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A Dynamic Simulation Model for Analyzing the Importance of Forest Resources in Alaska

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Abstract

A dynamic simulation model has been adapted for use in Alaska. It provides a flexible tool for examining the economic consequences of alternative forest resource management policies. The model could be adapted for use elsewhere if an interindustry transaction table is available or can be developed. To demonstrate the model's usefulness, the contribution of the pulp and paper and tourism industries to Alaska's economy is analyzed. A $105 million increase in final demand for goods and services provided by the tourism industry would compensate for the loss of employment and earnings resulting from the closure of Alaska's two pulpmills. Most of the loss would be confined to higher paying technical jobs in two remote locations; the increase in jobs would involve lower paying jobs located throughout the State.

Keywords: Economic importance (forests), models, simulation, Alaska, management planning (forest).

Assessing Impacts

The livelihood of many Alaska residents is dependent on forest resources. Employees of the forest products industry are obviously dependent, but to varying degrees, employees in commercial salmon fishing, tourism, and some mineral-based industries are also influenced by forest resource management policies.

Any plan involving changes in National Forest management policies should include an analysis of socio-economic impacts. For example, the Alaska National Interest Lands Conservation Act (ANILCA) requires that the USDA Forest Service prepare periodic assessments of management for the Tongass National Forest. These assessments must include an analysis of how timber management policies affect the employment, income, and population of southeast Alaskans.

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To perform the economic impact analyses, a dynamic simulation model (IPASS) was adapted for use in Alaska. This paper describes how it can be used to evaluate forest resource management situations in Alaska.[1]

Analyzing Hypothetical Scenarios

IPASS can help to answer many of the questions facing policy analysts: Questions such as who would be affected by the closure of wood processing mills in Alaska? who would be affected by new investment in recreation and tourism facilities? and might the growth of the tourism industry counteract the decline in timber-based industries? The following discussion will show how IPASS can be used to analyze the economic significance of three resource-related scenarios.

Scenario 1: Alaska's Pulpwood Industry

The two pulpmills in southeast Alaska produce dissolving pulp. In 1977, production and export was roughly valued at $105 million. But increasing world-wide competition, depressed markets, and the high cost of installing pollution abatement equipment threatens the operation of these mills.

In this scenario, we assume the worst case—a complete shutdown of both mills with a permanent loss of $105 million in regional exports. Table 1 shows the impact of the mill shutdown on both employment and earnings, by year, in aggregated sectors of the economy.[2] The effect on the pulp and paper industry is immediate and, also, is greater than for any other industry. The two other wood products sectors, however, are also adversely affected because they provide logs and mill residues to the pulpmills. For years 2 through 5, the service industries show the indirect impacts of the loss of personal income, loss of population, and the overall reduction in economic activity caused by the mill closures.

Table 1 also shows how the various occupations were affected by the closure of the two pulpmills. Industrial technicians, who account for the largest proportion of the pulp and paper employees, experience the greatest and most lasting impact.

The pulpmills account for most of the basic jobs in the communities where they are located. Consequently, the mill closures would undoubtedly cause many individuals to move elsewhere—in the State or otherwise—because of the lack of reemployment opportunities. Pulpmill workers have traditionally received above-average wages; consequently, former pulpmill employees choosing to remain somewhere in Alaska would undoubtedly have to be retrained or accept lower wages.

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[1] A brief description of the IPASS model is provided in Appendix 1. For a more complete explanation of the IPASS system see, Olson, Doug; Schallau, Con; and Maki, Wilbur. IPASS: an interactive policy analysis simulation system. Gen. Tech. Rep. PNW-170 Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1984. 70 p.

[2] Appendix 3 provides a list of the 75 sectors in the Alaska model. Data for 75 sectors were derived and then were aggregated for the purpose of this paper.

Table 1—Impact on the Alaska economy[1] caused by closure of two pulpmills

Industry	Year of simulation 1	2	3	4	5
	JOBS LOST OR GAINED, BY SECTOR				
Agriculture, forestry, and fisheries	-11	-11	-12	-7	-8
Mining	-1	-3	-5	-4	-4
Construction	-14	-59	-82	-52	-42
Manufacturing:	-1,578	-1,646	-1,319	-1,068	-991
Logging	-460	-518	-342	-164	-138
Sawmills	-48	-56	-46	-41	-41
Pulp and paper mills	-1,065	-1,056	-917	-843	-793
Transportation, communications, and utilities	-91	-136	-156	-136	-123
Trade	-30	-153	-315	-331	-417
Finance, insurance, and real estate	-13	-69	-14	-77	-75
Services	-21	-102	-172	-156	-187
Government	-18	-30	-46	-59	-57
Total	-1,778	-2,208	-2,122	-1,891	-1,905
	EARNINGS LOST OR GAINED (THOUSAND DOLLARS)				
Agriculture, forestry, and fisheries	-241	-263	-223	-105	-138
Mining	-33	-112	-170	-155	-130
Construction	-501	-2,156	-3,000	-1,900	-1,526
Manufacturing:	-36,879	-38,440	-30,764	-24,900	-23,079
Logging	-10,753	12,111	-7,981	-3,826	-3,222
Sawmills	-1,025	-1,179	-965	-868	-867
Pulp and paper mills	-25,012	-24,817	-21,537	-19,805	-18,646
Transportation, communications, and utilities	-2,113	-3,170	-3,923	-3,268	-2,932
Trade	-605	-2,763	-4,805	-3,780	-5,545
Finance, insurance, and real estate	-196	-1,052	-205	-1,172	-1,129
Services	-495	-1,750	-2,681	-2,442	-2,815
Government	-244	-440	-654	-862	-848
Total	-41,305	-50,147	-46,426	-38,584	-38,143
	EMPLOYMENT, LOST OR GAINED BY OCCUPATION				
Managers	-78	-125	-128	-122	-130
Professional	-91	-121	-130	-121	-125
Technical	-18	-28	-42	-39	-42
Service	-81	-117	-173	-177	-195
Industrial technicians	-1,327	-1,494	-1,289	-1,050	-1,002
Clerical	-164	-269	-279	-298	-314
Sales	-17	-54	-77	-81	-95
Farm	-1	-1	-3	-3	-3

1/The impact is derived by subtracting the baseline data (that is, simulation of historical data) from the impact scenario data. A minus sign indicates a loss of employment or earnings.

Scenario 2: Changes in Tourism

In this scenario, we assume that promotion of Alaska tourism will increase the sale of goods and services produced in Alaska by $105 million.[3] What impact will this have on employment and earnings? To answer this question we used[4] national averages for tourism-related expenditures to derive estimates of tourism expenditures by industry. Table 2 shows that increased tourism would greatly stimulate employment and earnings in the service, trade, and transportation industries. All occupational categories would also grow.

Scenario 3: Will growth in tourism offset a decline in pulp production?

Scenario 3 is a combination of scenarios 1 and 2. This scenario examines the extent to which an increase in annual tourism expenditures of $105 million compensates for a coincidental decrease of $105 million in exports resulting from a closure of the two pulpmills.

Table 3 shows the impact of this scenario on employment, earnings, and employment by occupation. After the third year, an increase in tourism can more than compensate for the loss of total employment and earnings resulting from closure of the two pulpmills.

A $105 million increase in demand for goods and services provided by the tourism industry would eventually compensate for the loss of two pulpmills in terms of total employment and earnings. The employees losing work as a result of the mill closures would not, however, necessarily be people employed in the tourism industry. An examination of the changes, industry by industry, indicates that there are "gainers" and there are "losers." The wood products industry loses a large number of its employees and earnings, but the service and trade sectors gain. Employment by occupation also varies; for example, the employment for industrial technicians declined while service employment increased (fig. 1).

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[3] The value of expenditures by tourists would exceed the net economic contribution to Alaska's economy. Many of the items purchased by tourists, and the services provided, rely heavily on imports. Total tourism expenditures would consequently have to exceed $105 million.

[4] The Research and Analysis section, Alaska Department of Labor, provided unpublished tourism survey data showing expenditures by nonresident tourists. These data were converted to expenditure classes in the Bureau of Economic Analysis' "National Income Product Account" (NIPA) that were identified as "tourism" related. The distribution of tourist dollars among Alaska industries was derived from the NIPA expenditure classes.

Table 2—Impact on the Alaska economy[1] of increased tourism expenditures

Industry	Year of simulation 1	2	3	4	5
	JOBS LOST OR GAINED, BY SECTOR				
Agriculture, forestry, and fisheries	3	22	23	28	25
Mining	0	23	25	26	24
Construction	3	213	82	76	36
Manufacturing	1	94	94	100	89
Logging	0	1	0	1	0
Sawmills	0	1	1	0	0
Pulp and paper mills	0	0	0	0	0
Transportation, communications, and utilities	652	970	945	928	893
Trade	101	540	920	845	982
Finance, insurance, and real estate	21	42	75	93	105
Services	121	770	753	884	858
Government	27	48	30	74	80
Total	929	2,722	2,947	3,056	3,090
	EARNINGS LOST OR GAINED (THOUSAND DOLLARS)				
Agriculture, forestry, and fisheries	58	347	358	412	370
Mining	0	894	934	990	903
Construction	100	7,848	3,003	2,809	1,283
Manufacturing	22	1,739	1,642	1,766	1,552
Logging	0	29	0	16	6
Sawmills	0	25	13	8	3
Pulp and paper mills	0	0	0	0	0
Transportation, communications, and utilities	13,072	19,532	19,304	18,627	17,796
Trade	1,406	7,267	11,477	8,220	10,911
Finance, insurance, and real estate	320	635	1,142	1,436	1,589
Services	2,310	9,240	8,936	10,533	10,053
Government	417	717	428	1,098	1,196
Total	17,700	48,220	47,223	45,891	45,654
	EMPLOYMENT, LOSS OR GAIN BY OCCUPATION				
Managers	115	271	296	295	308
Professional	29	114	126	151	150
Technical	15	88	91	105	104
Service	49	615	670	838	752
Industrial technicians	528	1,031	977	933	940
Clerical	154	496	590	599	637
Sales	41	103	194	127	191
Farm	0	4	5	8	7

1/The impact is derived by subtracting the baseline data (that is, simulation of historical data) from the impact scenario data. A minus sign indicates a loss of employment or earnings.

Table 3—Impact on the Alaska economy[1] caused by the coincidental closure of two pulpmills and increased tourism trade

Industry	Year of simulation 1	2	3	4	5
	JOBS LOST OR GAINED, BY SECTOR				
Agriculture, forestry, and fisheries	-8	10	12	21	16
Mining	-1	20	20	22	20
Construction	-11	150	-7	31	-5
Manufacturing:	-1,576	-1,552	-1,224	-969	-903
Logging	-460	-517	-341	-163	-138
Sawmills	-48	-54	-45	-40	-41
Pulp and paper mills	-1,065	-1,056	-917	-843	-794
Transportation, communications, and utilities	562	833	788	793	768
Trade	78	439	551	535	513
Finance, insurance, and real estate	8	2	2	24	28
Services	102	672	615	686	676
Government	17	9	-15	16	22
Total	-829	583	742	1,160	1,134
	EARNINGS LOST OR GAINED (THOUSAND DOLLARS)				
Agriculture, forestry, and fisheries	-180	73	144	306	224
Mining	-30	770	764	835	771
Construction	-381	5,526	260	1,153	-188
Manufacturing	-36,854	-36,701	-29,099	-23,153	-21,538
Logging	-10,752	-12,083	-7,965	-3,818	-3,222
Sawmills	-1,025	-1,155	-952	-860	-863
Pulp and paper mills	-25,012	-24,817	-21,537	-19,805	-18,646
Transportation, communications, and utilities	10,959	16,341	15,375	15,378	14,830
Trade	885	5,168	5,965	4,703	4,716
Finance, insurance, and real estate	128	26	35	375	419
Services	1,860	7,556	6,652	7,556	7,402
Government	283	157	-210	248	337
Total	-23,332	-1,083	-634	7,400	6,975
	EMPLOYMENT, LOSS OR GAIN BY OCCUPATION				
Managers	40	156	155	171	171
Professional	-60	-5	-1	23	23
Technical	-3	58	51	64	63
Service	-30	501	498	658	557
Industrial technicians	-793	-452	-329	-114	-75
Clerical	-7	256	267	300	309
Sales	26	65	100	52	82
Farm	-1	3	3	5	4

1/The impact is derived by subtracting the baseline data (that is, simulation of historical data) from the impact scenario data. A minus sign indicates a loss of employment or earnings.

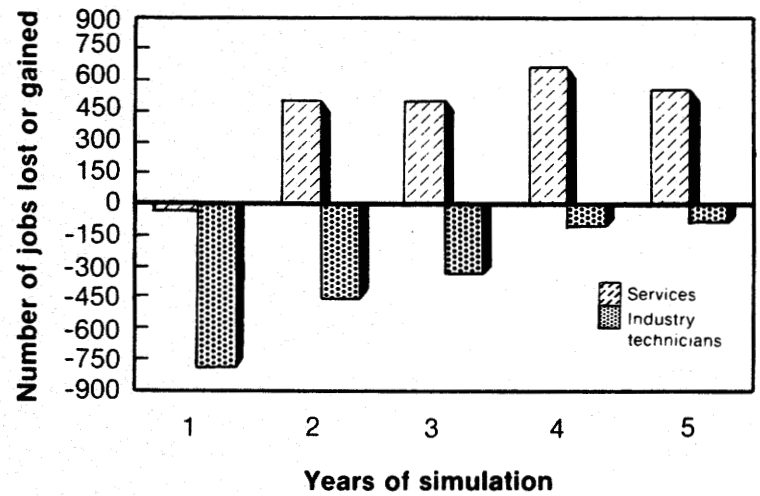

Figure 1.—Change in employment resulting from coincidental closure of two pulpmills and increased tourism expenditures does not affect all occupations equally.

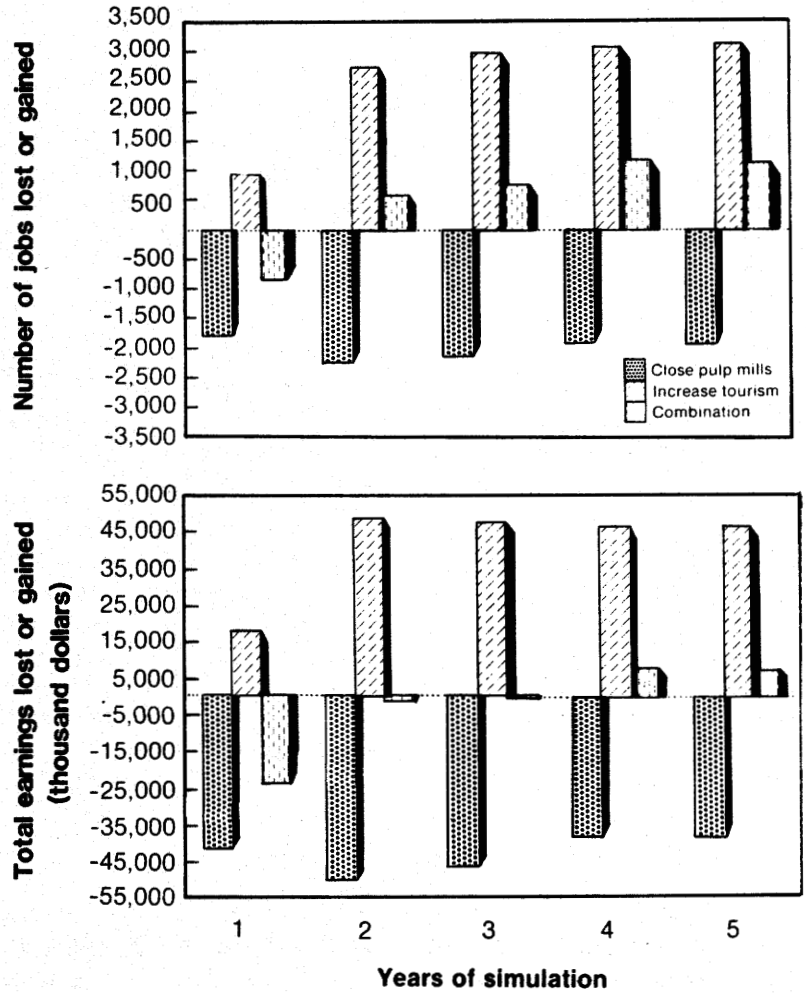

Figure 2.—Changes in total employment and earnings resulting from : (1) the closure of two pulpmills; (2) an increase in tourism expenditures; and (3) a combination of (1) and (2).

Summary

Figure 2 summarizes the change in employment and earnings associated with the three scenarios. The impact on employment and earnings caused by the closure of two pulpmills (scenario 1) is immediate and negative throughout the simulation. Most of the impact is felt by employees in the industry technician category, and most of the loss in jobs is likely to be limited to the towns in which the mills are located.

If tourism expenditures increase (scenario 2), the impact is immediate and positive throughout the simulation with service occupations making the major gains. These gains in employment would probably be spread throughout Alaska.

When the decrease in pulpmill activity coincides with increased sales by the tourism industry (scenario 3), the negative impact in loss of earnings resulting from the former is greater than the positive gains from the latter until the fourth year of the simulation, at which time the net impact is positive. In terms of employment, the impact of increased tourism is greater than the loss of pulpmill activity after the first year of the simulation. This apparent anomaly is explained by the fact that earnings per worker in pulp and paper is much higher than earnings per worker in tourism.

Although a $105 million increase in demand for goods and services provided by the tourism industry would compensate for the loss of employment and earnings resulting from the closure of Alaska's two pulpmills, worker displacement must be kept in mind. Most of the loss would be confined to higher paying, technical jobs in two remote locations, and the increase in jobs would involve lower paying jobs located throughout the State.

Appendix 1

A Brief Explanation of the IPASS Model

IPASS measures change over time.—The IPASS model provides analysts with a flexible, interactive technique for simulating how a particular economy will react to changes in both supply and demand associated with policy alternatives. The IPASS system is composed of eight basic elements or "modules" (fig. 3). Unlike the traditional interindustry model, IPASS introduces the element of time. The dotted lines indicate how each of the modules are linked recursively for use in measuring changes over several time periods.

The eight IPASS modules deal with both demand-side and supply-side factors that affect a region's growth and development. The investment module calculates the investment needed to expand capacity in order to produce more goods and services. This module is connected to the final demand module. The latter forecasts changes in final demand; for example, change in exports. The production module is a Leontief inverse that performs the conventional multiplier calculations of the individual industry impacts of changes in the demand for a region's industrial output. This module also responds to the production constraints emanating from the demand side via the final demand module and the supply side via the investment and labor force modules.

The employment module updates model parameters that influence labor productivity, while the labor force module calculates the supply of labor by occupation classes. The population module uses migration and cohort survival rates, as well as age-specific birth rates, to estimate year-to-year changes in a region's population. Components of value added, including personal income, are calculated by the primary inputs module.

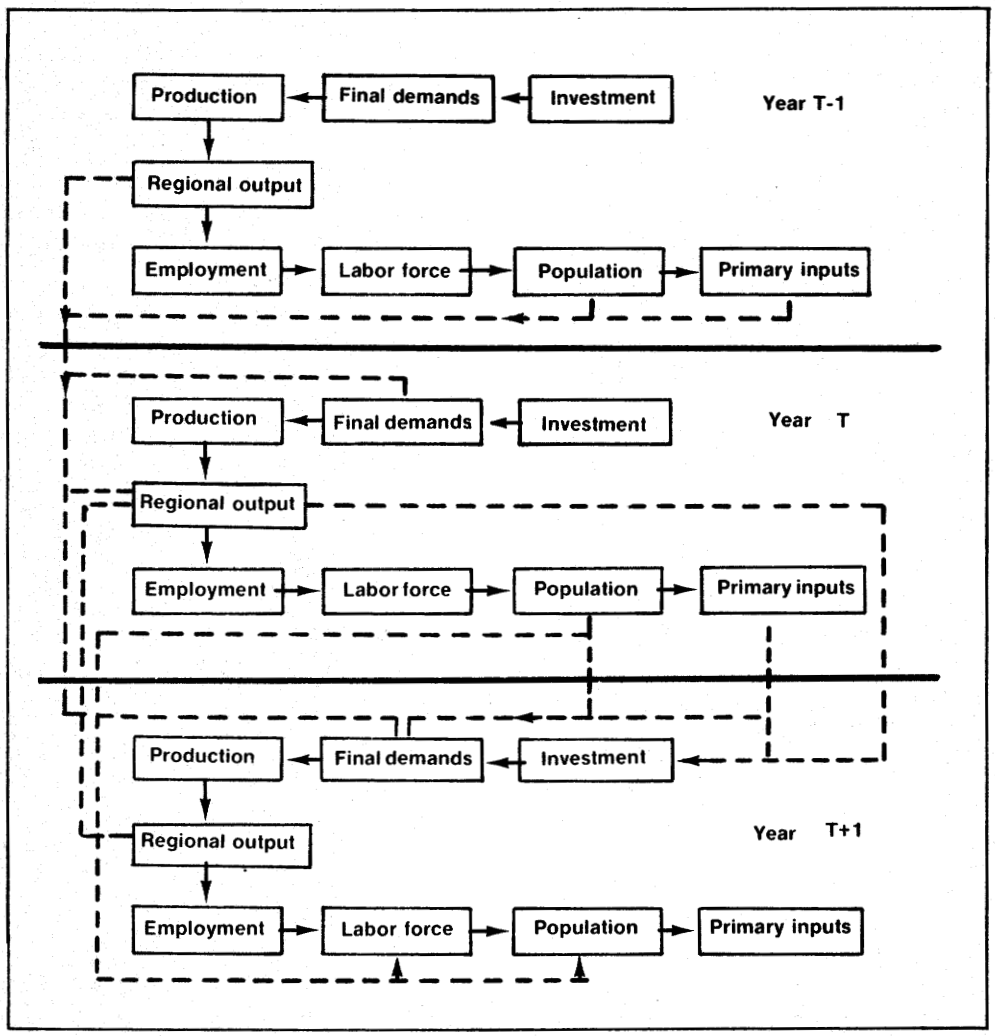

Figure 3.—IPASS is a dynamic, recursive system. Estimates for year T are influenced by transactions during the current as well as previous years. Investments for year T, for instance, are a function of regional output and primary inputs for year T-1.

Appendix 2

Assembling and Calibrating the Alaska IPASS Data Base

Ideally, all data for a particular IPASS model would be unique to the geographical area to be analyzed (see Appendix 3 for industry classification used for Alaska). For Alaska published data sources for some of the economic indicators and model parameters are lacking, however, and conducting a survey to obtain this information would be too costly and time consuming. For the Alaska model, we have, therefore, augmented Alaska published sources with data for the United States. Population and labor force participation, for example, are specifically for the State of Alaska. Capital-output ratios, however, are based on national ratios and trends. The USDA Forest Service software system, IMPLAN,[1/] was used to develop a synthetic input-output (I/O). Because the IMPLAN system uses direct coefficients from the national I/O model, coefficients for the Alaska IPASS model were modified to reflect Alaska's economy.

[1/] Unpublished report, 1982, "IMPLAN User's Manual," Land Management Planning, U.S. Department of Agriculture, Forest Service, Fort Collins, Colorado.

An important feature of the IPASS simulation system is the ease with which the user can examine the sensitivity of forecasts based, in part, on nonlocal sources. By introducing a range of values for a parameter, for example, the user can determine how much a particular economic indicator would be affected by a change in the underlying assumptions.

Calibrating the Alaska IPASS data base.—Parameters and rate-of-change variables were adjusted so that the 1977 to 1982 baseline simulation corresponded to historical trends of value added, employment, earnings, and population for Alaska. Economic impact analyses will be the principal uses of IPASS; consequently, the change of a particular indicator is a more important consideration than its absolute level. During calibration, we were mainly interested in simulating the historical levels for various indicators. The calibration can be viewed as an ongoing activity since the model can be easily recalibrated as new information becomes available.

Tables 4 and 5 compare the calibrated baseline simulation of selected employment and earning indicators with historical 1977-1982 data. With few exceptions, the IPASS estimates corresponded closely (that is, ± 10 percent) with the historical data. In general, the more annual fluctuations exhibited by an industry (for example, the construction and mining sectors), the larger the deviation between simulated baseline estimates and actual levels.

Table 4—Percentage of difference between the baseline simulation by IPASS and Alaska historical employment by industry

Industry	Year					
	1977	1978	1979	1980	1981	1982
	Percent					
Agriculture, forestry, and fisheries	2.24	-20.69	-8.72	-1.79	2.13	7.38
Mining	-5.41	13.05	25.64	15.74	-7.34	0.15
Construction	0.00	1.9	31.30	34.53	18.29	-4.29
Manufacturing	2.08	-5.67	-7.36	-11.84	-8.81	5.52
Transportation, communications, and utilities	2.23	-4.02	-5.17	-3.58	-5.74	-3.15
Trade	-0.88	4.72	6.50	12.81	7.58	2.82
Finance, insurance, and real estate	-0.15	-4.93	-2.27	4.64	3.69	-0.58
Services	-0.07	-0.97	-0.90	-3.11	-7.46	-11.69
Government	0.34	-4.03	-5.05	-1.04	.09	-0.30
All employment	0.22	-2.27	-0.21	2.33	0.04	-1.46

Table 5—Percentage of difference between baseline simulation by IPASS and Alaska historical earnings by industry

Industry	Year					
	1977	1978	1979	1980	1981	1982
	Percent					
Agriculture, forestry, and fisheries	-15.63	-28.56	-14.42	-17.92	21.44	22.59
Mining	-6.01	17.34	37.58	22.54	-0.88	3.12
Construction	-14.67	18.40	64.55	61.57	35.17	6.41
Manufacturing	0.45	-5.52	-11.64	-14.98	-7.42	-0.55
Transportation, communications, and utilities	1.08	4.21	6.23	9.65	3.36	1.26
Trade	0.0	8.62	16.48	24.02	15.33	5.22
Finance, insurance, and real estate	0.0	-2.56	3.60	11.17	9.62	-5.59
Services	0.01	24.32	33.90	29.17	13.97	-0.94
Government	1.98	0.23	0.67	1.66	0.92	-3.94
All employment	-3.25	5.61	13.19	14.99	8.42	0.83

Appendix 3

Table 6—Comparison among IPASS, Bureau of Labor Statistics, and Bureau of Economic Analysis input-ouput model sectoring schemes and the Standard Industrial Classification code

IPASS sector number	Industry	Bureau of Labor Statistics (154 sectors)	Bureau of Economic Analysis (466 sectors)	Standard Industrial Classification (1972 edition)
1	Dairy and poultry	1	1,2	pt.01,pt.02
2	Meat animals	2	3	pt.01,pt.02
3	Feed, food grain	4	5	pt.01,pt.02
4	Other crops	3,5	4,6-10	pt.01,pt.02
5	Agricultural services	pt.7	pt.12	0254,07(exc.074)
6	Forest products and services	pt.6,pt.7	pt.11,pt.12	081-085
7	Fish products and services	pt.6,pt.7	pt.11,pt.12	091-092,097
8	Gold and silver mining	pt.10	17-18	1041,1044
9	Other metal ore mining	8,pt.10	13-16,19,21-23	10(exc.1031,1044,1081)
10	Metal mining services	pt.10	20	1081
11	Coal mining	11	24-25	111,pt.112,1211,pt.1214
12	Natural gas and petroleum	12	26-28	1311,1321,pt.138
13	Stone, gravel, and clay	13	29-43	141-145,pt.148,149
14	Chemicals and fertilizers	14	44-50	147
15	New construction	152	51	pt.15,pt.16,pt.17,pt.108,pt.1112,pt.1213 pt.138,pt.148
16	Maintenance and repair	15	52	pt.15,pt.16,pt.17,pt.138
17	Ordnance and related	16-17	53-58	348,3761,3795
18	Meat products	18	59-62	201
19	Dairy products	19	63-67	202
20	Canned, cured seafood	pt.27	68	2091
21	Fresh, frozen seafood	pt.27	73	2092
22	Other canned, preserved food	20	69-72,74	203
23	Bakery products	22	82-83	205
24	Beverages	25-26	88-92	208
25	Animal, marine fats, and oils	pt.27	97	2093
26	Other food and tobacco	21,23,24,pt27,28	75-81,84-87,93-96,98-106	204,206-207,209(exc.2091-2093),21
27	Textile goods	29-31	107-120	22(exc.225)
28	Apparel and fabrics	32-34	121-135	225,23(exc.239),39996
29	Logging	35	136	2411
30	Sawmills	36	137-139	2421,2422,2429
31	Other wood products	37-38	140-149,388	243-245,249
32	Furniture and fixtures	39-40	150-162	25
33	Pulp and paper mills	pt.41	163	261-262
34	Other paper and allied	pt.41-42	164-175	263-266
35	Printing and publishing	43-45	176-190	27
36	Chemical and allied	46-53	191-210	28(exc.28195)
37	Petroleum and refining	54	211-213	29
38	Rubber products	55-57	214-219	30
39	Leather products	58-59	220-228	31
40	Stone, clay, and glass	60-64	229-253	32
41	Primary metals	65-69	254-275	33
42	Fabricated metals	70-76	276-303	34
43	Nonelectrical machinery	77-87	304-345	35
44	Electrical machinery	88-96	346-375	36
45	Ship and boat	99	383-384	373
46	Other transportation	97,98,100-102	376-382,385-387,389	37(exc.373)
47	Scientific instruments	103-107	390-399	38
48	Miscellaneous manufacturing	108-110	400-419	39
49	Railroad	111	420	40,474,pt.4789
50	Local transit	112	421	pt.41
51	Truck transportation	113	422	42,pt.4789
52	Water transportation	114	423	44
53	Air transportation	115	424	45
54	Pipeline	116	425	46
55	Transportation services	117	426	47(exc.474,pt.4789)
56	Communications	118-119	427-428	48
57	Electrical utilities	120	429	pt.491,pt.493
58	Gas utilities	121	430	492,pt.493
59	Water and sanitation	122	431	494-497,pt.493
60	Wholesale trade	123	432	50,51(exc.Mfgrs. Sales Off.)
61	Retail trade	125	433	52-57,59,7396,8042
62	Finance and insurance	126-128	434-438	60-64(exc.pt.613),67
63	Real estate	129-130	439-440	65,66,pt.1531
64	Hotels and lodging	131	441	70(exc. Eating & Drinking)
65	Personal services	132-133	442-443	72,762-764,pt.7699
66	Business services	134-136	444-446	73(exc.7395),769(exc.7699),81,89(exc.8922)
67	Eating and drinking	124	447	58,pt.70
68	Auto repair	137	448	75
69	Motion pictures and recreation	138-139	449,450	78,79
70	Health services	140,pt.141	451-453,456-457	80(exc.8042),074
71	Education and nonprofit	pt.141-144	454-455	82-84,86,8922
72	Federal enterprises	145-146	458-461	4311,pt.491,pt.613
73	State and local enterprises	147-148	462-464	pt.41,pt.491
74	Scrap	151	466	
75	Administrative government			