402 ·

The Effects of Regional Population Growth on Hunting For Selected Big Game Species In Southcentral Alaska 1976-2000

by

William Alves
Thomas Lane
Michael Scott

Institute of Social and Economic Research

and

Robert Childers
Childers Associates

A Report for the Coastal Fish and Wildlife Resource Profile of Southcentral Alaska
U.S. F.W.S. Contract No. 14-16-0009-77-077

Arctic Environmental Information and Data Center
University of Alaska

August 4, 1978

This publication is printed on recycled paper.

Foreword

This report represents an initial attempt to incorporate available hunting and fishing harvest data gathered by the Alaska Department of Fish and Game into a comprehensive framework employing econometric modeling to forecast future hunting pressure on the state's game resources. This project was fraught with difficulties at every turn, not the least of which was retrieving and formatting the hunting data in a form which could be employed for our modeling experiments. Consequently, the project could not have taken place at all without the ready cooperation of the Alaska Department of Fish and Game, who generously made staff time available to us, and Mr. Ed Murphy of the University of Alaska Institute of Arctic Biology, who supplied and ran the programs which made SPSS access to the hunting data possible.

The population projections were made by Tom Lane, with the aid of Mike Scott, while the hunting data manipulation, species habitat, and the hunting effort programming and projections were handled by Bob Childers and Bill Alves. Typing was done by Darla Siver and Marge Matlock.

We believe this study to be a useful first attempt to forecast hunting demand in Alaska for long-range planning purposes. As funding becomes available, the Institute plans future research in this critical quality-of-life aspect of a rapidly growing state.

Michael J. Scott
Assistant Professor of Economics
Principal Investigator

Table of Contents

Table of Contents (continued)

Table of Tables

Table of Figures

I. INTRODUCTION

This study was undertaken to assess the impact of anticipated growth and development in Alaska on wildlife resources in the Southcentral region between now and the turn of the century. We sought to determine when and where within the region the course of development and its attendant population growth might present resource managers with serious threats to the viability of healthy big-game animal populations. For reasons discussed below, we focused on the impact of population growth on hunting pressure for three important big-game species in the region.

Early in our research, we realized the multifaceted nature of the problem. One consideration was the scale at which to study the problem. Should we consider the impact of each prospective large development project individually, allowing us to project site-specific impacts, or should we deal more generally with expected development and population growth in large subregions? We chose the latter approach for several reasons. We felt it was impossible to predict the location of large developments within Southcentral Alaska with a degree of accuracy that would give us confidence in the first approach. In any case, we felt that the major impact of individual developments on wildlife resources was likely to result from the growth in consumptive demand associated with induced developments. The population growth accompanying induced development usually exceeds that from direct employment and is often concentrated far from the site of development, in urban centers.

To broadly project population growth from direct and induced development at five-year intervals from 1980 to 2000, we used an econometric and population model of Alaska to estimate resident populations by 14 regions in Alaska, of which nine were in Southcentral Alaska. One set of projections was generated for each of our two development scenarios--one assuming moderate to high growth, and the other assuming low growth.

Next, we developed a simple methodology for calculating demand for wildlife resources and allocating it among several species-specific hunting destinations within the state. In essence, we assumed that demand grew apace with population, and that its incidence was the same as the 1976 geographical pattern. For moose hunting, we also adjusted this pattern in the future if projected demand exceeded an area's estimated ability to accommodate that level of hunting.

Wildlife-related demands can be classified as consumptive (hunting and fishing) and nonconsumptive (nature study, wildlife viewing, photography, etc.). We were forced to ignore nonconsumptive demand because we had no data base adequate to project future demand.* Even narrowing our focus to consumptive use proved insufficient. For only three species prevalent in Southcentral--moose, deer, and sheep--could we find adequate data on the travel behavior of hunters, a necessary link between location of population growth and location of hunting effort. We had travel data

---

*We anticipate and hope such data will become available within the next year with the completion of a statewide interagency, survey-based recreation study.

for mountain goat hunting as well. However, since most goat hunting was already under permit in the study region, it neither reflects the existing underlying demand adequately, nor did it seem reasonable to project future increases in demand for areas already subject to a quota. Bear hunters need not submit harvest tickets; rather, hunting data is collected when hides are sealed and is, therefore, available for successful hunters only.

Data on origins and destinations for sport fishing trips are also lacking, although Alaska Department of Fish and Game has taken steps to remedy this.

Our projections give hunting pressure by habitat region for each of the three species treated. Of course, the rate of growth in hunting pressure depends on the Alaska development scenario we use as a base, but the general picture that emerges is one of complete saturation of moose hunting areas by 2000 everywhere in Southcentral except for the most remote areas. Since we are unable to calculate the capacity of an area to support any given level of deer or sheep hunting, we cannot say when areas will saturate. We do project an increase of between 42 and 90 percent in deer hunting pressure in Southcentral Alaska between 1976 and 2000 and an increase of between 86 and 194 percent in sheep hunting pressure. Of course, the increase varies considerably from one habitat area to another, with the most heavily impacted being those most accessible from Anchorage and nearby areas.

We cannot say where within our habitat regions this pressure will bear most heavily. We realize the necessity of eventually doing so, but we felt that this sort of fine tuning of projections is best executed at a later date when the details of location of large industrial facilities, transfer of land to Native corporations, and d-2 classification are available. Nevertheless, we believe the results of our study should be invaluable to resource managers and researchers on two counts--first, in providing for the first time an assemblage of statewide hunting data of computer files for easy manipulation to aid further research; and second, in providing both a methodological and forecast base on which to build future refinements.

The reader should be aware that our projections do not include effects of deterioration of habitat, changes in the transportation network, changes in land tenure, or trends in the popularity of hunting or economic trends which may affect people's ability to afford hunting trips. Suggestions for including these and other factors in a forecasting model are discussed at length in the text.

II. DATA SOURCES AND LIMITATIONS

A. Introduction

Three general classes of data were required for this project: data on hunters and hunting effort, data on the capacity of the resource to sustain hunting pressure (moose only), and socioeconomic data including population growth projections. More specifically, we needed to know where hunters lived and hunted, how they got there, and whether or not they were successful. We required estimates of the mean sustainable yield of moose, deer, and sheep that might be possible for each hunting destination over the next twenty years, and we needed to make estimates of how many and where people would live in Alaska under two different assumptions about how Alaska would develop and grow between now and the year 2000.

Of the six major big game species hunted in Southcentral Alaska, we selected three for analysis--moose, Dall sheep, and Sitka deer Mountain goat was rejected because most of the study area (excepting Prince William Sound and the Gulf coast east of the Copper River) was already restricted to permit hunting only. There seemed little point in projecting hunting pressure for areas already under quotas. Brown and black bear were unsuitable, as sufficient hunting data exists only for successful hunters--so-called "sealing data," gathered when bear hides are brought to fish and game offices for measurement and affixing of a seal.

B. Hunting Data

Hunting data was gathered from Alaska Department of Fish and Game (ADF&G) species harvest tickets for the 1976-77 season. In 1976-77, harvest tickets were required of all persons who hunted for deer, sheep, goat, or moose in any of the state's 26 Game Management Units (GMUs), and for caribou in GMUs 11, 12, 13, 14, 20 (5AAC 81.010), excluding permit hunts. Harvest tickets must be returned to ADF&G within 15 days after either season closure or after the legal bag limit for that species is taken.

Harvest ticket data are stored on IBM computer tapes in Anchorage and are made available to researchers by special arrangement.

Harvest tickets for 1976-77 requested the following information:

1. Hunter name and address;
2. Resident or nonresident license;
3. Was ticketed species hunted;
4. If hunt made, number of days;
5. Game Management Unit and specific locality of hunt;
6. Species killed;
7. Date of kill;
8. Means of transport to hunting area (not included on deer harvest); and
9. If a kill was made, some species tickets request information relating to the animal itself (e.g., sex, length of longest horn, etc.).

Use of harvest tickets involves three significant data problems:

1. Missing data on returned tickets;

2. Unreported hunts and kills;

3. Reporting of permit hunts.

A more general problem is the difficulty of establishing compatible boundaries among different ADF&G data bases.

Missing Data: Missing data problems are most serious for location of hunt. Hunters are asked to indicate both the GMU and "specific locality" of hunt, usually the drainage. ADF&G personnel then code this information into three increasingly specific categories: "GMU," "Subunits," and "Area." GMUs are the same for all species, while "Subunit" and "Area" designations vary considerably in size from species-to-species and GMU-to-GMU. Subunit codings in most cases do not correspond to GMU regulatory subunits used for establishing hunting seasons and bag limits. (The latter class of regulatory subunits are designated by letters; i.e. GMU 13A, 16B, etc.) Generally speaking, "Subunit" and "Area" coding designations for any particular species are much smaller and more numerous close to urban centers and in other GMUs having significant hunting pressure, and larger elsewhere.

At the GMU level, unreported destinations for 1976-77 were: dall sheep, 4.7 percent (153 of 3,236); moose, 5.8 percent (985 of 16,999); and deer, 6.0 percent (410 of 6,843). These represent hunters giving no destination information on returned harvest tickets.

A more serious problem exists for those hunters who identified the GMU in which they hunted but gave no specific locality. For most species and GMUs, these hunters are classified as having hunted in subunit 10. For moose hunters, those classified as visiting subunit 10 by GMU in 1976-77 (20 percent sample) are as follows:

GMU 1-2.1 percent (3 of 144)	GMU 5-28.6 percent (4 of 14)
GMU 6-8.3 percent (1 of 12)	GMU 7-18.2 percent (16 of 88)
GMU 9-16.3 percent (16 of 98)	GMU 11-50 percent (21 of 42)
GMU 12-10.3 percent (6 of 58)	GMU 13-23.9 percent (144 of 603)
GMU 14-9.0 percent (36 of 399)	GMU 15-9.4 percent (39 of 415)
GMU 16-6.8 percent (23 of 340)	GMU 17-28.1 percent (9 of 32)
GMU 18-17.6 percent (3 of 17)	GMU 19-14.4 percent (19 of 132)
GMU 20-5.7 percent (25 of 440)	GMU 21-16.5 percent (17 of 103)
GMU 22-7.9 percent (10 of 126)	GMU 23-10.3 percent (6 of 58)
GMU 24-18.8 percent (3 of 16)	GMU 25-16.7 percent (8 of 48)
GMU 26-25.0 percent (5 of 20)	

This represents 12.9 percent of all moose hunters reporting GMU hunted.

In those GMUs having lettered (regulatory) subunits, some hunters incorrectly enter those letters as the "specific locality." In those instances, the coding subunit is generally coded as 10 (and included in the above percentages) with specific "areas" codes to indicate the (regulatory) subunit hunted. For example, of the 144 hunters in GMU 13, subunit 10, the area designations were: 0 = unknown location in GMU 13 (104 hunters); 1 = unknown location in GMU 13A (6 hunters); 2 = unknown location in 13B (9 hunters); etc.

Similar problems exist at the "area" level for known subunits with "area 10" usually representing those hunters in a known GMU and "subunit" but unknown "area."

In this project, hunters with unknown destinations were allocated to known destinations as described in the Methods Section below.

In addition to incomplete or insufficiently accurate destinations, a second problem with hunt location information arises for hunters who hunted in more than one location or on more than one occasion in the same location. Except for deer, harvest tickets neither request how many times the subject species was hunted, nor provide space for indicating more than one GMU and specific locality. Likewise, the "number of days hunted" inquiry could represent more than one hunt, thereby over-reporting the days afield per hunt, or only one of two or more hunts, effectively understating hunting pressure.

A second missing data problem with harvest tickets was zipcodes used for constructing hunter "origins." Names and addresses of hunters requesting harvest tickets are entered on a detachable portion of the issuing agent and forwarded directly to ADF&G at that time. Zipcodes, however, are frequently omitted and numerous misspellings and/or varying abbreviations used in addresses necessitate a time-consuming manual review of records before assigning zipcodes by computer. Unknown origins for corrected files were: moose (20 percent sample) - 1.4 percent (48 of 3,392); deer - 1.2 percent (81 of 6,843); sheep - 0.5 percent (15 of 3,236).

A final data problem occurs with the "primary method of transport to the hunting area" question. Although there is no way of checking this data for errors, there appear to be three problems associated with it. First, either through mistaken entries or during the coding process, a particularly unlikely mode was occasionally recorded (e.g. snow machines for summer or early fall hunts). Second, in some cases, it appears hunters indicated transport means actually used in the hunt area, rather than to get to the area from their place of residence. Finally, because the question only addresses transport to the hunting area, but not within it, and allows only one answer, it is not possible to assess the role of multimodal hunts (e.g. cars and boats, boats and ATVs, etc.). In most cases, one can identify the most important methods of transport to a specific destination, or between any particular origin and destination, and can allocate costs based on each method weighted by its relative importance. These can then be used to derive an average cost for the entire population traveling from origin x to destination y. The data cannot, however, be used to estimate intraregional travel. In many cases, costs of such travel will be sufficient to mask differences between alternate origin-destination dyads, making reallocations of hunter effort based on a travel-cost gravity model highly problematical. It should also be noted that the 1976-77 deer harvest tickets do not request travel mode information.

Unreported Hunts and Kills: The second major limitation to use of harvest tickets to estimate hunting pressure is noncompliance. Except in a few limited areas and for specific species, there are not reliable estimates of unreported hunts and kills in the state. Nonreporting occurs throughout the state but is most prevalent in isolated, rural areas where the activities of wildlife managers and bureaucrats are far removed from the everyday concerns of the area's inhabitants. In some rural areas where urban-based hunters exert little pressure, unreported kills may exceed reported kills by several times.

No effort was made to account for unreported hunts and kills in this report.

Permit Hunts: A final limitation of harvest ticket data involves controlled permit hunts. Permit hunters are not required to obtain or return harvest tickets, but an undetermined number do so. In the past, harvest tickets reporting permit hunts have not been excluded from harvest ticket records nor given any special identifying designation. In order to accurately determine hunting pressure and take, it would be necessary to review permit records and cross check them with harvest tickets to exclude double counting.

Permit hunts exist for several species and localities; however, the only species substantially under permits in 1976-77 was goat, with permit hunts in GMUs 4, 7, 8, 14A&C, and 15.

No effort was made to count permit hunts during this project, as our aim was to assess the expected increase in hunting pressure over the next 20 years. The very fact that a certain species is hunted only by permit in an area indicates, in most cases, that hunting pressure is already at a maximum and that any additional increases in hunting pressure will come about only through ADF&G policy decisions exogenous to the socioeconomic variables under examination here.

Geographic Compatibility: A related problem, not restricted to the use of harvest tickets, is the difficulty associated with developing common geographic boundaries for different data sources. For example, coding "subunits" are frequently incompatible with regulatory subunits (i.e. 16B, 5A, etc.), necessitating the use of "Area" level codes at considerable additional effort. In addition, subunit codes are specific to individual species and, in most cases, the Anchorage regional office does not have maps of coded "subunits" or "areas." To make matters worse, species management areas described in "Alaska Wildlife Management Plans" do not conform to GMU, coding, or regulatory subunits; nor were we able to locate a list of corresponding designations.

The use of hunting "subunits" and "areas" required the locating of areas from species coding lists on 1:250,000 scale U.S.G.S. quadrangle maps--a time-consuming task.

C. Resource Data

As population and hunting pressure increase in the future, those hunting areas near population centers can be expected to yield progressively fewer moose per unit effort. At the same time, some hunters who put a high value on success and are also able to expend the requisit time, effort, and money will travel to more distant areas offering a greater probability of success. We can approximate this reallocation of effort by the use of limits on the number of hunters visiting each destination. Assuming for any particular area constant mean effort per hunter and success rates, a rough approximation of allowable annual harvest can be used to identify these limits, driving the reallocation of effort in a mathematical model.

Allowable harvest estimates in theory may be generated in one of three ways:

1. Based upon estimates of the actual population and an assessment of the proportion of that population which may be harvested annually;

2. based upon estimates of the theoretical carrying capacity of the habitat and a proportion of that theoretical population which could be harvested; and

3. some combination of these, based upon assumptions about both loss of critical habitat to succession or development over time and rebuilding of populations toward theoretical levels when existing populations have been subjected to abnormally high mortality factors (e.g. unusually severe winters).

Theoretical estimates of carrying capacities for several species in Alaska have been made and mapped by the University of Alaska's Arctic

Environmental Information and Data Center for the U.S. Fish and Wildlife Service (scale: 1:1,000,000 and 1:2,500,000). Alaska Department of Fish and Game has made and published estimates of actual populations for some species ("actual estimates") in their Alaska Wildlife Management Plans and Annual Reports of Survey-Inventory Activities (S&I Reports) which are compiled pursuant to the Federal Aid in Wildlife Restoration Program. In addition, some ADF&G area biologists are willing to make rough population estimates for their areas. In most cases, however, species data is limited to "composition counts" of preselected areas. These areas are recounted periodically at approximately the same time of year to obtain trends in the size, stability, and composition of the subject species population.

In this study, the use of limits for reallocating hunting effort was limited to moose for two reasons: it is the primary species hunted in Southcentral Alaska, and it has the most complete statewide population information. Limits were based upon actual population estimates only, due to the time required to disaggregate carrying capacity information to our hunter destination areas and the financial constraints of this project.

Limitations: Generating estimates of allowable harvest for hunting areas is subject to a very considerable uncertainty for two reasons: first, existing population estimates are quite limited in extent and are not very reliable; second, in many if not most cases, existing data is limited to area composition counts collectively representing most of a GMU in some cases but, more frequently, a relatively small proportion of the available habitat for that species. In addition, population counts vary widely with different observers and under differing conditions.

D. Human Population Data

Human population data used in this study were developed by combining a run of the ISER Man-in-the-Arctic Program (MAP) econometric and population models with researcher judgments concerning past and projected economic and demographic occurrences in specific census divisions within the state. These projections and judgments depend upon two primary sources of data: Alaska Department of Labor Current Population Estimates by Census Divisions, published annually, and annual summaries of Alaska Department of Labor estimates of employment, payroll, and wage rates, based upon Employment Security Division employer reports.

The populations reported in Current Population Estimates are developed by Department of Labor manpower economists using a variant of the U.S. Census Bureau's Component Method II for making population estimates. The method involves five steps: 1) subtracting Armed Forces from the 1970 Census count to arrive at estimates of civilian population on April 1, 1970; 2) adding to this count an estimate of civilian births from vital statistics supplied by the Alaska Department of Health and Social Services; 3) subtracting an estimate of civilian deaths; 4) adding an estimate of Armed Forces stationed in the state, provided by the Alaskan Command and U.S. Coast Guard; and 5) adding an estimate of civilian migration.

Civilian migration was estimated by developing net migration rates for children between the exact ages of 6 1/4 years and 14 1/4 years based on the 1970 Census and enrollment information for grades one through eight from the Alaska Department of Education and Bureau of Indian Affairs. These rates were multiplied by a factor to obtain estimated migration rates for the total population suggested by the Bureau of the Census, based on the age structure of intercounty migrants. Resulting rates were applied to civilian population of all ages (adjusted by one-half the births since 1970) in each census division in 1970 to obtain estimates of migration since 1970. Prior to 1974, these preliminary migration estimates were brought into line with Bureau of Census statewide estimates by adjusting areas with few urban centers and a nomadic way of life, since school age population changes were more likely to reflect school facilities availability than migration of the underlying population.

Since 1974, the state has not adjusted its population estimates to Census totals because there has been disagreement over the adequacy of Census method in estimating migration of childless individuals. This feature of migration has caused the state numbers, which rely partially on Alyeska consortium-supplied employment information, to yield significantly higher (and possibly more accurate) population estimates than the Bureau of the Census. In general, the degree of error for larger population centers for both sets of estimates will tend to be smaller for Anchorage than for the smaller census divisions.

Employment data used to construct the model and disaggregation methodology is reported quarterly by the Alaska Department of Labor, Employment Security Division, Research and Analysis Section, in a document called Statistical Quarterly. The primary data is collected from quarterly reports of employers subject to state unemployment insurance law and quarterly reports of Federal agencies made in connection with the state-administered program for unemployed Federal workers. Since the first quarter of 1964, the state has also estimated noncovered nonagricultural wage and salary employment. The estimated total excludes self-employed, unpaid family help, domestics, and most persons engaged in agriculture--perhaps a total of four thousand or so persons out of 200 thousand total employed. The military (about 13 thousand within the study region) are also excluded. These must be added in to obtain total employment.

The employment data are reported by industry in conformity with the Standard Industrial Classification Manual, U.S. Bureau of the Budget, 1972 edition, which provides for classification of establishment on the basis of principal activity conducted. Also, to obtain the data by census division, the state attempts to collect separate payroll and employment data for each employer in each census division where he operates establishments. Where this is not possible, employment of multi-area employers is allocated to the area of major activity.

Due to the small number of employers in some industries in some census divisions, the state is required to summarize or suppress data in its publications so that individual employer employment and payroll cannot be identified. ISER has obtained direct access to the worksheets and records of the Research and Analysis Section, however, so the employment data used to compile this report are the most exact data available from any public source.

Use of the data to develop the disaggregation methodology is described in the Methods Section of this report. A brief description of the ecnometric and population models appears in the January 1976 issue of ISER's <u>Alaska Review of Business and Economic Conditions</u>.

III. METHODS: DATA MANIPULATION

A. Introduction

The purpose of this study was to investigate the effects of population change on hunting pressure in Southcentral Alaska with some geographic specificity. In order to account for interregional travel into and out of the study region, hunter "origin" and "destinations" had to be defined for the entire state. Allowable harvest estimates were then generated for each destination (moose only), and travel costs were calculated from Anchorage, the largest origin, to each destination to examine the role of cost in reallocating demand from "full" destinations to alternative hunting areas.

B. Data Tapes

ADF&G's harvest ticket data is stored on computer tapes in IBM format. Due to differing species' needs and the evolution of ADF&G's data requirements, data for each species may differ in format and content. The first task was to copy files onto Honeywell format tapes, rework all species data into a common format suitable for use by SPSS (Statistical Package for the Social Sciences), correct hunter addresses, and assign missing zip codes. These tasks were accomplished by a series of programs originally written under a National Park Service contract with the University of Alaska (Fairbanks) for application to the Wrangell Mountains area and were performed by the program's author in Fairbanks. The cleaned files were then purged of those cases where hunters obtained species harvest tickets but did not hunt that species.

Due to the large number of moose hunters (16,999), all supporting analyses of moose hunting were performed on a random 20 percent sample. Final runs incorporated a multiplication factor to represent all moose hunters. Other species files were analyzed in toto.

Origins: Hunter origins were defined using the Institute's Man-in-the-Arctic Program (MAP) regions and U.S. Census Divisions. In those cases where Census Divisions crossed study region boundaries, they were divided along the study boundaries. Hunter origins, used for all species, are given in Table 3.1. The new variable, origin, was constructed from zip codes. Recode statements and hunter origin maps may be found in Appendices A and B. It should be noted that origins were based on actual rather than legal residence of the hunter.

In general, hunter origins are relatively large for rural areas outside the study region and more detailed for urban centers and for communities within the Southcentral region. Because population growth projections were based upon the MAP model of the Alaska economy, whole MAP regions were used whenever possible. Where more detailed forecasts were required, data were disaggregated as discussed in the population projections methodology section below.

Table 3.1.

Hunter Origins

Origin	MAP Region(s)	Census Division(s)
1 - Northcentral	North Slope & Central	Barrow, Upper Yukon, Yukon-Koyukuk, Kobuk, Nome
2 - Southwest	Southwest	Kuskokwim, Wade-Hampton, Bethel, Bristol Bay Borough, Aleutian Islands
3 - Fairbanks	Fairbanks	Southeast Fairbanks, Fairbanks
4 - Southeast	Southeast (excl. Yakutat)	Haines, Juneau, Angoon, Wrangell-Petersburg, Ketchikan, Outer Ketchikan, Prince of Wales, Skagway-Yakutat (part)
5 - Kodiak*	Southcentral (part)	Kodiak
6 - Mat-Su*	Southcentral (part)	Matanuska-Susitna
7 - W. Kenai*	Southcentral (part)	Kenai-Cook Inlet
8 - Anchorage*	Anchorage	Anchorage
9 - Seward*	Southcentral (part)	Seward
10 - Ahtna	Southcentral (part)	Valdez-Chitna-Whittier (part), Cordova-McCarthy (part)
11 - Whittier*	Southcentral (part)	Valdez-Chitna-Whittier (part)
12 - Valdez*	Southcentral (part)	Valdez-Chitna-Whittier (part)
13 - Cordova*	Southcentral (part)	Cordova-McCarthy (part)
14 - Yakutat*	Southcentral (part)	Skagway-Yakutat (part)
15 - Rest of U.S.	--	--
16 - Foreign	--	--

*Denotes origins within the study region

Unknown origins: Unknown origins occurred in less than 1.5 percent of the cases for each species and arose from two different sources: occasional uninterpretable addresses or nonexistent zip code information and a few locations with nonunique zipcodes. The latter class includes Whittier, which has an Anchorage zipcode, and the zipcodes 99695 and 99790. These codes are used for several remote communities which fall into more than one hunter origin; they denote only the regional post office from which they are distributed.

In practically all cases, hunters with unknown origins hunted in known destinations. (For example, only six deer hunters, four moose hunters (20 percent sample), and no sheep hunters gave unusable information regarding both their origin and destination.) Hunters with knwon destinations and unknown origins were assigned to defined origins on the basis of the proportion of all hunters hunting in that destination who came from each origin. For instance, if 30 percent of all hunters in destination x came from origin y, and ten hunters in destination x came from unknown origins, three would be assigned to origin y, and so forth.

Non-Alaskan Hunters: Non-Alaskan hunters are included in the 1976 data, but no effort was made to project future changes in their participation. For subsequent (projected) years, participation by non-Alaskans is assumed to be stable in absolute terms and, therefore, represents a generally declining proportion of hunters for projected years. Statewide, non-Alaskans represent 6.4 percent (187) of reporting moose hunters

(20 percent sample); 4.0 percent (271) of all reporting deer hunters; but 16.8 percent (542) of reporting sheep hunters, reflecting sheep's status as a trophy species.

Non-Alaskans were excluded from projections of growth in hunting pressure on two accounts: As the purpose of this project is to estimate the significance of socioeconomic development in Alaska for hunting in Southcentral Alaska in the future, non-Alaskans are exogenous to the factors under consideration. And, secondly, the relatively minor role these hunters play for moose and deer would largely be masked by the uncertainties inherent in other variables of our model, while the projections for non-Alaskan hunters would themselves be highly speculative. In the case of dall sheep, however, the exclusion of non-Alaskan hunters probably results in a significant underestimation of statewide demand. The effect is less significant within the study region, where non-Alaskans account for only 5.6 percent of sheep hunters.

Of the moose destinations within the study area (again, based on 20 percent sample), non-Alaskan hunters represent less than 2 percent of all hunters in every destination with significant pressure except two: Northwest Kenai Peninsula (GMU 15A), 3.5 percent; and across Cook Inlet (lower portions of GMU 16B), 5.5 percent. Non-Alaskans do represent a significant proportion of moose hunters in three lightly hunted areas within the region: Pacific drainages of the upper Alaska Peninsula, 57.1 percent (4 of 7); lower west Cook Inlet (GMU 9A), 25 percent (1 of 4); and the Malispina Glacier forelands, 16.7 percent (1 of 6).

For deer, non-Alaskans constituted more than 2 percent of the hunters in seven of fifteen destinations within the study region, as follows:

Table 3.2.

Non-Alaskan Deer Hunters

Deer Destination	Non-Alaskan Hunters	% of Hunters	Total Hunters
Kodiak-Afognak	149	10.4	1,440
Naked Island	3	7.9	38
Montague-Green Island	5	2.5	201
Hawkins Island	4	2.9	136
Knight Island	1	6.25	16
Yakutat	1	20.0	5
Valdez-Port Fidalgo	1	20.0	5

Non-Alaskan sheep hunters represent more than 9 percent of reporting 1976-77 hunters in seven of eleven destinations statewide. Of the state's 542 non-Alaskan sheep hunters, 510 (94.1 percent) hunted outside the study region. This compares with 2,152 (79.9 percent) of the 2,694 sheep hunters living in Alaska who hunted outside the study region. Non-Alaskans account for 5.6 percent (32 of 574) sheep hunters who hunted in the Southcentral region in 1976-77.

Of the six destinations within the study region, participation by non-Alaskans exceeded 2 percent of all reporting sheep hunters in four, as follows:

Table 3.3.

Non-Alaskan Sheep Hunters

Sheep Destination	Non-Alaskan Hunters	% of Total Hunters	Total Hunters
Matanuska-Susitna	18	10.9	165
W. Central Kenai Peninsula	4	3.6	110
S.W. Kenai Peninsula	2	23.1	13
E. Kenai Peninsula	5	3.7	135

Destinations: Hunter destinations were constructed from ADF&G species specific hunt location codes for Game Management Units (GMUs), "subunits," and "areas."

It should be noted that "subunit" and "area" designations vary considerably in geographic detail from species-to-species and, for any one species, from GMU-to-GMU. Missing data problems increase significantly with increasing levels of detail.*

Destinations were created using the following general criteria:

-- individual destinations should represent contiguous areas with broadly comparable geographic and logistical characteristics;

-- to minimize data problems, whole GMUs and submits should be used where practical;

-- within the study region, destinations should be large enough to represent a meaningful level of hunting effort, but sufficiently small to reflect significant geographic specificity;

-- beyond the Alaska Range, very large destinations would be allowed to simplify analysis; and

*See preceding discussion in "Data Sources and Limitations" section.

-- in the case of moose, destination boundaries were selected to correspond, where practical, to available population data. (See "Allowable Harvest" below.)

Unknown destinations occurred in moose in 7.5 percent, or 264 of 3,392 cases (20 percent sample). Of these, 74 cases, or 28 percent, had sufficient information to partially classify them, e.g., GMU hunted, but subunit not specified, etc. In only four cases were both the origin and destination unknown.

Deer hunters with unknown destinations accounted for 480 of 6,843, or 7.0 percent, of all reported deer hunters. Of these, 1.3 percent, or 6 cases, also had unknown origins.

Sheep hunters with unknown or partially known destinations accounted for 168 (5.2 percent) of 3,236 reporting hunters.

For all species, hunters with unknown destinations were reallocated to established destinations, based on the distribution of all other hunters of that species from the same origin. Hunters with partially known destinations were allocated in the same manner among the smaller class of possible destinations.

Destinations for each species are given in the following tables. Computer statements and destination maps may be found in Appendices A and B.

Table 3.4.

Moose Destinations

Number	Destination	Comments
1	North Slope	GMU 26
2	Northwest	GMU 22, 23
3	Southwest	GMU 18, 19, 21
4	Northern Interior	GMU 24, 25
5	Southern Interior	GMU 20
6	Paxton Lake-Wrangell Mountains	GMU 11, 12, 13B, 13C
7	Susitna-Tazlina Lakes	GMU 13A and 13D
8	Southeast	GMU 1, 2, 3, 4
9	Yakutat-Russell Fjord*	GMU 5 (from Yakutat Bay to Harlequin Lake)
10	Malispina Glacier Forelands*	GMU 5 Yakutat Bay to Icy Cape)
11	Cape Suckling*	GMU 6A
12	Copper-Martin Rivers*	GMU 6B
13	Cordova-Eyak*	GMU 6C
14	North Bristol Bay	GMU 17, 9B, 9C
15	Alaska Peninsula-Northwest	GMU 9E (Bristol Bay drainages)
16	Alaska Peninsula-Southeast*	GMU 9E (Pacific drainages)
17	Upper Western Cook Inlet*	GMU 16B (Beluga Mtn.-Redoubt Bay)
18	Lower Western Cook Inlet*	GMU 9A
19	Upper Skwenta-Yentna River	GMU 16B (Northwestern portion)
20	Susitna Basin	GMU 16A, 13E, 14B
21	Mat-Su Valley*	GMU 14A
22	Anchorage*	GMU 14C
23	Southwest Kenai Peninsula*	GMU 15C
24	West Central Kenai Peninsula*	GMU 15B
25	Northern Kenai Peninsula*	GMU 15A
26	Eastern Kenai Peninsula*	GMU 7

*Within study region

Table 3.5.

Deer Destinations

Number	Destination	Comments
1	Southeast 1	GMU 1
2	Southeast 2	GMU 2
3	Southeast 3	GMU 3
4	Southeast 4	GMU 4
5	Yakutat*	GMU 5 (from Yakutat Bay to Harlequin Lake)
6	Cordova-Martin River*	GMU 6 (part)
7	Hawkins Island*	↓
8	Hinchinbrook Island*	↓
9	Montague-Green Islands*	↓
10	Bainbridge Chenega Latouch*	↓
11	Knight Island*	↓
12	Naked Island*	↓
13	Perry Culcross Lone Island*	↓
14	Nelsen Bay-Point Gravina*	↓
15	Port Fidalgo-Valdez*	↓
16	Passage Canal*	GMU 6 (part)
17	Kodiak Afognak Island*	GMU 8

*Within study region

Table 3.6.

Sheep Destinations

Number	Destination	Comments
1	Brooks Range	GMU 23, 24, 25, 26
2	North Central Alaska Range and Interior	GMU 20
3	West Alaska Range**	GMU 9, 16, 17, 19
4	Wrangell Mountains and Northeast Chugach Mountains	GMU 11, 12
5	Talkeetna Mountains and Southcentral Alaska Range	GMU 13, 14B
6	Matanuska-Susitna*	GMU 14A
7	West Chugach*	GMU 14C
8	North Kenai Peninsula*	GMU 15A
9	West Central Kenai Peninsula*	GMU 15B
10	Southwest Kenai Peninsula*	GMU 15C
11	East Kenai Peninsula*	GMU 7

*Within study region

**Although portions of GMU 9 and 16 are partially within study boundaries, all reported hunting occurred outside the Southcentral region as defined for this project.

C. Allowable Harvest

To explore the role of hunters traveling to more distant destinations as hunting pressure grows in the future, we decided to experiment with upper limits on the hunting effort allowed at each destination for one species, reallocating "excess" latent demand to alternative destinations not yet full. The species selected for this investigation was moose, for two reasons: it is the most important game species hunted within the study region and, unlike most species, usable population data exists throughout most of the state.

Behind the reallocation of hunting effort is the assumption, that as hunting pressure increases in nearby destinations, the probability of success will drop. As a result, some hunters will be willing to incur greater expenditure of time, money, and/or effort to hunt in more distant or otherwise less accessible destinations in order to increase their chances of success.

The specific modeling of this concept would necessitate the generating of functions for declining success rates resulting from increasing hunting pressure, the willingness to incur additional expense as a function of the probability of success, and complex reallocation formulae, thus, cumulatively exceeding the available resources for this project. As a somewhat crude surrogate for modeling the expected behavior, we opted for a set of limits. Additional hunters were allowed into a destination until this limit was reached; thereafter, additional "demand" was reallocated among the remaining "unfilled" destinations. (See Moose Model discussion below.)

The approach used involves a number of imbedded operational assumptions:

-- mean effort per hunter for each destination would be constant over time;

-- management policies for each destination would remain unchanged except that a limit on total hunting effort (and, therefore, the number of hunters) would be imposed;

-- moose populations would remain at their 1975 estimated levels and be able to sustain a consistent "allowable harvest"; and

-- hunter success rates per unit effort (and, therefore, per hunter) would remain constant.

The net effect of these assumptions is the ability to establish limits based on the value for allowable harvest and to drive the model and reallocation function with the single variable, "number of hunters," by origin.

As modeled, growth in hunting pressure in any particular destination would parallel the population growth in Alaskan hunter origins, weighted by their individual contributions to hunter pressure in that destination, until "full." Beyond that point, no growth in hunting pressure occurs. The expected actual behavior would be less dramatic--a gradually increasing dispersion of effort to less crowded destinations as the probability of success declines in the presently favored destination. The modeled behavior simply indicates the approximate period during which the latent demand for moose hunting in destination x is expected to exceed available opportunities, and how unmet "demand" in destination x may be expected to affect hunting pressure in other destinations.

Our use of limits may be seen as representing a management decision to limit hunters within a destination by instituting permit hunts without affecting mean effort (days afield) per hunter. A frequently-used management alternative to permit hunts is to simply shorten the season. In cases where the new season occurs during a predominantly stormy period, during times of high labor force demands, or if the shortened season leads to more crowded conditions afield and lower hunt aesthetics, one could argue that mean hunter effort would decline. Were this, in fact, true, our projected numbers would overstate the actual pressure afield.

Allowable harvest figures were generated from various estimates of population size and the proportion of a population which could be harvested. Population estimates were primarily from two published sources: ADF&G's Annual Report of Survey and Inventory Activities Vol. VII (1975 data), Part III - Moose, September 1977 (S&I Reports) and Alaska Wildlife Management Plans (ND) - Moose Management Plans (MMP). Where no data exists, estimates were sought from ADF&G's area biologists or extrapolated from surrounding regions. Table 3.7 gives allowable harvest figures used for each destination, the published source of the population data used, if any, and the assumed percent allowable. Allowable harvest estimates range from 7-15 percent of estimated populations and are generally smaller in the northern areas and larger further south, reflecting general differences in growing seasons and, hence, productivity of browse. Percent allowable estimates also reflect in

Table 3.7.

Estimated Allowable Harvest - Moose

Destination (#)	Allowable Harvest	Comments
Arctic (1)	155	From MMPs, 7% of est. pop. where available; S&I est. Sustained yield elsewhere.
Northwest (2)	510	MMP mean pop est. (4,250); allow @ 12% (good range conditions noted)
Southwest (3)	1,200	S&I est. take in GMU 19 + 21 + 20%.
N. Interior (4)	215	Reported 1976-77 take + 30%; (pop. stable or declining)
S. Interior (5)	1,500	S&I counts (GMU 20 A&B)x2; assume: Take/Pop(GMU 20 AB&D) = Take/Pop(20D); pop. est. = 10,000+ allow @ 15%.
Paxton Lake-Wrangell Mountains (6)	638	GMU 13 B&C pop. est.** = 4,810; allowable @ 10%; GMU 12 - 1975 take x 1.2 = 90; (S&I recommends stable seasons with possible future reduction); GMU 11 - 1976 take x 1.4 = 67
Susitna-Tazlina Lakes (7)	481	GMU 13 A&D pop. est** = 4,810; allow @ 10%.
Southeast (8)	144	MMPs pop. est. = 957; allow @ 15%.
Yakutat-Russell Fjord (9)*	31	S&I Yakutat forelands est. x .5 (165) + Nunatak Fjord pop (40); allow @ 15%.
Malispina Forelands (10)*	28	S&I pop. = 186; allow @ 15%.
Cape Suckling (11)*	18	S&I pop. = 117; allow @ 15%.
Copper-Martin Rivers (12)*	20	S&I pop. = 132; allow @ 15%.
Cordova-Eyak (13)*	29	S&I pop. = 191; allow @ 15%.
N. Bristol Bay (14)	172	MMPA pop (=1,800) - 9A pop. (assume=80); allow @ 10%.

Destination (#)	Allowable Harvest	Comments
Alaska Pen.-NW (15)	412	MMP - MMPAs 37+39+(38x.5) pop. est. = 2,750; allow @ 15%.
Alaska Pen.-SE (16)*	52	MMP - MMPA (38x.5) + 40 (est. 100) = 350; allow @ 15%.
Upper W. Cook Inlet (17)*	480	GMU 16B pop. est. (8,000) x .6 (portion within dest.) = 4,800; allow @ 10%.
Lower W. Cook Inlet (18)*	8	Pop. est. = 80; allow @ 10%.
Upper Skwentna-Yentna Rs. (19)	320	GMU 16B pop. est. x .4 (portion within dest.) = 3,200; allow @ 10%.
Susitna Basin (20)	750	MMP-MMPA 22 pop. est. + (MMPA 30 & 31 mean count x 1.4) + GMU 13 E pop. est.** = 1,000 + ((1,500 + 750) 1.4) + 3,380 = 7,495; allow @ 10%.
Matanuska-Susitna Valley (21)*	247	S&I 1974 count x 1.6 = 3,091; allow @ 8% (winter habitat less).
Anchorage (22)*	90	MMP mean pop. est. = 900; allow @ 10%.
S.W. Kenai Pen. (23)*	134	S&I 1974 count x 1.4; allow @ 10%.
W. Central Kenai Pen. (23)*	144	S&I GMU 15A&B pop; 1973 count allocate 15B-38%; pop. = 1,437; allow @ 10%.
N. Kenai Peninsula (25)*	235	S&I GMU 15A&B pop. x .62 = 2,345; allow @ 10%.
E. Kenai Peninsula (26)	104	S&I 1973 count x 1.5 - 1,299; allow @ 8%.

*Denotes destinations within study area.
**Population estimates for GMU 13:
Assume moose density: 13A=Med.; 13B=High, 13C=High, 13D=Low, 13E=Med, where High = 2xLow; Med=1.5xLow. Area relationships: 13A=19%; 13B=19%; 13C=9%; 13D=27%; 13E=26%.
Then % GMU 13 pop in subunit i = $\text{Area}_i \times \text{Density}_i / \Sigma_{i=A}^{E} (\text{Area}_i \times \text{Density}_i)$;

then pop. 13A=2,470; 13B=3,250; 13C=1,560; 13D=2,340; 13E=3,380.

some cases S&I or MMP comments reflecting range conditions, population productivity, or recommendations regarding season and bag limit modifications, as well as comments by Arctic Environmental Information and Data Center biologists. In those cases where population estimates were not available, 1976-77 reported harvest figures were multiplied by a somewhat arbitrary factor to arrive at an allowable harvest estimate. Again, variations in this factor from destination-to-destination reflect available circumstantial information contained in the source documents.

Due to their considerable uncertainty, the allowable harvest input data file was structured to be easily ammended.

D. Travel Costs

Travel costs were calculated for hunting trips from a major town or city within each region to each destination region based upon the most frequently-used mode of travel reported by hunters from that origin hunting in that destination. Road travel was based upon 25¢/mile, shared by a party of two hunters; air travel between points with scheduled services was based upon published coach fares, including tax, and charter fares were based upon $100/hour and an average ground speed of 100 statute mile/hour. We assumed each hunting trip using charter aircraft required two round trips from origin to destination with the cost being shared by a party of two hunters.

Costs were calculated to put the hunter more or less in the middle of his destination region. No cost of time was included except where the trip could not reasonably be completed in a single three-day weekend. When it could not, we added $50 per day's travel per hunter to travel costs.

Travel costs were regressed on hunter success rates and number of hunters at each destination from Anchorage. (See discussion in Results Section.)

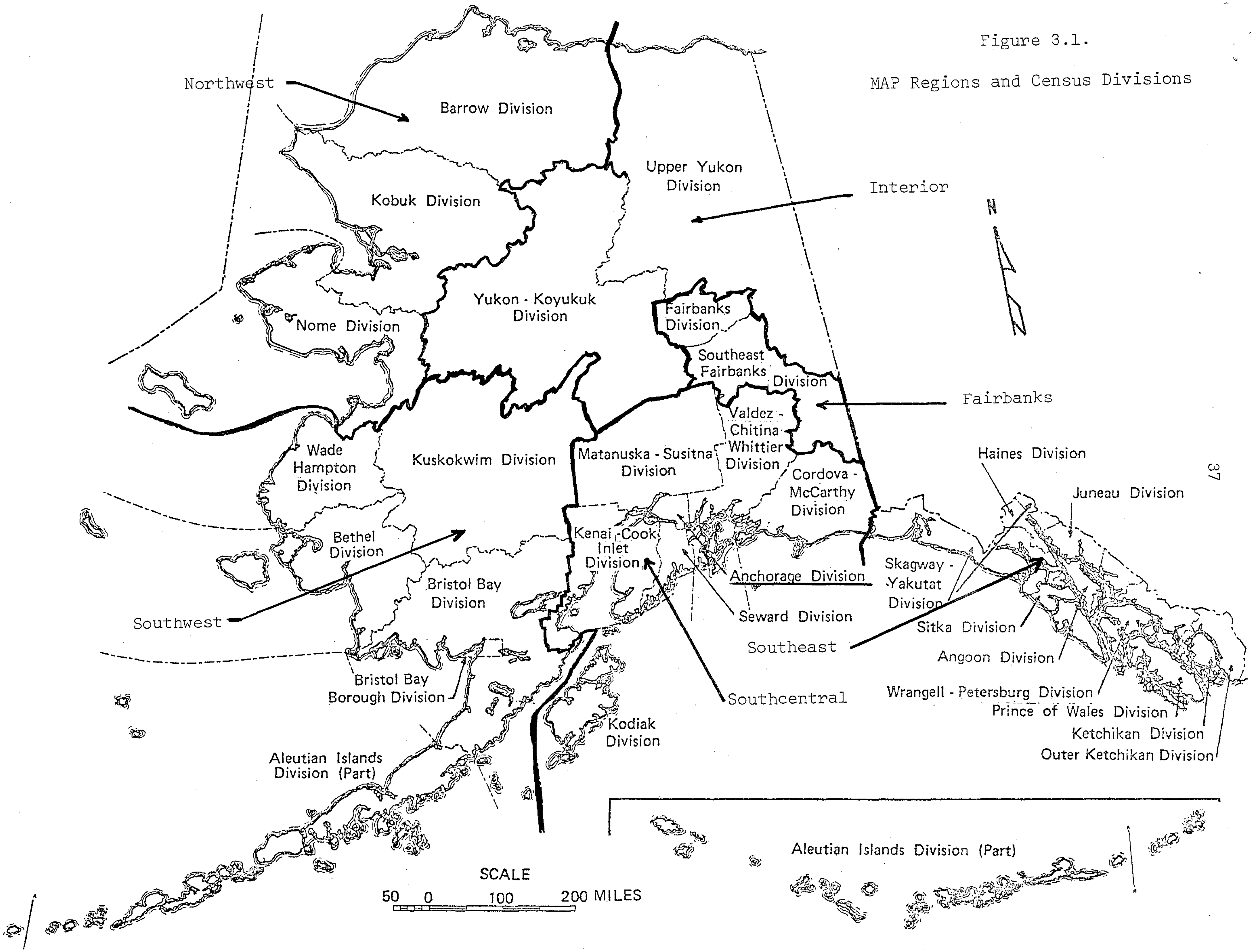
E. Resident Population Projections

This section briefly describes the methodology used to develop estimates of the number of people resident in each census division within the study area to the year 2000. These estimates were in turn used to estimate potential hunter populations. Full detail appears in Appendix C.

As a baseline for estimating resident populations, we used a run of the ISER Man-in-the-Arctic Program (MAP) regional econometric and population models done in December 1976 for the Municipality of Anchorage, which provides estimates for seven geographical regions within Alaska shown in Figure 3.1. The run was intended to project high to moderate development statewide and in Southcentral Alaska, and to estimate population for Anchorage and "Other Southcentral." For a second lower estimate, based on our experience with many model simulations, we used approximately 50 percent of the population growth which was

Figure 3.1.

MAP Regions and Census Divisions



expected in the high case as a control total. The forecast assumptions are shown in Table 3.8.

The regional forecasts were then disaggregated to the census division level. This was a fairly complex multistep process which used virtually all information available on economic and population structure and trends in individual census divisions (and even below the census division level). The process initially involved projecting and allocating "basic" employment, which is primarily export-based or whose level of activity is otherwise determined outside the locality. For purposes of this exercise, "basic" employment was defined as agriculture, forestry, and fisheries; mining; manufacturing; construction; and federal government. Secondly, a relationship between non-basic employment and basic employment was estimated from recent historical data and projected into the future. Finally, population to employment relationships were estimated to allocate civilian population, and military population was added to the civilian total. Populations for the two projections are shown in Tables 3.9 and 3.10.

Adjustments to the process outlined above had to be inserted for Valdez, Anchorage, and the Matanuska-Susitna (Mat-Su) Borough. In the case of Valdez, it was necessary to develop an estimate of the "stable" or "natural" population, since recent data has been impacted by pipeline construction and identifiable shifts in the structure of the economy due to oil terminal operations. Basic long-term employment was estimated as 100 construction workers (the pre-pipeline average), 500 Alyeska terminal

Table 3.8.

Forecast Assumptions

	Low Development Case	Moderately High Development Case
General Development	Low	Moderate
Gas Pipeline	Yes	Yes
Capital Move	No	Yes
Devil's Canyon Dam	No	Yes
OCS Development	Exploration Only	Significant finds; support development in Yakutat and in Cordova, Seward, Kenai Census Divisions.
Copper River Highway	No	Yes
Whittier Highway	No	Yes
Knik Crossing	No	No
Turnagain Crossing	No	No
Alpetco	No	Yes; in Kenai area
Fairbanks Development	Weak	Strong

Table 3.9.

Population: Low Development

Area	1976	1980	1985	1990	1995	2000
Anchorage	185,179	211,177	242,902	277,725	310,462	344,216
Mat-Su	14,010	18,452	22,393	26,718	30,783	34,976
Kenai	16,753	20,418	26,549	24,506	26,550	28,594
Seward	3,395	3,549	3,720	3,945	4,127	4,321
Kodiak	9,366	9,809	10,294	10,861	11,378	11,906
Valdez						
Whittier Area	292	312	338	365	391	417
Valdez & Tatitlek	8,253	3,600	3,663	3,741	3,810	3,880
Other	4,455	1,688	1,697	1,714	1,725	1,738
Total	13,000	5,600	5,698	5,820	5,926	6,035
Cordova						
Cordova Area	2,000	2,167	2,302	2,437	2,504	2,596
Other	353	382	406	430	440	458
Total	2,353	2,549	2,708	2,867	2,944	3,054
Total Southcentral Region	244,056	271,554	314,264	352,442	392,171	433,102
Yakutat Area	600	640	688	832	975	1,118
Other Southeast	50,572	61,613	73,068	83,298	91,628	99,666
Total Southeast Region	51,172	62,253	73,766	84,130	92,603	100,784
Total Northwest Region	15,405	16,286	23,726	19,005	23,293	25,206
Total Southwest Region	28,448	29,646	32,161	35,284	37,426	39,892
Total Interior Region	15,886	15,883	16,925	13,942	15,069	15,080
Total Fairbanks Region	58,322	50,015	60,032	60,781	61,986	63,481
TOTAL STATE	413,289	445,637	520,874	565,584	622,548	677,545

Table 3.10.

Population: Moderately High Development

Area	1976	1980	1985	1990	1995	2000
Anchorage	185,179	213,525	275,530	339,681	406,714	468,058
Mat-Su	14,010	20,791	42,694	58,400	74,462	89,818
Kenai	16,753	24,082	36,345	32,258	36,346	40,434
Seward	3,395	5,370	8,082	6,058	7,110	7,944
Kodiak	9,366	10,932	12,925	11,730	12,129	12,528
Valdez						
Whittier Area	292	318	465	512	561	610
Valdez & Tatitlek	8,253	3,746	3,849	4,045	4,251	4,468
Other	4,455	1,763	1,811	1,880	1,953	2,033
Total	13,000	5,827	6,125	6,437	6,765	7,111
Cordova						
Cordova Area	2,000	3,911	6,553	4,428	4,686	5,011
Other	353	453	577	702	827	885
Total	2,353	4,364	7,130	5,130	5,513	5,896
Total Southcentral Region	244,056	284,891	388,831	467,430	549,039	631,789
Yakutat Area	600	1,345	2,090	2,118	2,145	2,173
Other Southeast	50,572	59,535	64,489	58,287	55,173	60,354
Total Southeast Region	51,172	60,880	66,579	60,405	57,318	62,526
Total Northwest Region	15,405	17,156	32,037	22,595	31,171	34,996
Total Southwest Region	28,448	30,843	35,873	42,119	46,403	51,335
Total Interior Region	15,886	15,883	16,925	13,942	15,069	15,080
Total Fairbanks Region	58,322	54,612	72,160	80,940	93,252	101,317
TOTAL STATE	413,289	464,265	613,443	688,079	792,742	897,309

workers, and about the same number of "other" basic employees as in 1976--75 workers. Fourteen quarters of data from 1974 to 1977 were used in a regression equation to derive total employment from basic employment. Finally, population was regressed on total employment and compared with past population estimates to determine total population. In the case of Anchorage and Mat-Su, the two areas were treated as a single employment and population unit because of the suburbanization of Anchorage into the Matanuska and Susitna Valleys. Since total employment in Mat-Su is a nearly constant proportion of Anchorage employment, a regression equation using Anchorage employment as the explanatory variable was used to estimate Mat-Su employment. Combined Mat-Su and Anchorage civilian population was used in the same way to estimate Mat-Su population, based on Mat-Su's status as a suburban population center.

IV. METHODS: MODELING HUNTING PRESSURE

A. A Description of the Models Used

The Model for Deer, Sheep, and Goat Hunting: Our simplest model was used to protect the growth in hunting demand for three species--deer, sheep, and goat--while availability of superior data allowed the use of a more complex model for moose. For each of these species, the model uses a 1976 origin- (14 regions of residence) destination (region hunted) matrix compiled from Alaska Department of Fish and Game harvest tickets together with our origin region population projections* to generate destination specific hunting pressure projections for 1980, 1985, 1990, 1995, and 2000.

Our model embodies two very straightforward assumptions:

1) In each community, the fraction of the population engaging in hunting for a given species remains constant from 1976 to 2000.

2) The travel pattern of these hunters in the future is identical to that evidenced in the 1976 data. That is, for example, if 40 percent of Cordova deer hunters hunted on Hinchinbrook Island in 1976, then 40 percent of the deer hunters living in Cordova in 1995 will also hunt Hinchinbrook.

Mathematically, if the subscript i denotes region of residence; j, the destination region; and k, the year, then the number of deer hunters (H) living in region i and hunting in region j in year k is:

$$H_{i,j,k,} = H_{i,j,1976} \times \text{population}_{i,k}/\text{population}_{i,1976}$$

*We used two sets of projections to yield two different forecasts of hunting pressure--a low Alaskan population growth and a moderately high Alaskan population growth assumption.

While these assumptions are certainly oversimplifications, available studies do not suggest operational alternatives given the available data Consider assumption no. 1. It is reasonable to expect that through time, as hunting pressure increases and game becomes scarcer, the fraction of the population engaging in hunting will decline. Available data, however, leaves some question concerning the sensitivity of hunting demand to declining success. Our 1976 Alaska harvest ticket data shows that people living near good hunting areas go hunting more frequently. Kenai and Matanuska-Susitna residents, for instance, are about twice as likely to hunt moose as Anchorage people. Data on 1975 resident hunting license sales by state gives further evidence that hunters outside Alaska are responsive to hunting success. The fraction of population buying licenses declines with increasing population density* (see Figure 4.1). Alaska (along with some of the sparsely populated intermountain states) led the nation in the fraction of population purchasing hunting licenses in 1975 with 19.9 percent. The relationship found here suggests, however, that Alaskan population could increase manyfold before hunting license sales would slump more than a few percent. However, differences in productivity of northern game habitat makes the comparison difficult.

---

*High population density means less wildlife habitat and more competition for what game can be supported, the makings for poor hunter success. Note that the figure shows the population density-license sales relationship for U.S. Census Districts rather than states. Because hunters can easily travel outside their state of residence for weekend trips (especially in the East), we felt state population density might not be a good prediction of license sales. Aggregating state data to census divisions mitigates this problem.