy resources. At present, the surface tanker has a great edge over the various submarine concepts simply because large tanker technology is far more advanced than that of large submarines. Certainly the difference between a successful voyage and a set of well drawn plans is appreciable. However, the greater the delay in the use of water transportation of Arctic resources, the better are the chances for the development of submarine technology, and the greater is the opportunity for hard refinements in what are presently paper advantages of such a vehicle.

The use of large scale water transportation for the Arctic can be expected to be rewarmed toward the completion of the first of the many proposed Arctic pipelines. The staggering money requirements of simultaneous expenditures for such costly systems as the water and land transportation alternative for the Arctic's oil most certainly preclude expenditures for more than one alternative at a time. The fact remains that, though continental oil can move to continental markets through pipelines, the tapping of the Canadian Arctic Islands' resources virtually dictates water transportation. In addition, North America's Arctic oil and gas cannot move to Japanese or European markets through pipelines.

The writer anticipates the beginning of the construction of ice breaking super tankers toward the close of the coming five year period. When tankers have developed the technology of large size ice breakers, other intercontinental transportation will quickly follow. After all, the water distance from Japan to Europe via the Arctic Ocean is approximately \( \frac{1}{2} \) the distance through the restrictive Panama Canal. With such advantages certainly the day is rapidly approaching when the only disadvantage—sea ice—will be economically conquered.

---Charles E. Behlke
This Issue

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MEETING NOTICES, NEWS ITEMS, AND CURRENT PUBLICATIONS

THE COVER: A view of petrochemical wharves along Alaska’s Cook Inlet near Nikiski.
The Nature of Tidal Hydraulics In Cook Inlet

ROBERT F. CARLSON

Cook Inlet in South Central Alaska is one of the unique bodies of water in the world. Its most famous characteristic is the high tide which has a mean range of 15 to 25 feet (Figure 2) with an occasional diurnal tide range up to 30 feet. It is certainly the largest marine inlet in Alaska and is rivaled world-wide only by the Bay of Fundy. The inlet is long, wide, and shallow (150 miles, 20 miles, and 200 feet) with a natural partition caused by the relatively narrow forelands that divide it into an upper and a lower part. The upper part is joined by Knik Arm and Turnigan Arm. (Figure 1)

Although the great tide range receives the most publicity, the inlet has a number of other physical characteristics that combine to make its waters unlike any other. At the upper end above Anchorage, over 200 miles from the Gulf of Alaska, the Knik and Matanuska Rivers discharge up to 150,000 tons of glacial silt per day into the inlet during the summer months. The Susitna River adds another large amount further down across from Anchorage. With the silt, of course, comes the fresh water run-off at a flow rate of over 100,000 cubic feet per second. Because of its northern latitude (61°N) the upper part of the inlet is usually covered with ice floes each year from late November to early March. The high tidal fluctuations give rise to currents of up to 3 knots in most of the inlet and up to 6 knots in certain localities. When conditions are just right a tidal bore (a wall of water 6 feet high) is created in Turnigan Arm.

These hydraulic characteristics interact with the physiographic features to make up a very complex water mass. If the inlet were situated in a far-off, remote corner of the world it still would be of great scientific interest. But it happens that under, within, at the surface, and around the shores of the inlet lie an important part of Alaska's resource economy. Cook Inlet is the site of Alaska's largest city, only producing petroleum field, an important fishery, the largest industrial complex in the state, and, most important, Alaska's busiest transportation linkage. The harsh environment presented by the inlet waters causes many problems to both the existing natural marine life and to engineering development activities in the inlet and along its shores. For example, one might expect that the design of a waste discharge outfall should be based on quite a different set of characteristics than found, say, in an ocean current on the coast of California.

Of all the unusual characteristics of the inlet, probably the most important
to engineering construction are the two variables of the tidal hydraulic regime—current velocity and water surface elevation. This concern, of course, is not peculiar to Alaska and a large reservoir of techniques, methods, and computation schemes have been developed to explain or "model" the flow of water in open channels. Some are more suitable from a scientific point of view of describing or explaining the flow characteristics and others are more applicable to predicting the effects of constructing engineering works in the tidal waters. These works can either cause a change in the tidal regime or can themselves be affected by the water flow.

The study of tidal hydraulics has traditionally been carried on by one of four techniques—harmonic analysis of the tidal record, analytic solution of the basic equations of free surface flow, numerical computation of the equations, and hydraulic modeling with the use of small scale replicas of a body of water. Each has its inherent advantages and disadvantages when applied to a given case. (An excellent review of the present state-of-the-art is given by Dronkers, 1969.)

The first, harmonic analysis, is primarily a descriptive technique which seeks to break the record of tidal height into its sine wave (harmonic) components. The technique is useful for predicting the exact time of occurrence of the tide level at a given location, provided the natural regime is not changed. Usually about 30 components are required to accomplish the task for most inlets. However, Cook Inlet, because of its complex physical configuration requires over a hundred components. The results of these analyses are best known as the tide tables published by the U.S. Coast and Geodetic Survey and as a simplified tide table by various commercial organizations.

The second method, an analytic solution, has the advantage of enabling the investigator to quickly predict at least some features of a given flow regime and form a base of comparison for other methods. The analytic solution typically begins with the two basic equations of fluid flow. The first, the equation of continuity, is a statement of the conservation of mass which simply says that if you push a certain quantity of water through one section of a volume, the quantity must either go out the other end or into storage within the volume. The second equation usually appears more complex but is based on the principle of conservation of momentum which is most familiarly expressed as applied to a solid body by \( F = ma \). In the fluid case the force, \( F \), is a pressure force caused by differences in water surface elevation and by the friction resistance to the flow.
caused by the bottom of the channel. The mass part is simply the mass of the water body times its acceleration with time. If one were able to use the information provided by a single particle, the equations would be simple. However, because a water body is made up of millions of even, large chunks of water of varying velocities, depths, pressures, and resistance forces, the equations must be of a partial differential type, intractable except in the simplest of cases. So the investigator is immediately faced with a dilemma between a usable but oversimplified mathematical solution or a more realistic solution but one requiring evaluation of empirical constants. For example, a common solution can be easily built up from a simple progressive wave traveling up the channel and reflected off the far end—for a constant width, constant depth, deep channel with no friction. A glance at Cook Inlet quickly indicates that such a model is entirely unrealistic. The inlet has a partial closure at the forelands and a very complex reflection pattern at the upper end in combination with a variable bottom depth and certainly a great deal of friction resistance.

The third method, numerical computation, seeks to circumvent the restrictions of the analytic models by including more of the momentum equation and more realistic boundary configurations. Another kind of compromise with reality quickly appears, however, as the infinite number of particles represented by the partial differential equations must be replaced by a finite number of segments of water. Even the largest computer cannot efficiently handle enough segments, so a different kind of approximation is introduced. The author has applied a one-dimensional model (the back and forth flow) to Cook Inlet with some success. (See Reference 2. and Figures 2 and 3 for typical results.) A two-dimensional model would appear more feasible but quickly becomes cumbersome and inefficient. Even the most sophisticated computer model requires verification by field data and sufficient field data is not usually available. The most desirable feature of computer models is the ease which the effects of changes can be inserted in the model. For example, the effect of a causeway across one of the Arms on the tidal variation at Anchorage could be easily approximated by a one-dimensional model.

The last method, hydraulic modeling, has been somewhat replaced by the computer model over the past several years. However, it is still quite useful, especially when the boundary configurations are quite complex as is the case with Cook Inlet. For example, it is extremely difficult to achieve a realistic solution of the tidal bore phenomenon or the exposure of large areas of tidal flats such as occurs in Turnigan Arm.

As development continues in the Cook Inlet basin, there will be an increasing need for more information on the characteristics of the water body. Some needs will arise from the desire to predict the effects caused by development and some from the desire to predict the effects of the inlet waters on the development itself. Much of the needed information will be centered around the hydraulic or water flow characteristics. It is par-
particularly important to realize that the inlet is vital to the whole of Alaska; it is unique, in so many respects, that standard engineering design practices and administrative rules and criteria that have been developed elsewhere simply cannot be transferred intact. Instead, the continuing development will require a high degree of ingenuity on the part of the engineer in combination with a continuing series of research studies and investigations.

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Manuscript received: December 1970

Study Programs

NORTHERN STUDIES PROGRAM

A two semester Northern Studies seminar is being offered at the University of Alaska. This interdisciplinary course gives students the opportunity of working with leading experts in all fields that relate to the North. This fall the seminar focused on three topics: native peoples, northern ecosystems and the literature of the North. Spring term the students will simulate the preparation for a scientific expedition to the North as a practical means of discovering what one needs to know about the region and how to go about learning what is necessary.

The seminar has been designed to cap the program of a Bachelor of Arts major in Northern Studies, a new program which is still in the formulative stage. Several universities offer northern studies programs in scientific disciplines but none has a comprehensive interdisciplinary one designed specifically for the nonscientist. Potential teachers, businessmen and administrators who expect to live and work in the North can gain a broad understanding of the region which will make their work more effective.

Information concerning the Northern Studies program can be obtained by writing to:

W. R. Hunt, Chairman
Northern Studies Committee
University of Alaska
College, Alaska 99701

ENGINEERING FOR THE ARCTIC—UNIVERSITY OF ALBERTA

The University of Alberta has been active in Arctic Engineering instruction and research since the early 1940's when they became involved in the engineering aspects of frozen soils. In the ensuing quarter century this program has developed into 3 general fields of Arctic engineering — geotechnology, environmental engineering and resource development.

The approach is twofold — instruction and research — with each complementing the other. Many of the graduate students and faculty make significant contributions to northern technology through their studies and research work.

Programs included in the 3 major fields mentioned are:

- Properties of Arctic Soils & Rocks
- Mechanics of Frozen Ground Phenomena
- Thermal Regime Near Pipelines
- Foundation Engineering
- Mechanics & Properties of Ice
- Biological Activity Under Ice
- Ice and Frost Formation
- Material Properties at Low Temperature
- Mineral Exploration, Mining and Beneficiation
- Petroleum Exploration
- Risk Analysis in Capital Investment Decisions
- Real Time Computer Applications
- Resource Management
- Arctic Land — Use Research

Active study and laboratory research is being carried out in these areas. In an effort to better coordinate their own efforts with others interested in Arctic technology the Faculty of Engineering has published and made available a booklet Engineering for the Arctic. This booklet describes their considerable interest and activity in the Arctic and can be obtained by writing the Faculty of Engineering, University of Alberta, Edmonton, Alberta, Canada.
Artificial Upwelling in Alaskan Fiord Estuaries

W. E. SHIELS and D. W. HOOD

The meaning of aquaculture varies among those who are concerned with it. To J. E. Bardach (1968) it means husbandry of aquatic animals to obtain high grade protein food. To others it may mean production of the useful species to either the larva or fingerling size for restocking natural fish populations; or the means for producing animals of higher quality, free of certain toxins and pollutants that can be better controlled by some form of impoundment; or providing algal forms for use in intensive husbandry in aquaria of highly selected marine organisms; or providing a place that is attractive to wildfowl, mammals, or other species that then could be harvested to advantage. A more general definition might be that aquaculture includes any system which utilizes naturally available energy for the enhancement of biological productivity. It is this latter scope which is especially applicable to Alaskan waters.

In certain areas of Alaska, high tides, intensive sunlight for extended periods in the summer, and an abundance of deep ocean-derived water close at hand provide the natural conditions desired for maximum productivity potential in an aquaculture system. The first objective of aquaculture is to harness the natural forces into providing the most valuable sources of plant products. These products may then be supplied to any appropriate primary consumers.

Aquaculture has been discounted by some individuals as not being particularly attractive economically for one reason or another. However, Bardach (1968) states in part as follows: "The products are now mainly luxury foods, but there are some indications that upgrading of the frequently primitive culture methods now in use could lead to increasing yields per unit of effort and to reduced production costs per unit of weight. Under favorable conditions, production of animal flesh from a unit volume of water far exceeds that obtained from a unit surface of ground. With high-density stocking of aquatic animals flushing is important, and flowing water or tidal exchange is essential. Combinations of biological and engineering skills are necessary for full exploitation of aquacultural potentials; these are only partially realized because economic incentives may be lacking to tend aquatic organisms..."
rather than to secure them from wild stocks, because of social, cultural, and political constraints. Nevertheless, a substantial development of aquaculture should occur in the next three decades and with it a severalfold increase in total yield."

Alaska has particular advantages for the development of aquaculture because of its extensive system of nearly all types and classifications of estuaries. These regions have an extremely rich abundance of flora and fauna, much of which has not been exploited or even explored. Some of the highest production figures ever recorded have been measured in Alaskan waters, both in estuarine environments and in the open sea (McRoy, C.P. in press; Goering, pers. comm.). Some have said that the cold climate and low light conditions of the high latitudes would retard photosynthetic growth. This concept appears to be greatly in error. Provided that adequate light and nutrients are available, the rate of net photosynthesis may become remarkably high. To verify that high production does occur under adverse conditions, one need only look at the extremely rich diatom growth occurring in arctic sea ice a few centimeters above the ice-water interface, which occurs under very low light conditions and certainly under subfreezing temperatures (Meguro, H. et al., 1967). In addition, it is known that photosynthesis is less affected by cold water than is respiration. In the economy of cell metabolism, the net energy fixed is more vitally important than the total energy fixed. Since respiration is low in cold water the cells need do less work to maintain themselves, and fixed energy from photosynthetic processes can accumulate into vast stocks of organic matter not possible in the more tropical waters.

Estuarine Aquaculture

The extremely rugged Alaskan coastline is characterized by many inlets, islands, and estuarine situations which have small bays with narrow entrances where low-cost impoundments could be constructed. Southeast Alaska illustrates this kind of coast-

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**Figure 2**

PYBUS BAY, S.E. ALASKA.

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The Northern Engineer
Engineering Considerations

Since most fisheries of any importance in the open ocean are associated with coastal upwelling regions (Ryther, J. H. 1969), many ideas have been proposed for producing artificial upwelling. Under normal situations, this is a difficult matter because the cost of the energy required to raise the stable water from below the pycnocline to the surface is in excess of the value of the water obtained. However, in some areas of the world, especially Alaska, there are between 10-30 foot (~3-9m) tides in areas where deep nutrient-rich water can readily be found; usually in the fiord system. It therefore seems reasonable that one could utilize tidal energy to provide highly nutritious waters for growth of photosynthetic organisms behind impoundments.

A sketch of a possible impoundment is presented in Figure 4. A pipe is run through the dam to a depth of 25 fathoms (~47.5m) in the adjacent fiord where water rich in nutrients occurs. As the tide comes in, deep water is forced into the impoundment by the hydrostatic head. To facilitate mixing, several outlets for deep water may be constructed along the pipe within the impoundment. On the ebb tide the flow of water is reversed, and is channeled through an adjacent pipe to an area outside of the embayment. The portion in Figure 4 labeled TIDAL BAY may either be deep or shallow, since interest is only in the euphotic zone. The water beneath the euphotic zone need be of no concern except that it may enhance or limit the ability to grow and collect organisms. Thousands of acres of similar systems prevail in Alaskan estuaries, offering a unique opportunity for the investigation of techniques to maximize production in either shallow water or fiordal type estuaries.

Economics

The first consideration is the cost of an impoundment and the associated pipe for transfer of large volumes of water from the deep adjacent fiord to the channel of impoundment. For purposes of estimation, consider a dam 25 feet (~7.6m) high, 15 feet (~4.6m) wide at the bottom and two feet (~0.6m) wide at the top, and 50 feet (~15.2m) long, built at the neck of an inlet which is nearly dry at low tide. The dam would be coupled with other types of fill to bring the banks in line. This design should be adequate to impound many suitable shallow inlets adjacent to fiords for the purpose of obtaining high nutrient water. It is estimated that the cost of such a dam would be approximately $100 per cubic yard (~$131/m³) concrete in place or $800 per running foot (~$2625/m) of the dam, making a total of $40,000 to build such a structure of concrete 50 feet (~15.2m) wide. An earthen dam, however, of the same dimensions, reinforced by timber pilings, would cost approximately $240 per running foot (~$787/m), or a total of $12,000.

It is estimated that the pipe should be four feet (~1.2m) in diameter, constructed of steel, and should be

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Table 1 Typical Nitrate And Phosphate Values For Spring, Summer And Fall At A Station Near Pybus Bay (Wallen, Unpublished Data)
approximately 500 feet (≈152.4m) long. Such a pipe in place would be expected to cost about $100 per foot (≈$328/m) or $50,000 total cost. These fixed costs plus contingency allowance would bring the total expense of such an impoundment to approximately $75,000 if the earthen dam were chosen.

A pipe this size with an average tidal head of not less than 10 feet (3.1m) would produce water in the impoundment at 130 cubic feet per second (≈3.7m³/sec). If we assume a flood tide lasting for a total of eight hours each day, then approximately 86 acre feet (≈1.06 x 10⁵ m³) of water per 24-hour period would be supplied.

**Productivity**

The depletion of nitrate from surface waters between April and August is roughly 23.5 µg-at/liter (Table 1). If it is assumed that this difference in nitrate is available to plants growing in the impoundment, then the net potential of carbon fixation can be computed based on a supply of 86 acre feet (≈1.06 x 10⁵ m³) per day of deep ocean water.

On the basis of a carbon to nitrogen ratio of 6.25:1 (Harvey, H. W. 1963), about 218 kilograms of carbon would be fixed per day if all the nitrate (23.5 µg-at/liter) were removed from the water. Since the ratio of carbon to biomass is about 1:42 for phytoplankton (Cushing D. H. et al., 1958), then approximately 9,160 kilograms live weight of plants would be produced per day.

This plant material would now become available as food for consumers. Its value is difficult to appraise because much depends upon the type of organism or the system selected. Even so, it may be useful to continue the calculation based on primary consumers such as clams, herbivorous fish, etc. If it is assumed that the conversion efficiency of plant food to primary consumer is 1:5 (Ryther, J. H. 1969) and that the ratio of grams carbon fixed to animal biomass is also about 1:42 (Cushing, D. H. et al.,
1958), then the energy fixed would be equivalent to about 1,830 kilograms live weight of animals per day. The growing season in Alaska is approximately 200 days per year, which would provide an annual yield of 366 metric tons or about 22.5 metric tons per hectare. These calculations compare favorably with some of the highest production values ever recorded in aquacultural systems (Bardach, J. E. 1968, p. 1104), and are made without enrichment of the water by any means other than the natural enrichment by deep water. No selection of organisms to obtain higher quality either in terms of the plants or the consumer is proposed. The value of the product can be enhanced in several ways: hatchery rearing of larval animals; raft culturing; concurrent growth of either exotic organisms for special uses such as pharmaceuticals, or of luxury fish foods such as king crab, dungeness crab, shrimp, etc.

Direct utilization of plants commercially, such as eelgrass or red algae, may be found more valuable than dealing with primary or secondary consumers. The agars and carrageenins obtained from red algae are already important items of commerce, and many species of red algae are already in slight supply and great demand.

Summary

The selection of a proper site for aquaculture in Alaska would require: (1) the choice of an embayment with a depth and substrate conducive to normal growth of the species to be cultured, (2) a basin with a narrow neck and a shallow sill which was situated close to a source of nutrient-rich deep water, and (3) an area with maximum exposure to sunlight. A dam would be constructed with readily available material to reduce the cost; pilings, rock, and dirt fill are suggested. The pipe extending through the dam and into the bay could have several outlets which would deflect the high nutrient water upward. This arrangement would enhance the physical mixing of the water for the maintenance of maximum uniform growth. In addition to mixing, the rate of exchange of water within the embayment could be studied with respect to maximum production values.

There is little question that ocean resources must be tapped in the near future to feed world populations. Many specialty products may also be derived from the ocean as our knowledge and skills become more advanced. Therefore, it would seem important at this time to make efforts to maximize the yield of organic production from the ocean by experimental efforts, taking advantage of special local situations with respect to available energy.

Alaska is an area which has intensive sunlight for short periods of the year, high nutrient waters, and high tidal energy. Investigations should be undertaken to determine the methodology required for obtaining productivity at a minimum cost, anticipating that time when such techniques will perhaps be essential to supply man's needs.

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D. W. Hood, Director, Institute of Marine Science; W. E. Shiel, MS Candidate Oceanography, University of Alaska, College, Alaska 99701.

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THE NORTHERN MUNCHAUSEN
BILL HUNT

Experts in the United States and Canada cast jealous eyes at the northern sea route of the U.S.S.R. and contemplate the development of a commercial Northwest Passage in the near future. Yet if we believe what we read of the extraordinary adventures of Jan Welzl published over thirty years ago, there is nothing to Arctic voyaging.

Jan Welzl, purported author of the books Thirty Years in the Golden North and In Quest of Polar Treasures was a Czech who traded, hunted and prospected in the North for many years from the 1890's through the 1920's. His home base was in the New Siberian Islands where he lived in a cave. The Russians thought the islands were uninhabited.

His trading circuit entailed fantastic travels. Each season he sailed to Nome and St. Michael, called at St. Lawrence Island "where the gold miners were," to the Anadyr River, then through the Bering Strait to call at Eskimo settlements as far east as the Mackenzie River. From the Mackenzie he went on to Franz Josef Land and Novaya Zemlya before returning to winter again in the New Siberian Islands. That is some journey to make in a small boat, but beyond conceding he could be crushed by ice, Welzl gave no indication his voyages were arduous. Men were better in those days!

The Laura, Welzl's little trading schooner, which cost him $400,000, was not used when he and other hunters made their annual winter hunting expeditions. They used dog sleds and traveled from the New Siberian Islands to the Mackenzie River which they ascended. In that region they met such characters as "the King of the Rocky Mountains," a hermit who showed them two animals the size of foxes which dwelled underground at all times, and other such wonders. From the Mackenzie they crossed over to the Yukon River system and sold their furs in Nome.

Part of his trade was with hermits who lived in caves all over the Arctic. No one but Welzl knew about these strange fellows. He also knew all...
about the Eskimos. Little Eskimo girls were mature at six and generally had their first child between the ages of six and eight.

To supplement his income Welzl took charge of the Alaska mail, using twenty-four sleds tied in a line and pulled by 350 dogs, the lead dog’s line extending some half mile from the lead sled. Harnessing all the dogs was some task but if driving such a team caused anxiety Welzl did not mention it. Mail was delivered throughout the Arctic on a circuit longer than the distance between America and Europe. For all the travails and mileage involved there was profit in the mail route. Welzl once got $1,000 from a lonely man for delivering one letter.

Once one of Welzl’s friends had his nose so severely frost bitten that it simply fell off. Quick as a flash Welzl went for the Eskimo “prophet” who secured some skin from a child and grafted the nose back on. It grew into place in no time.

Arctic survival experts had better heed some of Welzl’s experiences. Scurvy could be caused by too much meat with the consequence that the gums were affected and the teeth loosened. One remedy was to take a mouthful of mashed potatoes, retain it in the mouth for about one half hour, then spit it out carefully so that the teeth did not go with the spuds. In the extreme cold Arctic residents held their noses firmly when they sneezed for fear the agitated protuberance would fall off.

Many curious things befell Welzl. Once a wealthy New Yorker sailed to the New Siberian Islands on his yacht with his sickly wife who was convinced that only the Arctic climate could cure her. Welzl was paid $28,000 for boarding her for a winter and complained that it was little enough because of the high cost of living.

A strange phenomenon that bears some investigation was the appearance of the “death bird” whenever a person was to die a natural death in the North. Invariably this black bird came out of nowhere to perch upon the cave of one marked for death, screech three times and fly away. Soon the occupant of the cave was no more.

One would assume that the learned book reviewers of London and New York rose as one to denounce such exaggerations when the two books appeared in 1932 and 1933, but in fact many of them swallowed the stories whole. A London Times reviewer felt the author “was too shrewd to be deceived and too simple and unimaginative to tell lies.” An enthusiastic reviewer for the New Statesman and Nation refused to take the question of fakery seriously. “Fake or no fake, take it which way you like, the Quest for Polar Treasures is a remarkable book, and I for one am ready to accept every word of it.” In the Christian Science Monitor we read praise for “a narrator who has lived so tremendously and is yet pleasingly self-effacing.” While the New Republic referred to “as striking a record of Arctic adventure as has ever been written and gives a more intimate and solid feeling of Arctic life than even the best books on Arctic exploration.”

Other reviewers were not taken in. The leading Arctic expert of the day, Vilhjalmur Stefansson, was outraged when his cries of fraud were ignored by the literary establishment and chagrined when Thirty Years was made a Book-of-the-Month Club choice. What particularly irritated Stefansson was that the public acceptance of these parodies as fact emphasized the general existing ignorance of the North.

Today it would be more difficult to pass off such tall tales as fact because people are more critical. Once I told an educated woman, a school teacher, that permanently frozen ground is characteristic of the North. She called me a liar and a fraud.
MARINE PLANT RESOURCES OF ALASKA

C. PETER McROY

Thousands of miles of rocky coast of Alaska support an abundance of seaweeds that are the potential for a new northern industry offering a technological challenge to engineers. Seaweeds are currently harvested in California, along the Atlantic coast of Canada and the United States, in Japan and numerous other countries. A new seaweed processing plant is under development in British Columbia. One use of marine plants exists in Alaska. In Southeast Alaska, the giant kelp, Macrocystis, when covered with herring spawn is collected and sold to the Japanese as a food delicacy. The potential for other types of seaweed utilization appears large.

Seaweeds are algae, they lack roots and the vascular system of terrestrial plants but their holdfast permits them to exploit hard rock surfaces and even withstand a battering surf. The chemistry of these plants also differs greatly from that of the land plants. Many species produce, through metabolism, gelatinous compounds and herein lies much of their commercial value. Although in some countries seaweeds are eaten directly, in the United States they are valued for their chemical extracts. Two major groups of seaweeds, the browns and the reds, are important to industry. Conveniently coded, color in this instance indicates a biological relationship among the species within each group.

The brown seaweeds (Phaeophyceae) are a group of intertidal and subtidal algae that epitomize the common notion of seaweeds. This group includes the kelps of which Macrocystis, Nereocystis, Alaria, and Laminaria are abundant and important species in Alaska. Kelp beds are features of the temperate and higher latitudes of the world ocean, exclusive of the tropics. Some species, such as Alaria, common in Cook Inlet, grow to 70 feet long. Also among the brown seaweeds is the ubiquitous rockweed of northern coasts, Fucus. The brown algae attain very high standing crops, up to 20 kg/m² in Alaska. An early 1912-14 survey of kelp by the U.S. Department of Agriculture estimated more than 10 million tons grew on the Pacific coast of Alaska (Table 1). I would guess that this quantity exists today since most of the coast remains unpolluted.

Kelp was once harvested for its potash and iodine, but today the most valuable products are algins. Algins are a group of compounds that have a remarkable water absorbing quality. They are used as thickening, stabilizing, emulsifying, gel-forming, or film-forming colloids in numerous industries—foods, pharmaceuticals, drugs and antibiotics, paint, cosmetics, printing and several others. Every bowl of ice cream, all powdered milk products and all beer contain a little seaweed.

The red seaweeds, Rhodophyceae, are smaller, less obvious inhabitants of the lower intertidal to deep subtidal. Some of the important Alaska species include the intertidal Gigartina, Iridaea, Porphyra, and Priapititis and the subtidal Schizymenia, Rhodomenia, Callophyllis, and Dasyopsis. All these plants have leaflike bodies that are red, brownish-red, or purple, and occur in dense coverings on rocks, reaching standing crops of 5 kg/m². No measure of total crops in Alaskan waters is available; a fair estimate might be 2 million tons.

Red algae are valued for their agar, which is a group of gelatinous compounds used widely in the medical, food, textile, paper, film, tanning, and other industries. Japan is currently the major world supplier of this material. The slicing quality of cheese is improved by agar additive.

With the exception of the herring eggs on Macrocystis, no current utilization of seaweeds exists in Alaska. As background for the industry that is sure to come, the Institute of Marine Science of the University of Alaska through the National Sea Grant Program began a study in the summer of 1970 of the distribution and abundance of seaweeds in Alaska. This research will provide the basic information on the regions and species available for harvest.

Although distribution and abundance seem like rather simple information to acquire, in practice they require some of the latest developments of ocean technology, especially when the entire Alaska coast is the goal. In current work scuba divers coupled with underwater television are the basic data acquisition system. More traditional trawls and grabs have only limited application. In the future we also hope to use satellite imagery with infrared photos to map intertidal and surface floating species over large areas of the coast. There appears to be considerable technological opportunity in developing

<table>
<thead>
<tr>
<th>Region</th>
<th>Tons</th>
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<tbody>
<tr>
<td>Western Alaska</td>
<td>2,437,000</td>
</tr>
<tr>
<td>Southeast Alaska</td>
<td>7,833,000</td>
</tr>
<tr>
<td>Puget Sound</td>
<td>397,500</td>
</tr>
<tr>
<td>Puget Sound to Pt. Conception</td>
<td>4,377,400</td>
</tr>
<tr>
<td>Pt. Conception to San Diego</td>
<td>9,000,000</td>
</tr>
<tr>
<td>San Diego to Cedros Island</td>
<td>8,500,000</td>
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Table 1. Standing Stocks of Kelp on the American Pacific Coast (USDA, 1915)
equipment for the rapid survey of shallow water areas, especially for tools that can be used in quantitative work. In general, available undersea cameras and related devices are for use from vessels and cannot be used in continuous surveys from the beach to deeper water. Scuba divers help but are limited to very small areas and need large amounts of time. The growing need for seaweeds in the world will before long make it economically reasonable to apply considerable technological effort toward seaweed survey equipment.

The development of a seaweed industry in Alaska awaits the solution of one other problem, the development of harvesting equipment suitable for the Alaska coast. The range of tides and depths of valuable algae species are, to considerable extent, features of a local geographical area. Techniques used on the Atlantic Coast and in California are not generally applicable to Alaska. While industry may not follow right on the heels of the University’s research, the growing demand coupled with a diminishing supply (largely due to pollution) cannot keep it out of Alaska; the technological challenge to engineers to develop the equipment for the seaweed industry appears unlimited.

References

George Back, Narrative of the Arctic Land Expedition . . . in the Years 1833, 1834 and 1835, Rutland, Vt., Charles E. Tuttle, 1970. $7.00.
John Franklin, Narrative of a Journey to the Shores of the Polar Sea in the Years 1819, 20, 21, and 22, Rutland, Vt., Charles E. Tuttle, 1970. $19.50.
Charles Francis Hall, Life with the Esquimaux, Rutland, Vt., Charles E. Tuttle. $7.50.
Edwin A. MacDonald, Polar Operations, Annapolis, U.S. Naval Institute, 1969. $11.00.

MacDonald dedicates his Polar Operations to “those early captains who dared to pit their small, weak vessels against the dangers and unknowns of the polar ice fields,” which is reason enough for reviewing this book together with the early narratives of Back, Franklin and Hall. Drawing on his long service as skipper of an icebreaker supporting scientific expeditions in the Arctic and Antarctic Oceans, MacDonald provides very able and concise descriptions of the polar environment, icebreaker design and operation, ice seamanship, preparations for wintering over, and safety and survival.

This book could be used as a guidebook to expedition planning but because it reads so well its value is not limited to such pragmatic purposes. Clearly the author has read and digested all the polar exploration literature and nicely relates past endeavors in the Arctic and Antarctic to the current state of knowledge.

MacDonald’s choice of illustrations is excellent and the well-designed book has maps and appendices that include a glossary, a wind chill chart, and an international listing of icebreakers with their statistics.

The narratives of the early nineteenth century explorers still retain a practical as well as a literary value. Scientists and anthropologists continue to mine these documents for their careful descriptions by trained observers at a time when the North was almost as remote as the surface of the moon and its peoples yet unaffected by Western expansion. From the scores of northern exploration narratives the publisher made excellent choices in the three books by Back, Franklin and Hall. Back and Franklin were Royal Navy officers who followed northward flowing rivers to the Arctic and investigated the neighboring shoreline to fill in some of the blanks on the Arctic map and support the efforts of other colleagues who were simultaneously probing the icy waters in quest of a Northwest Passage. Both write effective prose and reported their observations accurately.

Hall was an American who headed one of the many search expeditions in quest of possible survivors of the Franklin expedition. His narrative is a classic. Though he sometimes indicated a contempt for the Eskimo culture, he assiduously studied their ways. He was an extraordinary man, a self-educated adventurer who did not fit in the common mold. Like John Franklin he found his grave in the North on a subsequent expedition—probably poisoned by a companion.

Particular note should be made of both the price and quality of these reprints. All include the reproductions of the original maps in full size and the original black and white engravings are well reproduced. The colored plates are sumptuous! It is rare indeed to find books of the quality of these at such modest prices.

—Bill Hunt

ACKNOWLEDGMENT
The Institute of Arctic Environmental Engineering of the University of Alaska expresses sincere gratitude to the A. C. Ingersoll Jr. Memorial Fund for its recent gift of $1,000. The gift, in the form of a sponsorship, was presented to Robert C. Byrd, who is working toward a M.S. in Ocean Engineering.
AFFCO Symposium

A symposium entitled *Fire in the Northern Environment* will be sponsored by the Alaska Forest Fire Council April 13-15, 1971 at the Geophysical Institute, University of Alaska, College, Alaska.

AFFCO represents governmental, educational and private sectors concerned with wildfire and its effects in Alaska. Having recognized a serious need to assemble and summarize current information and opinion from the numerous interests affected by wildfire, AFFCO's symposium will provide a forum for exploration of the interaction of wildfire and aspects of the northern environment.

Papers will be accepted in the following areas:

I. Fire and the environment
   - Fire-vegetation relations
   - Fire and wildlife
   - Fire, air and water resources
   - Permafrost and wildfire

II. Fire and man
   - Effects of wildfire on the economy
   - Fire and military operations
   - Fire control
   - State and local government

Although abstracts were due by January 15, completed manuscripts are not due until April 1, 1971.

For further details write:
Dr. Charles W. Slaughter
Symposium Chairman
P.O. Box 1601
Fairbanks, Alaska 99701

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INTERNATIONAL CONFERENCE

Preliminary announcement has been made of an International Conference on Port and Ocean Engineering Under Arctic Conditions, to be held at Trondheim and Tromso, Norway, August 23-30, 1971. Sponsors are the Technical University of Norway and the University of Alaska.

The scope of the conference will include most aspects of Arctic marine engineering. Abstracts of papers should be submitted to the POAC Secretary, the Technical University of Norway, 7034 Trondheim, Norway, by March 1, 1971.

For information about the conference write to one of these gentlemen:

Dr. Arthur Brebner, Head
Department of Civil Engineering
Queens University
Kingston, Ontario, Canada

Dr. Per Bruun, Chairman
Department of Port and Ocean Engineering
Technical University of Norway
7034 Trondheim, Norway

Dr. Donald Hood, Director
Institute of Marine Science
University of Alaska
College, Alaska 99701 USA

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COLD REGIONS ENGINEERING SYMPOSIUM PROCEEDINGS

Proceedings of the Symposium on Cold Regions Engineering 1970 is now being published. A limited number of the 500-page two volume edition will be available soon through the Department of Civil Engineering, University of Alaska, College, Alaska 99701. Those interested may write to John L. Burdick, head of the department and Proceedings editor. The two volumes will sell for $10.00.

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ENVIRONMENTAL ATLAS OF ALASKA

The popularity of the first edition of the University of Alaska's Environmental Atlas of Alaska has prompted a second printing by the Institute of Arctic Environmental Engineering. No fundamental changes have been made in the volume's content.

The Atlas, compiled and edited by Philip R. Johnson of IAEE and Charles W. Hartman of the University's Institute of Water Resources, covers a broad range of Alaskan environmental material. Forty-nine plates are encompassed within the five major sections, with text furnished for each one.

PHYSICAL DESCRIPTION provides information on such topics as permafrost, glaciation, forest types, potential cultivable land, earthquakes and distances within the state. Depths, summer and winter currents of coastal waters, summer and winter sea temperatures, sea ice distribution, and extreme tides at harbors are provided in ALASKAN WATERS. Two sections are devoted to LIGHT and CLIMATE, while ENGINEERING INFORMATION gives heating degree days, thawing and freezing indices for Alaska. But
the Atlas gives much more than that mentioned here.

The 111-page volume sells for $12.00 and can be obtained by writing:

Institute of Arctic Environmental Engineering
University of Alaska
College, Alaska 99701

Current Publications

DIRECTORY OF CANADIAN SCIENTIFIC AND TECHNICAL PERIODICALS

The fourth edition of the Directory of Canadian Scientific and Technical Periodicals now contains 890 titles, 529 more than the inaugural issue published in 1961. It is a guide to current journals covering the broad spectrum implied by the words science, technology and medicine, including trade journals, annual research reports, monograph series, report series and other publications issued on a continuing basis.

Such diverse titles as The Atlantic Fisherman and Shipping Review, the Canadian Journal of Genetics and Cytology, and Naturalist Canadien are represented. Bibliographical data, prices, frequency of publication, and editorial addresses are based on the latest available issues or information supplied by publishers. Each directory entry contains an indication of where a particular title is abstracted or indexed.

Copies of the Directory may be obtained at $5.00 each from the National Science Library, Sussex Drive, Ottawa, Ontario.

BUILDING RESEARCH IN SCANDINAVIA

The third Progress Report, dated 1969, of the Joint Scandinavian Working Group has recently been published. A limited number of copies of the English translation have been provided to NRC's Division of Building Research through the kindness of Dr. O. Birkeland, Director of the Norwegian Building Research Institute. These are available on an expanded loan basis from the DBR Library.

Exemplary cooperation in building research has been developed by the Nordic countries. In the Progress Report the eight participating institutes are described, as well as lists of projects and publications. When the publication is not in English, a translated title is given.

For those who would like to use this convenient report for a quick review of current Scandinavian work and literature in building research, a copy can be obtained by writing the DBR Library and requesting loan of Scandinavian Building Research, Biennial Report 1968.

BIBLIOGRAPHY OF ARCTIC WATER RESOURCES

The University of Alaska's Institute of Water Resources has recently published Bibliography of Arctic Water Resources by Charles W. Hartman and Robert F. Carlson, a two-part volume carrying more than 2,900 references to available literature on the nature of land-based water in arctic and subarctic Alaska.

For easy reference the computerized listing is divided into two sections—key words and citations. Key words run in alphabetical order, with as many as three separate entries for each bibliographical reference. An accession number is printed to the right, indexing the specific reference in the citation section.

Copies of Bibliography of Arctic Water Resources, Report No. IWR-11 November 1970, may be obtained at no charge by writing:

Institute of Water Resources
University of Alaska
College, Alaska 99701

National Research Council (NRC)
Division of Building Research
Ottawa 7, Ontario, Canada


DBR/NRC Research Program 1970.
July 1970, 61p. A listing of Divisional research projects including a brief description of the project, the name of the research officer responsible, and estimated completion date.

NRCC 11373 Permafrost as an ecological factor in the subarctic by R. J. E. Brown — reprint from Symposium on Ecology of Subarctic Regions held in Helsinki, 1966, p. 129-140
(DBR Technical Paper No. 313) $0.25.


U. S. Army Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

(available in photocopy or microform for cost of reproduction from the Clearinghouse for Federal Scientific and Technical Information [CFSTI] 5285 Port Royal Road, Springfield, Virginia 22151.)


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25-1340 Snow And Ice Control In California, Forbes, C. et al California Division of Highways Aerop April 1970 B-4-3 55p. PB-190 953 14 refs. Stewart, C., Spellman, D.
25-1342 Here's How Russian Experts Are Tackling The Permafrost, Belov, V. Oil and gas international Aug. 1970 10(8) p. 84, 89-90
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