

NATIONAL SCIENCE FOUNDATION

# MOSAIC

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Man in the Arctic  
Gravitational waves  
Deep-sea ecology  
Managing sewage sludge  
Input-output economics  
Technical education

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## NATIONAL SCIENCE FOUNDATION

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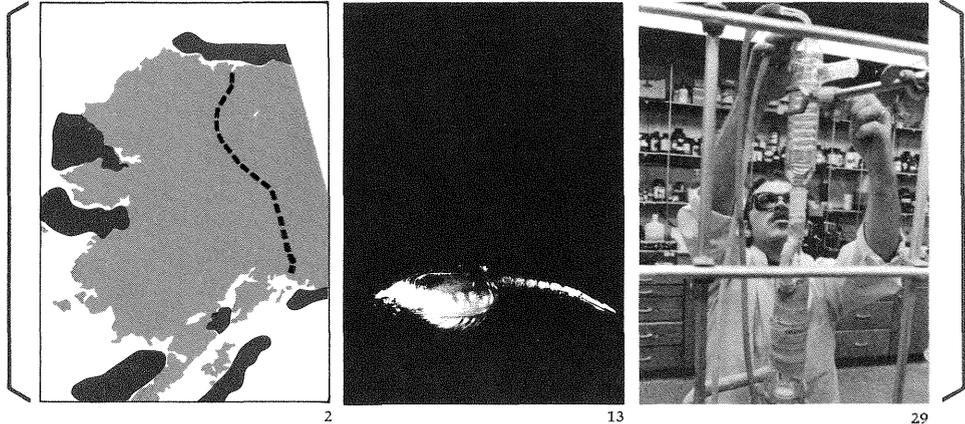
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*Cover:* A truck hauling pipe sections heads north from Fairbanks, main staging area for construction of the Alaska pipeline. The economic and social impacts in Alaska of petroleum development are being studied in the Man-in-the-Arctic Project. See page 2.



### Man in the Arctic

Research to try to understand and cope with rapid changes in Alaska's economic and social structures.

### Those Elusive Gravitational Waves

In the next few years, improved experimental detectors may finally confirm their existence.

### The Deep Seas—Unexpectedly, An Astounding Variety of Life

Findings of the past few years may result in some changes in ecological theories.

### What To Do With Sewage Sludge?

This necessary byproduct of tighter water quality standards is becoming harder and harder to manage.

### No (Economic) Man is an Island

The ability of input-output analysts to relate the elements of an economy to each other makes I/O a practical tool of growing importance.

### Graduating to a Job

Four college programs emphasizing technical skills.

### NSF Estimates 1976 R&D Spending at \$37.8 Billion

2

9

13

20

25

29

34



When Alaska became the 49th State in 1959, it was the culmination of efforts that extended over almost a half a century. Motivating the statehood push were two factors: the desire for political self-determination and the desire for economic development. Just 17 years later, many Alaskans aren't sure they really have the first or want the second. The reason: oil.

Alaska is a national energy resource, probably the Nation's greatest, but a large portion of its land is federally owned. For that reason, Alaska's future involves much more than the 360,000 Alaskans. The Federal program to develop energy resources on public lands may mean development whether Alaskans want it or not, and that development may threaten things that Alaskans

**The oil rush.** During its construction period, the Alaska pipeline is employing as many as 16,000 people, many of them working out of construction camps like this one for 1,000 workers at Sheep Creek, 20 miles from the southern terminus at Valdez.

value. Alaska, the Nation's last frontier, may be turning out to be a proving ground for the Nation's ability to reconcile economic growth with a concern for human and environmental values.

In response to what seemed to be the dawning of an era of significant change in Alaskan society, in 1972 the University of Alaska's Institute of Social, Economic, and Government Research, supported by the National Science Foundation, began the Man in the Arctic Program (MAP). MAP's general objectives are:

- To define patterns of Alaska's growth and development and to identify the critical forces of economic change.
- To determine the effect of outside forces on Alaska's economic, social, and political institutions, and to project changes in these forces and institutions.
- To use these findings to analyze specific problems and policy alternatives.

### Booms and busts—an old story

The current oil rush in Alaska is the latest in a series of "rushes" that go back almost to the 18th century when Alaska was discovered by Vitus Bering,

a Dane employed by Russia. Since the United States purchased Alaska in 1867 for \$7.2 million, economic activity has been characterized by boom and bust cycles. First it was the fur trade, then salmon fishing and, starting about 1880, gold followed by copper. In World War II the lure shifted from natural resources to strategic location, and the Armed Forces "occupied" Alaska. Late in 1939, 524 servicemen were in Alaska; by 1943, the number had risen to 152,000. By 1946 it had dropped to a low of 19,000.

The Cold War and the buildup of Alaska as a bulwark in the defense of the Western Hemisphere ushered in a new "military Alaska," and with it a steady climb in population. At the same time, the main economic props of pre-World War II crumbled as salmon fishing and gold mining declined. The military continues to be important in Alaska, but its period as the dominant element in the economy had passed by 1959 when Alaska became a State.

As Alaska achieved statehood, its basic economy began to shift back towards natural resources, principally involving fisheries, oil and gas in the Kenai Peninsula-Cook Inlet area, and timber.

# MAN IN THE ARCTIC



Simultaneously, the political environment changed as Alaska began to evolve as a State. This evolution involves two peculiarly Alaskan phenomena: a small population, which encourages participation in the political process, and the emergence of the native population as a political force.

The natives' new clout stems from consequences of the Alaska Statehood Act, which gave the State the right to select 103.3 million acres of the 375 million acres of land (99 percent of Alaska) owned by the Federal Government. But these included the lands that Alaska's Eskimos, Indians, and Aleuts had always occupied, used, or claimed, and among the first lands the State selected were two million acres of Barrow Eskimo hunting and fishing territory on the North Slope. Spurred by this move, the natives set aside traditional hostilities and in 1966 formed the Alaskan Federation of Natives. A major victory for the Federation came when the Secretary of the Interior, under his mandate as trustee for Indian affairs, imposed a freeze on further land selections. The issue was not resolved until 1971 when Congress passed the Native Claims Settlement Act, which gives Alaska's native people 40 million acres of land, in addition to cash grants and royalties from leasing of State and Federal lands. By 1992, the natives are to receive about \$1 billion. The lands and monies granted under the Act are to be administered by 12 regional councils and about 220 village corporations. When all land selections are completed, which may not be for several years, the native corporations will hold 11.0 percent of Alaska's lands, the State 28.6 percent, and the Federal Government 59.9 percent; the remaining 0.5 percent will be in private hands.

### **Oil—the new story**

Alaska's current oil boom began in 1968 when oil was discovered on the North Slope at Prudhoe Bay. The largest oil field in North America, Prudhoe Bay will dwarf production from the Kenai Peninsula-Cook Inlet area, where, by the end of the 1960's, five oil fields

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**Trucking pipe north.** Fairbanks, the major staging area for construction, is once again trying to cope with the economic and social ramifications associated with a temporary population boom.

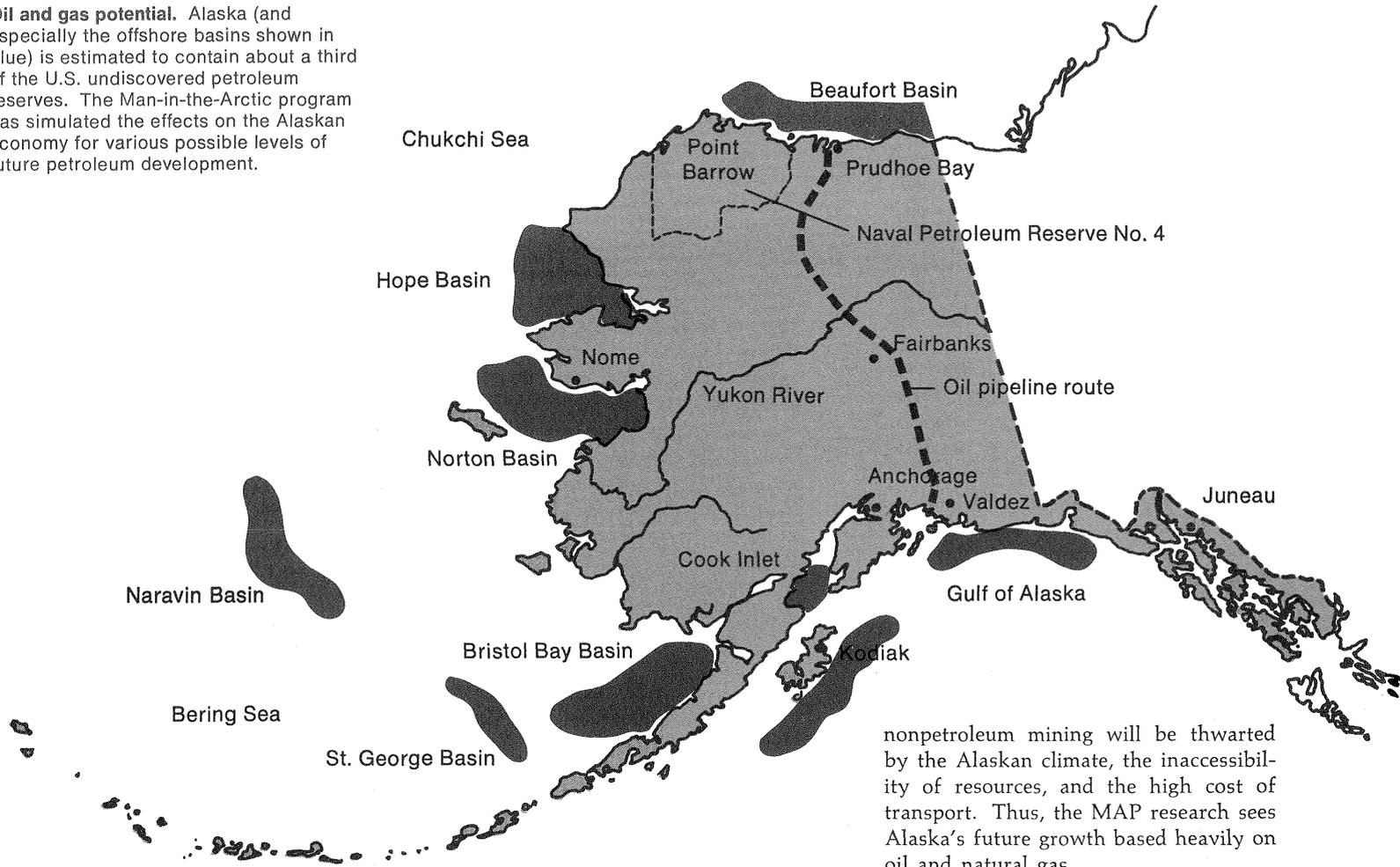
and nine natural gas fields were in production. Representing half of the value of Alaska's natural resource production, these southern fields were the central feature in the State's economic development pattern.

In 1969, the State sold leases on 450,000 acres in the Prudhoe Bay field, receiving a \$900 million bonus, plus royalties when production begins. Delays held up the start of construction of a pipeline to bring the oil from the Arctic until 1974. The largest single privately financed project in history—as of mid-1975, the cost is estimated at almost \$6.5 billion—the Trans Alaska Pipeline is being built by a consortium of eight oil companies formed for that specific purpose. The pipeline traverses 800 miles across Alaska to Valdez, a year-round, sheltered, ice-free port on the Gulf of Alaska. From there, the oil moves by tankers south to ports along the U.S. Pacific Coast. When completed—late in 1977, according to the present schedule—the 48-inch pipeline will be able to carry as much as 2 million barrels of oil a day, or 12 percent of U.S. needs at current usage rates.

As the Federal Government was resolving the legal barriers preventing pipeline construction, it was also taking other actions in response to the international energy crisis. The Interior Department announced it would lease ten million acres of Outer Continental Shelf lands, including large areas off Alaska's coastline. The Navy Department reactivated its exploration of Naval Petroleum Reserve No. 4 on the North Slope to the west of Prudhoe Bay. And the Interior Department initiated a "primary corridor system" study in Alaska to provide for an easement across public and prospective native lands, with particular emphasis on transport needs for "high value energy resources" development.

Estimating oil and natural gas resources is a highly speculative business; in mid-1975, for example, the Interior Department reduced drastically its estimates of total U.S. undiscovered recoverable oil and gas resources. But whatever the figure, about a third of U.S. oil and natural gas is likely to be found in Alaska, particularly its offshore waters where Federal policies will govern exploration and production. In addition, 75 to 85 percent of Alaska's onshore resources are believed to lie beneath lands owned or managed by the Federal

**Oil and gas potential.** Alaska (and especially the offshore basins shown in blue) is estimated to contain about a third of the U.S. undiscovered petroleum reserves. The Man-in-the-Arctic program has simulated the effects on the Alaskan economy for various possible levels of future petroleum development.



nonpetroleum mining will be thwarted by the Alaskan climate, the inaccessibility of resources, and the high cost of transport. Thus, the MAP research sees Alaska's future growth based heavily on oil and natural gas.

MAP constructed three scenarios of plausible futures for development of Alaskan oil. These scenarios all concentrate on leasing of State lands, since that generates revenue for the State. Production on Federal lands is not subject to State taxation and has only limited effect on Alaska's growth; Federal development will promote a short-term boom during the construction phase, but the long-term impact will be relatively minor because the permanent labor force required will be small.

In different scenarios, MAP projected total production and employment for assumed values at the wellhead of \$3, \$5, and \$7 per barrel (adding transportation costs gives refinery prices of \$7, \$9, and \$11), then calculated State revenues. The three scenarios are:

- *Limited development.* In this minimum case, developments under way in Cook Inlet and Prudhoe Bay are carried forward, with Prudhoe Bay beginning operations in 1978. A few additional oil fields are opened near existing areas, and the Federal Outer

bridge, Massachusetts, permit Alaska's future development to be projected and studied as a whole as well as for seven individual regions, and then for the impact of specific policy actions to be evaluated. The models project industrial employment, population, wages and salaries and, finally, disposable personal income.

Using these models, MAP investigators examined potential growth in several industries based on natural resources. In fisheries and forest products, they found that the supply of resources will limit the amount of expansion. Those industries will continue to be an important part of the Alaskan scene, particularly on the local level, but their contribution to economic growth will be quite limited unless the government provides major subsidies to promote their development. Agricultural output may well expand severalfold but, because agriculture is so small in absolute terms, it will have only slight impact on the State economy. Significant increases in

Government. The Nation needs Alaskan oil, and the Federal Government, rather than the State or the Native Corporations, is likely to be the dominant element in determining Alaska's future economic development. The State may, however, have the ability to control the pace of the growth so as to achieve specific social objectives.

**Helping Alaska cope**

In its research on Alaska's future development, MAP gave first priority to tracing the broad patterns of economic growth and to developing models of the Alaskan economy and related demographic change. With this information, project director Victor Fischer and the other MAP investigators can then examine the secondary effects on people and communities that are likely to accompany development.

The models, which were developed with the assistance of the National Bureau of Economic Research in Cam-

Continental Shelf program is limited to the Gulf of Alaska. Development is thus confined to a North-South axis, from the North Slope to Cook Inlet and the Gulf of Alaska. Native Corporation lands within hook-up distance of the Trans Alaska Pipeline are leased and brought into production, and a pipeline for natural gas is constructed across Canada to the Midwest. Since the State got a headstart in Prudhoe Bay, most of the production is from State lands. With the long lead time in Federal offshore development and relatively limited activity by Native Corporations, these lands are not yet producing substantial amounts of oil. In 1980, the State receives annual recurring revenues (excluding bonuses) of \$1.1 billion, assuming a wellhead value of \$5 per barrel. Production and employment in construction and in oil mining total: —2 million barrels per day, 5,000 employees in 1980

—3 million barrels per day, 6,200 employees in 1985  
 —4 million barrels per day, 7,200 employees in 1990.

- *Accelerated development.* The accelerated development case includes all the activities and effects of the limited development scenario. In addition, major increases in petroleum development occur in this second scenario primarily because the Federal Government opens the Naval Petroleum Reserve to leasing. It also holds another sale in the South at lower Cook Inlet, extends its offshore program to the Bering Sea, and further extends offshore leasing to Beaufort and Chukchi Seas in the North. Thus, new petroleum areas are opened up in the Northwest, onshore and offshore, and a second North Slope oil pipeline is constructed. The State follows the Federal Government into the Gulf of Alaska and is subsequently drawn back to the North and Northwest when the Federal Government looks to the Petroleum Reserve and the prospect of another oil pipeline. A Native Corporation's plans for further leasing on the North Slope are facilitated by nearby Federal and State developments. By the late 1980's, production from Federal lands has exceeded production from State lands. Production and employment from Alaska and the offshore areas total: —2 million barrels per day, 5,000 employees in 1980  
 —5 million barrels per day, 10,000 employees in 1985  
 —7.7 million barrels per day, 12,000 employees in 1990.

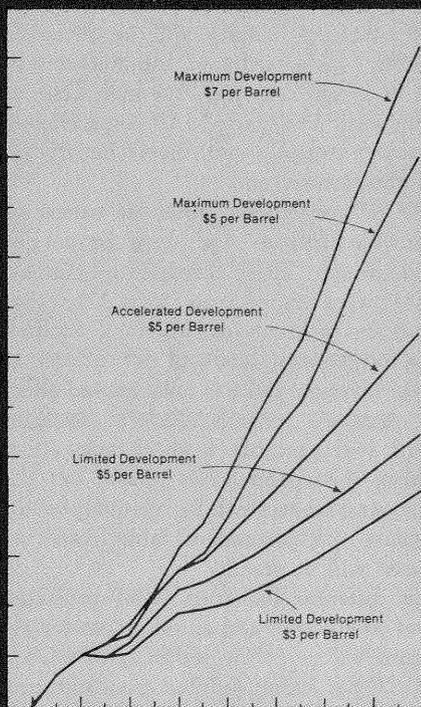
- *Maximum development.* The maximum development scenario includes all the activities of the two earlier scenarios, hypothesizes additional leasing through 1982, and projects the effects of all developments through 1990. As in the accelerated case, the Federal Government opens new regions to development, with Native Corporations and the State following the Federal lead. In this case, the Federal Government leases heavily in the Bering Sea and the Hope Basin of the Chukchi Sea. This, in turn, necessitates construction of an oil pipeline and a gas pipeline running from North to South in Western Alaska. With the pipeline, port, and processing

facilities, additional leasing in new Western areas is possible for Native Corporations and the State. Production from Federal lands is now substantially ahead of the combined production from State and Native lands. However, production from native lands in 1990 is nearly double that produced during the same year in the previous scenario. By 1990, Alaska's total population has skyrocketed to 739,000. Production and employment total:

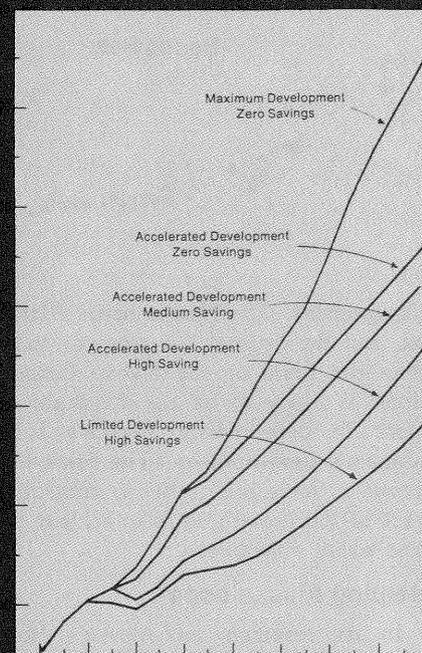
—2 million barrels per day, 5,000 employees in 1980.  
 —5.2 million barrels per day, 10,000 employees in 1985  
 —10 million barrels per day, 23,000 employees in 1990.

### Looking at policy issues

With these pictures of what Alaska's economic future might be, MAP then used the models to examine the effects of possible courses of action. A critical



**Statewide economic model.** A series of simulations (see text), for various levels of petroleum development, project wide differences in growth for Alaska. At the minimum, the model shows a population of 574,000 by 1990 a 69-percent increase over 1974; at the maximum, 1,013,700 people, the growth is a whopping 198-percent increase over 16 years.



**Effects of fiscal policy.** Projections show how actions by the State government in putting petroleum revenues in investment trust funds, then using the interest to finance current expenditures, could affect population growth. In the high savings rate case, 75 percent of recurrent revenues and 100 percent of bonuses are saved; the medium rate saves 25 percent of revenues and 50 percent of bonuses; the low rate saves nothing. All these projections assume a \$5 per barrel wellhead price, equivalent to \$9 per barrel refinery price.

issue involves what the State does with the enormous bonuses and royalties it will receive under the various scenarios. One possibility is for the State to place some of the revenue into an investment trust, as Venezuela is doing with some of its oil bonanza, then use the interest to finance current expenditures. Saving a high percentage of the revenues would be an approach that would slow inflation and the growth of the economy, perhaps helping to smooth out the boom-bust cycle.

The MAP models can also be used to evaluate the economic impact of specific projects. In one application, the researchers examined the State's proposal to sell leases in the Beaufort Sea. In another application, the MAP regional model was used to compare two alternative proposals for building a pipeline to carry natural gas from the North Slope to the continental United States. The first system would be an all-land pipeline from Prudhoe Bay through Canada to the midwestern United States. The second system would consist of a trans-Alaska pipeline, with shipment of liquefied natural gas by tanker to the U.S. Pacific Coast. Because of its greater size, the second system would have a much greater impact in all regions. Perhaps the most notable feature of the regional projections is that the bulk of the impact occurs in Anchorage, even though neither project passes through Anchorage itself, emphasizing just how important Anchorage is as the commercial center of Alaska.

To date, the MAP economic and demographic analyses have focused largely on the gross effects of economic growth. Now the research is turning to how those effects will be distributed, particularly how personal income will be distributed. Early MAP projections indicate that while total personal income will increase with petroleum development, per capita income will increase by only marginal amounts because development will attract more people to Alaska. Now the models will look in detail at how the economic benefits will be distributed among various population groups, based on such factors as age, sex, race, occupation class, and geographical region.

There is already evidence that the benefits are not being distributed equitably in Alaska now. Many Alaskans are getting well-paying jobs on the pipeline—the Alaska Local Hire Bill of 1972

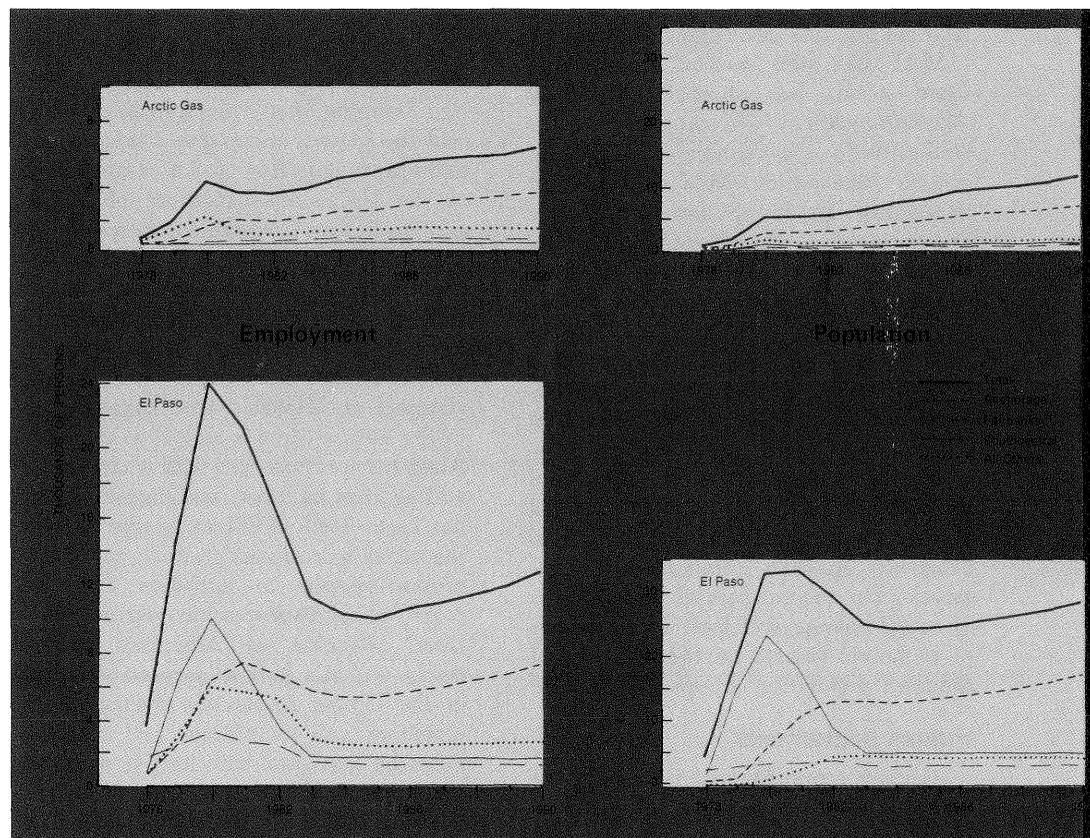
provides that certain jobs in the State, including those on the pipeline, be awarded on a first-priority basis to qualified Alaskans. But the many people not making big money on the pipeline—those working for local governments or support industries, for example—must still live with Alaska's big prices.

### Counting up the social costs

There is also evidence that the social costs, even in the early stages of the current boom, are considerable. For example, a dramatic, unanticipated increase in child neglect appears to be occurring, in part because parents take high-paying jobs on the North Slope; with the shortage of domestic labor, children are being left alone at home. The juvenile arrest rate has risen sharply, as has the number of runaways floating from house to house where parents are absent in remote construction camps. Drinking and violence have increased substantially in Native Villages where men return home with large pipeline paychecks. Food and

fuel shortages may also be occurring because air transport, on which the remote parts of Alaska rely heavily, is being deflected to pipeline service and because of the absence of men who would otherwise be hunting or performing other subsistence activities. Implementation of the Native Claims Settlement Act may be eroded. In the Tanana Chiefs Region, for example, only 14 of 44 villages could find a person at the offered salary to receive training for the role of business manager of the village corporation. Some of these problems may be a temporary result of the boom period of pipeline construction, but others will have long-term social costs.

Fairbanks is a city already hard hit by oil development. Located in the middle portion of the pipeline, it is being used as a staging area for construction. Its population has jumped from 24,000 before construction started to about 40,000 in mid-1975—and it is still climbing. Property values and income have skyrocketed, but Fairbanks is beset with



**Boom and bust.** Two principal systems are proposed for transporting natural gas from Alaska's North Slope to the continental United States. One, proposed by the Arctic Gas consortium, would go via Canada directly to the midwest; the other, that of the El Paso Alaska Company, would consist of a trans-Alaska pipeline and then shipment by liquid natural gas tankers to the west coast. Both the employment and population projections show significantly different effects for the two plans, notably both the greater peaking and permanent growth for the El Paso plan.

a host of social problems—rising rates of crime, juvenile arrests, alcoholism, and divorce; crowded schools and other overburdened municipal services; acute housing shortages, traffic congestion, and rampant inflation. When the huge construction army (16,000 at its peak) completes its job, Fairbanks probably faces the bust part of the cycle, because the permanent growth coming from the pipeline is likely to be in Anchorage, Alaska's largest city and major business center.

Another hard hit area is at the southern end of the pipeline. Valdez, which was built by the Russians, was wiped out by the 1964 earthquake and resulting tidal wave. It was subsequently relocated to a new planned urban site five miles from the old town. Once a largely middle class rural community of 1,000, Valdez has been almost instantly transformed into an industrial camp. It is the site of two major construction camps housing 3,500 workers, and a 200-residence housing complex is being built for management and technical personnel of Alyeska and one of its major contractors.

MAP has now turned to studying these social changes that accompany Alaska's growth. By correlating the studies with the economic and demographic information, MAP will attempt to identify the distribution of economic and social costs and benefits.

One phase of the studies of social change in Alaska covers the effects of development on such community problems as housing, law enforcement, and health services, and will draw on studies of earlier boom towns. The patterns in Alaska may differ considerably, however, due to such factors as the cultural backgrounds of Eskimos and Indians and the extremely small size and distribution of many Alaskan communities themselves. The second part of these studies of social change will look at the effects of economic growth on the lifestyles of different population groups.

### **Human settlements**

Alaska's economic growth has the potential to create opportunities for achieving a better system of human settlements. Because of special physical, biological, economic, social, and cultural constraints imposed by arctic and subarctic environments, it is particularly critical that the full range of possibilities be carefully considered. MAP is now

studying the impacts of many alternatives in the Alaskan context and also relating its findings to similar studies being done in Canada and the Soviet Union under the UN's Man in the Biosphere program and other international programs. Among the possible choices in development:

- Incorporate new oil-related development within an existing community; or establish a new settlement.
- Build well-rounded communities to develop resources in the Arctic; or use a camp approach, with families living in the south and workers being transported to remote sites, as is being done now in Prudhoe Bay.
- Concentrate growth in major centers such as Anchorage; or attempt to establish new growth centers.

### **Alaska—made rich or made poor?**

The research being carried out by the National Science Foundation's Man in the Arctic Program is producing information that can help illuminate key issues, and the information is being put to use almost instantly. Two MAP investigators are on leave to work with the State Division of Policy Development and Planning, one of them as its director, and the State is increasingly tapping the skills and expertise of the research staff at the University's Institute of Social, Economic, and Government Research.

A couple of years ago, as Alaskans contemplated their new-found wealth, they saw the future as "old Alaska made rich." Many now fear it may end up as "old Alaska made poor." The promise stamped on Alaska's auto tags—North to the Future—looms almost as a threat. Alaskans are concerned with what Alaska will be after its latest, and biggest, boom has spent itself. Will history repeat, with the benefits of Alaska's wealth going disproportionately to outsiders and the costs falling disproportionately on Alaskans? Because of America's energy needs, will Alaska's wilderness—the last in the United States—be overrun with pipelines, will its citizens and communities be burdened with long-term social problems, and will the many unique qualities that make up the Alaskan lifestyle be mere memories? ●

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