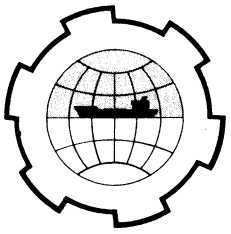
PORT AND OCEAN ENGINEERING UNDER ARCTIC CONDITIONS
TECHNICAL UNIVERSITY OF NORWAY



MARINE TRANSPORTATION IN ALASKA'S BERING SEA AND ARCTIC OCEAN AREAS

Walter B. Parker — I.S.E.G.R. — College, Alaska
Research Associate — U. of Alaska — U.S.A.

Since the end of World War II, Alaskans have pondered on how to develop high volume transportation systems that would allow them to develop the resources of their western and Arctic provinces. Generally, two major strategies have been developed: one based on providing surface transportation through rail and highway systems that would connect to the ice free ports on Alaska's Gulf Coast, and the other of short surface links to the ports of the icebound Bering and Arctic Coasts.

This study will concern itself primarily with the latter situation, but it will also incorporate a brief comparison between the two proposed solutions based on material developed by the State of Alaska, the United States Department of Transportation, and other federal government agencies.

Until the discovery of the Prudhoe Oil Fields on Alaska's Arctic Coast, the transportation requirements for western and Arctic Alaska were on a scale that could be handled by air service for the year round needs, and seasonal marine transport to satisfy major cargo requirements. It was a marginal system at best and generally provided the area with high cost, infrequent, and unreliable service. The reasons for poor service were manifold, but primarily they were due to the scattered, small, and poverty stricken population that generated few transportation requirements; and to the difficulties created by the physical environment which restricted marine transportation to a limited season varying from a few weeks to five months in length, and which created high cost factors for all forms of transportation.

The level of transportation needs for this part of Alaska simply could not justify expensive investments in all weather navigation aids for air and marine systems, extensive communications circuits, icebreakers, and the other infrastructure necessary to support a reliable transportation system with low direct operation costs.

The same situation had existed in interior Alaska until a substantial federal investment in the Alaska Railroad and the Richardson Highway made year round surface transportation to Fairbanks and other points in the eastern interior possible.

Bulk cargo needs of the remote areas were met by ships and barges that visited some Bering and Arctic Coast communities only

once annually, with a few fortunate locations having four to six visits. In bad years, ice conditions would prevent the delivery of the entire annual needs of some of these communities. In 1970, a shipload destined for Barrow had to be taken back to Seward, on the Gulf Coast of Alaska. Here, it was unloaded and forwarded by railroad to Fairbanks, and finally airlifted to Barrow. All this because the onshore ice prevented the ship from unloading at its original destination. In this case, the federal government bore the substantial costs of rerouting.

Up until 1968, the annual marine shipping needs of the area were around 125,000 tons annually with about 50,000 tons of that total being military needs. The major export was about 12,000 tons of prepared seafoods shipped from Bristol Bay canneries.[1] These exports would vary widely due to the large annual differences in the Bristol Bay salmon runs.

Imports to serve the needs of 31,000 people living in the region[2] constituted almost all of the rest of the tonnage. The great bulk of all imports was composed of petroleum products with the 1968 total being 83,000 tons, or over seventy percent of the import total.

This freight was shipped to twenty-seven ports of record plus the many destinations that are not listed in the records of waterborne commerce. The major ports were Nome (about 25,000 tons annually) and Naknek River (about 35,000 tons each year). It is obvious that such cargo flows cannot support large port infrastructures with their expensive investments in harbor construction and maintenance.

In contrast to these diffused shipments of limited amounts of cargo was the operation of the oil industry at Prudhoe Bay, where over 98,000 tons in 1969, and 185,000 tons in 1970, were put across the beach.[3] Both of these sealifts were conducted in convoy operations from a rendevouz point in the Chukchi Sea, southwest of Point Barrow, to Prudhoe Bay. The barges that comprised the convoys originated at such disparate points as Houston, Seattle, and Japan. Substantial freight was also brought in from the east via the Mackenzie River.

The Prudhoe freight was handled at destination by small barges lightering to a single dock from large sea-going barges lying about six miles offshore in a semi-protected roadstead. The methods used to handle this large aggregation of cargo were little different from those used at low activity ports except that larger cranes were available to make the transfer from lighter to dock.

The necessity for long lightering trips, if deep draft vessels are used at most locations along the shallow coasts of the Bering and Arctic Oceans, has made barge operations more and more popular in this area. In the Prudhoe venture, several large barges were constructed especially for carrying the four-foot diameter pipe for the Trans Alaska Pipeline (115,000 tons in 1970) and the other heavy units needed to set up oil production facilities.

Historically, lightering costs have represented one-third of the total landed freight costs at Bering and Arctic Coast locations. Lowering surface transportation costs for this area has always foundered on the problem of ship to shore cargo movements. The rest of this paper will consider possible solutions to the area's transportation problems based on an improved ports structure. Then, it will compare that solution with systems based on large cargo air-

craft, highways, and railroads to the ice free ports of South-central Alaska. It will also consider more esoteric solutions such as large air cushion vehicles.

Marine Transportation System Improvements

The concept of improved marine transportation systems has generally been based on regional ports with a connecting network of roads to the hinterland, or in some cases river transportation systems. The major areas to be served are Bristol Bay and the Alaska Peninsula, the Yukon-Kuskokwim Delta area, Seward Peninsula and Norton Sound, the Kobuk River Valley, the Northwest Coast, and the Arctic Coast. Under the regional port concept, each of these areas would have an integral transportation system for its own area that would rely upon marine transportation for major cargo movements to other areas, and air transportation for most intra and inter regional passenger movements. Local cargo movement would be by a limited road system, rivers, and off road vehicles.

Some goals of marine transportation for all of the above areas should be: (1) to lower general cargo costs at all ports by elimination of or improving lightering operations, and by expanding containerized shipments; (2) to lengthen the shipping season where feasible; (3) provision of more refrigerated transportation capacity to enable fish, marine mammal, and reindeer processing plants to expand and operate more efficiently; and (4) to make feasible the extraction of the natural resources of the area.

Bristol Bay and the Alaska Peninsula are presently served by the port facilities that have been developed by the salmon canning industry. It is difficult for a ship of more than fourteen foot draft to operate past Port Moller into Bristol Bay. The extremes in tidal ranges and extensive shallows of the bay make all shipping hazardous and expensive. The chief settlement, Dillingham, has some of the highest lightering costs in Alaska.

The termination of the Alaska Steamship Company has relegated service in Bristol Bay to the barge companies. One of the two competing companies has stated that it has little interest in providing services to Dillingham because of the high costs of operating there. The same situation pertains to a lesser degree to the various small ports in the upper reaches of Bristol Bay.

The best method devised by Salmon Carriers, the major shipping agent for the 1971 Bristol Bay slamon pack, was to palletize the cased canned salmon. This was done at the cannery where it was then loaded on the small lightering barges. Fork lift trucks made the transfer from the lighters to sea going barges which were towed to Seward, Alaska. There, the pallets were shifted to rail cars and taken on the Alaska Railroad to Whittier. At the port of Whittier, the cars were loaded on Alaska Hydro-Train barges for the final stage of the trip to Puget Sound.

This method was considered a major advance. Even though it involved five transshipments to destination, it was faster and cheaper than previous shipments of the salmon pack.

There are two major alternatives for a deep water regional port for this region. One would involve a road to Port Moller along the north side of the Alaska Peninsula. The other, a road across the Alaska Peninsula to an ice free location on its southern shore.

ALASKA'S BERING AND ARCTIC COASTS

Two major considerations give preference to the latter option. First, while Port Moller is relatively ice free, having from 0.5 to 0.7 coverage during the peaking of the winter sea ice conditions, a port on the southern shore would be almost totally ice free. Secondly, the Alaska Marine Highway system could connect to a port on the south shore with the sea going ferries that presently serve Kodiak and Cook Inlet.

Another option is to retain the present system. The present bulk cargo needs of the area are reasonably well served by seasonal service. The fish pack is shipped in late summer and storage facilities have been built to store the chief import, petroleum products, on an annual basis. It could prove more expensive to ship petroleum products across the peninsula by truck from the southern shore than to bring them in by tanker barge as now occurs. Without the fish pack and petroleum products, there are only about 10,000 tons of general cargo brought into the area by surface freight at this time.

The trade area population of a regional port would be around 4,600 persons. Until larger cargo flows are generated in the area, the gains from establishing a regional deep water port would seem to be minimal.

The Yukon-Kuskokwim Delta area has been served principally through Bethel, St. Michael, and by freight brought down the Yukon River from Nenana, the river terminus for the Alaska Railroad.

The port of Bethel can be served by eighteen foot draft vessels. Its trade area has a population of about 11,000. Total cargo flows have been around 6,000 tons annually; this small total representing the low income levels of the population, and the general lack of economic activity in the area. There are two barge lines serving Bethel at present, and container service is possible to Bethel and upriver points. Bethel is the only point, however, where the containers can be off-loaded, since the small barges operating on the Kuskokwim River do not carry cranes or other off-loading facilities. The quay where the barges are unloaded at Bethel is in bad condition and needs rebuilding.

At St. Michael, ocean going vessels must lie offshore since the docks can handle only a three foot draft at low tide and about seven foot on the highest tides. The tidal range is 3.9 feet. The harbor, however, is the best sheltered on this part of the Bering Coast. For this reason, it was selected as a trading post location by the Russian American Company in 1839. Later, it became the chief port of transfer from ships to the riverboats serving the Yukon River ports. Use of St. Michael declined when riverboat service became possible from Nenana with the completion of the Alaska Railroad in 1921. St Michael, at present, serves a trade area of slightly over 3,000 people, most of whom live on the lower Yukon.

Unfortunately, the mouths of the Yukon are notoriously difficult to navigate and present a problem for the shallow draft barges and tugs used on the Yukon, even under moderate sea conditions. If heavy seas are running, it is almost impossible to keep from grounding at the bottom of the wave trough.

In the summer of 1970, the village of Emmonak, one of the villages on the south bank of the Yukon, had to take their fish pack out to sea in small river boats where it was transferred to a waiting freezer barge. Then, it was necessary to shift the fish again at St. Michael. All of this was accomplished in open roadsteads.

Transportaion methods this cumbersome make it difficlt for the village fishing cooperatives of this area to maintain a competitive position in the fishing industry.

The Yukon-Kuskokwim area needs a regional port which will meet the needs of the riverine populations of both valleys, and which will make it possible to utilize the efficiencies of containerization to a greater degree than is now possible. Alternatives advanced include: (1) a canal between the Yukon and the Kuskokwim which would make it possible for Bethel to serve as a port for the lower Yukon villages; (2) a road system from St. Michael to the lower Yukon which would eliminate the problem of entering the Yukon through its shallow approaches; or, (3) a road from Bethel to the lower Yukon, or from somewhere on the Kuskokwim to the Yukon.

Alternative one has never received other than a cursory study. Analysis has not yet received the point where it is known what the respective heights of the two rivers to be joined are, and whether locks would be necessary. An estimate of twenty million was made several years ago for the costs of the canal, but this figure was not based on any engineering data and was doubtless just an educated guess. In any case, there can be little doubt that building a canal large enough for container carrying barges would entail considerable expense.

A road from St. Michael to St. Mary's, which is the main air transportation hub for the lower Yukon, would be well over one hundred miles in length. Even a minimal gravel road could cost around twenty million dollars. Once at St. Mary's, the freight, in large part, would again require transshipping. Therefore, roll-on roll-off or some easy method of moving containers should be utilized at both ends of the road to achieve a reasonable measure of efficiency. This would require installation of a dock at St. Mary's and considerable upgrading of the aging installations at St. Michael. Such facilities should not prove expensive. The cost of a barge dock at St. Michael suitable for unloading containers has been estimated at thirty-five thousand dollars.[5]

The above road would not have an appreciable effect on freight rates to the area due to the trucking costs, and might even cause an increase. It would, however, greatly increase the reliability and safety of handling cargo for this area.

The third alternative could most cheaply be implemented by a road across the narrow neck between the two major rivers. A thirty to forty mile road should cost under ten million, if constructed across the first available high ground, and would provide the same service to the lower Yukon villages as alternative two. The benefits would be the concentration of freight through Bethel, making possible some economies of scale and more frequent service. However, the feasibility and costs for these roads has never been determined.

The Seward Peninsula already has a small network of roads. One of these connects the deep water anchorage at Port Clarence to the population center at Nome. Other port candidates for the area are at Golovin Bay and at Cape Nome, the latter being favored by the city of Nome.

In a 1968 study, the Coast Guard estimated that it would require $1,517,000 to dredge Port Clarence to a depth suitable for deep water docking facilities.[6] The channel at Port Clarence is forty-two feet in depth. There has been considerable activity at

nearby fluorite and tin deposits at Lost River, and a study is underway to determine the best way and location to load the ore.

Golovin Bay has a channel depth of only thirteen feet, and has no road connections to other villages. It has been the site of a fish processing and freezing facility in the past.

The city of Nome has requested that a harbor that can accomodate ships of thirty to thirty-five foot draft be constructed in the vicinity of Cape Nome, or some other suitable location close to their city. At present, the community relies on lightering by barge into a turning basin with an eight foot channel. The costs of the deep water harbor have not been determined, but there would be substantial expense in providing a protected roadstead and dock. It is hoped that some of the costs could be recovered by extracting gold from the materials dredged from the channel and port areas.

Since Port Clarence has the best prospects of large cargo flows and, as far as is known, requires the least in development costs, it would seem to have an advantage for consideration as a regional port at this time. The sixty mile road haul into Nome should not keep freight from this port from being considerably cheaper than that which is lightered ashore now at Nome, provided that containers can be offloaded directly onto trailers at Port Clarence.

There is little possibility that major improvements can be made in port facilities at Kotzebue, the transportation center for the Kobuk Valley, except at great expense. Ships must now anchor three to six miles out. An offshore terminal for general cargo would be difficult to justify and one for loading potential ore flows would be very difficult to develop, unless slurry pipelines were used to get the ore from shore to the terminal. If such a terminal were to be used during the ice season, it would have to provide protection from ice movements to some degree, even if cargo carriers heavily stressed for ice are used.

Until cargo flows justify such expensive facilities, improvements in lightering techniques seem to offer the best hope for Kotzebue. If cargo for Kobuk River points can be loaded directly onto the river barges, and if roll-off containers can be used to speed unloading times, it should result in substantial savings for Kotzebue and the other Kobuk villages. The Kotzebue trade area has a population of about 4,500 people.

The situation at Barrow is similar to Kotzebue except that ships can lie much closer inshore, and the problems of a sudden onshore move of the ice pack is ever present. At Barrow, provision of a deep draft dock or any harbor facility is simply beyond the bounds of present feasibility. The same general situation pertains along the entire Arctic Coast, with all protected anchorages being very shallow and without well defined entrances. Most of these protected roadsteads lie behind the offshore bars and low islands that are a feature of this coast.

The first good harbor proceeding eastward from Point Barrow is at Herschel Island in Canada. This port was formerly a rendevouz for whalers and traders in the western Arctic. There has been some study of Herschel Island as a loading terminal for large ice breaking tankers plying the Northwest Passage, as well as possible submarine tankers covering the same route. If the oil industry revives its interest in these modes of transport, Herschel Island would seem to require a close look. However, it would entail building a pipeline from Prudhoe, some two hundred fifty miles to the west, includ-

ing an underwater portion from the mainland to the island. It is very possible that offshore facilities that provide some protection from ice could be built much closer to Prudhoe.

In any case, Herschel Island has deep water access to the Arctic Basin via Mackenzie Submarine Canyon, and channels of over forty feet exist from the canyon to a deep water hole off the east side of the island. It is the only known deep water refuge in the western Arctic that is known at present.

The need for a deep water port or offshore terminal is largely a moot question until substantial cargo flows develop from the area. The present system of barges, if container service can be expanded to almost all points, can serve the Bering and Arctic Coasts well with a minimum investment in capital facilities. The major problem facing the barge operators is transit time and weather across the Gulf of Alaska. The development of a container transshipment point at Dutch Harbor which would allow fast containerships to be used to that point would be a tremendous boost in the speed and reliability of the service, if transfer time and expenses can be kept to a minimum. This same system has been successfully used for petroleum products for many years with sea going tankers used to Dutch Harbor and tanker barges from that point on.

The most immediate prospects for heavy cargo flows are the previously mentioned fluorite and tin ores at Lost River near Port Clarence. If the copper ores of the Kobuk are developed in the next five years, Port Clarence is a likely candidate for a shipping terminal to handle all of these mineral ores. The largest potential flows for marine transportation are in the oil and coal resources of the Northwest Coast. This area does not possess a single natural harbor, and the development of some form of offshore terminal appears most likely in this area. Hopefully, the political climate will not permit revival of schemes such as Project Chariot, which planned to blast a harbor on this coast with nuclear explosives!

The major problems that must be overcome for developing offshore terminals in this area appear at present to be: (1) protection of loading ships from moving ice pack; (2) protecting pipelines, both oil and slurry, from ice scour; and (3) elimination of ice pile up on the offshore structure.

In conclusion, it seems evident that with a judicious investment in container transfer facilities at Dutch Harbor and the regional ports combined with an investment in a few strategic roads that good seasonal transportation can be supplied to western and northern Alaska. This would even result in some rate reduction as containerization is expanded. However, the region will still have to bear the costs of long storage periods as well as large inventories. It is upon the reduction of these costs that some of the alternatives to marine transportation that have been advanced make their case.

Alternatives to Marine Transportation

The transportation systems that are now advanced as providing a better alternative to the present combination of marine and air service for western and Arctic Alaska are: extensions of the highway network to most of the major towns and larger villages; a rail extension to the Arctic and to the Kobuk Valley; large cargo carrying aircraft that would bring general cargo to regional airports;

and, the use of off-road vehicles, such as air cushion vehicles, to provide year round surface transportation. Various other plans use all or part of the above system.

The Alaska Department of Highways has estimated that it will take twenty years and about $2.6 billion to provide road links to all Alaskan communities with a population greater than 1,000.[8] However, it is possible to connect some of the areas under consideration to the main Alaska highway system within a reasonable time. The before mentioned road across the Alaska Peninsula and a highway to Nome via the Kobuk Valley appear to have the first priority. Completion of these roads would leave only about 20,000 of the state's people without access either to the highway or marine highway systems. However, Alaska's highway funds are, in large part, committed to the urban areas for the next five years. After that, construction of the above roads will require some imput from Alaska's anticipated oil revenues in addition to the federal highway matching funds unless long construction periods of fifteen to twenty years are involved.

Expansion of the road system will give businessmen an alternative to placing their orders on an annual basis, and those goods requiring warm storage and high cost items that increase inventory costs would probably be carried by truck for a good part of the year. It is not likely that, during ice free seasons, trucks from Anchorage and other southern and central Alaskan points could compete with efficient containerized freight traveling by sea, at such places as Nome and Kotzebue, since the truck journey would be almost one thousand miles.

There is little doubt that Alaska's road system will be gradually extended. However, it will supplant only a part of the marine freight business and certainly not be a competitor in most bulk items such as coal and oil.

A railway extension to the Arctic and to the Kobuk Valley has been estimated to cost $463 million for the track alone, without consideration of rolling stock.[9] The proposed railroad would not serve any of the population centers of western and Arctic Alaska unless connecting road links were built to the railhead. The prime objective of the railroad is to make the mineral resources of northern Alaska accessible to and competitive in the world markets. The only known major ore body where the railroad would compete with a marine system is the Kobuk copper prospect. There have been several studies made of the best means of moving this copper ore to market but they are largely inconclusive. The Coast Guard estimated that a road to Port Clarence thence by ore freighter with icebreaker support in the winter was the proper system.[10] It is probable that any ore flows generated further east in the Central Brooks Range would be cheaper to ship by rail to an ice free port since the distance to Bering Sea ports would begin to closely approximate those to the southcentral ports.

There can be little doubt that large cargo carrying aircraft offer attractive alternatives to the businessman or resource developer who is in a hurry and cannot wait for the shipping season. However, as the great North Slope air lift proved, there is still a premium to be paid for this freight expedition if the smaller cargo carriers, such as the Lockheed Hercules, are used. But, if the road system serving a port is poor, there is a point where such aircraft become competitive. At Prudhoe, it was found that at a point roughly seventy-five miles from the port, the costs of trucking added to the costs of marine shipping to Prudhoe about equaled the costs of

surface freight to Fairbanks and Hercules air lift from that point. The main equalizing determinant here was the high cost of surface freight on the North Slope.

When the next generation of cargo carriers, the Boeing 747F and the Lockheed C5A, are brought into play, a completely new set of factors must be considered. These aircraft operate at about one third the ton mile rates of the Hercules. There can be little doubt that they will offer tremendous advantages to those Alaskan towns large enough to utilize the one hundred ton and larger cargos that they will debouch. Here, the two factors that first attracted the merchants to air freight, storage and inventory costs, begin to work against him again because of the tremendous capacity of the new aircraft.

Another problem, one that occurred earlier with the Hercules, is that operators are very reluctant to risk their very expensive machines by operating into what they regard as marginal airports. The cost of equipping an airport to the standards demanded by the operators may not be worthwhile for any but the larger communities unless state and federal monies can be used.

There is little doubt that those places, such as Barrow and Kotzebue, that suffer from a short shipping season and poor harbor facilities, will benefit tremendously from the large cargo carriers when they come into use in Alaska. It well may be that a large part of the general cargo requirements of such places will be met by air.

These large cargo carriers will aslo be the prime competitors for off road vehicles that may enter the long haul market. However, as distances decrease, air cushion vehicles and other off road machines should become more competitive due to the high terminal (start-stop) costs of large aircraft. It may well be that a marriage of large containerships and ore freighters operating into such deep draft harbors as exist, such as Port Clarence, with efficient low cost off road vehicles can prove to be the answer for cheap transportation in western and Arctic Alaska. Certainly, if containers can be readily transferred to large cargo carrying off road vehicles, the concept of regional ports will be enhanced. The use of amphibious off road vehicles as lighters is another concept that needs further exploration.

The Bell Model 7380, which is designed to carry a twenty-five ton payload could prove valuable for short haul runs from an airport or port to an off road location. Larger air cushion vehicles have been proposed. The success of such vehicles is dependent upon the ton/mile costs which they can operate under at short and intermediate distances. Comparative studies submitted at the Alaska Transportation Commission Air Cushion Vehicle Hearings in January, 1971, indicated that ACV's must operate under fifteen cents a ton mile where they must compete with the Hercules or more efficient air cargo carriers.

Conclusions

Improvements to the present system of barges and improved container unloading facilities offer the best opportunity of achieving low freight rates with a minimal capital investment. A container transshipment facility at Dutch Harbor would probably be the biggest single improvement that could be made that would have a direct impact on reliability and speed of transit. The effect on rates cannot be determined without further study but certainly should not

increase them.

Other than Port Clarence, there are few natural deep draft harbors available in the American Arctic and Bering Sea areas. Ports for handling bulk flows of oil or ore, in all probability, will be off shore facilities.

Extension of the shipping season through extensive icebreaker support or the use of ice breaking tankers and ore carriers will not be feasible until bulk cargo flows are developed that must be moved on a year round basis.

The determination whether bulk cargo flows should be routed through the ice free ports of southcentral Alaska or through Bering Sea or Arctic Ocean ports will depend on the location and type of such flows. In the case of ores, it is likely that deposits from the south slope of the central Brooks Range, the upper Kobuk Valley, and the central valleys of Alaska will be routed through the south-central ports. The copper deposits at Bornite are located very close to a dividing line between the two transportation options. The decision for Bornite could well rest upon what supporting cargo flows have been developed by either system at the time when the Kobuk copper is ready for development.

Any massive ore deposits from the Northwest Coast of Alaska, the Seward Peninsula, or the mountains abutting the southern coasts of the Bering Sea, would probably be shipped most cheaply from the nearest suitable marine terminal. The major problem that must be resolved is whether to use shallow draft ore carriers or far off-shore terminals for deep draft carriers. It is most likely that the first alternative may prove most feasible for smaller deposits that are so isolated that their cargo flows cannot be aggregated with those from other mines.

The decision on transportation methods for any oil fields discovered in the area under consideration will rest upon the eventual outcome of the Trans Alaska Pipeline dispute. The immense cost of building major pipelines into Arctic areas will favor the use of tankers whenever possible. If the environmental problems can be overcome, shipping by tanker from the Northwest Coast is a possibility, but if the Trans Alaska Pipeline was in existence and had excess capacity, a spur to that line could prove most feasible.

Development of oil discoveries off shore and in the central zone in the Bering Sea areas south of Point Lay will largely depend upon tanker transportation. If the problems of offshore drilling rigs in these areas can be overcome, the problems of suitable loading facilities should be overcome by the same techniques with necessary adaptations. Year round tanker operation in these waters using strengthened ships with ice breaker support does not appear to present unsurmountable problems.

Tankers in the Bering Sea, as elsewhere in the world, must insure that oil spills and operational infusions of oil in loading and unloading operations are reduced below present levels, or it will be difficult to convince the members of the North Pacific community that fish and marine mammals of the area are not imperiled by the transport of large amounts of oil.

Finally and most important, cheap transportation in and by itself can neither solve the social problems of the area under study nor can it create the total economic climate necessary for resource extraction. It is possible to build good roads to all the poverty

stricken villages and generate little or no economic impact on those places. There are hundreds of examples of this in the other states and several in Alaska. Likewise, fine dock facilities can be provided that will lie unused because other cost factors make resources development impossible.

Investments that do not directly lower freight and passenger rates to these regions should be examined to determine if they could not be used more effectively by some other transport system. The costs of those systems that serve resource extraction alone should be borne by the resource served, except in those rare cases where a national strategic need is involved. Resources requiring transportation subsidies to compete in national and world markets can rarely offer real economic advantages to a region in the form of reduced unemployment or a rise in per capita income. Such subsidies might be better used to bolster the basic regional transportation system and thus lower costs to all.

In this area of immense distances and small population, maximum effectiveness in transportation investments can only be achieved by developing the most efficient system to its utmost, rather than a dispersal of capital into several systems with none being truly efficient. Determining where to concentrate investment will require regional transportation plans that encompass all modes rather than separate plans by each competing mode as is now the case.

Notes

[1]United States Department of the Army, Corps of Engineers, Waterborne Commerce of the United States, Part 4, 1964 to 1969 Editions were used. These can be secured from the District Engineer, Corps of Engineers, San Francisco, California. All tonnage figures are derived from these documents unless otherwise noted.

[2]All population figures are based on the 1970 Census of the United States.

[3]Figures acquired from participating oil companies by the author.

[4]George C. Silides, Project feasibility Report for a Dock Facility at St. Michael, Alaska (prepared for the Alaska Department of Public Works, Division of Water and Harbors). Fairbanks, Alaska, January, 1971, p.14.

[5]Ibid, p. 28.

[6]United States Department of Transportation, Coast Guard, Polar Transportation Requirements Study Report, Vol. II, GPO, 1968, p. A-78.

[7]Clark and Groff, Engineers, Nomeport, A Preliminary Investigation of a Deepwater Harbor at Nome, Alaska (prepared for the City of Nome, Alaska). Salem, Oregon, November, 1968, p. 45.

[8]United States Senate Committees on Commerce and Public Works, Problems of Alaska, GPO, 1970, p. 327. This figure has been amplified by later Alaska Department of Highway estimates to as high as $8 billion.

[9]United States Department of Transportation, Interim Report, Alaska Transportation Corridor, Vol. III, p. 4.

[10]Op. cit., Coast Guard, p. A-78.