

The Value of Alaska Moose



northern  economics inc.

Prepared for
Anchorage Soil and Water
Conservation District

and the

Alaska Soil and Water
Conservation District

June 2006

The Value of Alaska Moose

Prepared for the

Anchorage Soil and Water Conservation District

and the

Alaska Soil and Water Conservation District

June 2006

Prepared by

northern  **economics inc.**

880 H Street, Suite 210,
Anchorage, AK 99501

T: 907.274.5600
F: 907.274.5601

1801 Roeder Ave., Suite 124
Bellingham, WA 98225

T: 360.715.1808
F: 360.715.3588

W: www.northemeconomics.com **E:** mail@norecon.com

PROFESSIONAL CONSULTING SERVICES IN APPLIED ECONOMIC ANALYSIS

Anchorage

880 H St., Suite 210, Anchorage, AK 99501
TEL: 907.274.5600 FAX: 907.274.5601

President & Principal Economist: Patrick Burden, M.S. **Vice President & Senior Economist:** Marcus L. Hartley, M.S. **Senior Consultant, Planning Services:** Caren Mathis, MCP, AICP **Economists:** Leah Cuyno, Ph.D., Jonathan King, M.S. **Policy Analyst:** Nancy Mundy, Ph.D. **Socioeconomic Analyst:** Don Schug, Ph.D. **Analysts:** Michael Fisher, MBA, Cal Kerr, MBA **Office Manager:** Diane Steele **Document Production:** Terri McCoy

Bellingham

1801 Roeder Ave., Ste. 124, Bellingham, WA 98225
TEL: 360.715.1808 FAX: 360.715.3588

Economists: Ken Lemke, Ph.D., Kelly Baxter, M.S.
Associate Economists: Ben Frerichs, Ph.D., Hart Hodges, Ph.D.



E-mail: norecon@norecon.com Web: www.northerneconomics.com

Contents

Section	Page
Abbreviations	iii
1 Moose Benefits and Costs, Summary	1
1.1 Net Value of a Moose, 2005	1
1.2 Current Net Value of Moose, 2006 – 2026	2
2 Introduction	5
2.1 Objective	5
2.2 Project Scope	5
2.3 Methodology	5
2.4 Consumptive Uses, Values, Costs	6
2.5 Non-consumptive Uses, Values	6
2.6 Costs	7
2.7 Current Value of Future Moose Population	7
2.8 Typical Habitat	8
3 Consumptive Benefits, Costs.....	11
3.1 Sport Hunting.....	12
3.2 Hunting Experience	12
3.3 Subsistence Hunting	14
3.4 Moose Meat Salvage	14
3.5 Moose By-products.....	15
4 Non-Consumptive Benefits and Costs	17
4.1 Tourism	17
4.2 Wildlife Appreciation.....	18
4.3 Moose-Automobile Accidents	18
4.4 Moose-Railroad Accidents	19
4.5 Other Costs	19
5 Current Net Value of Moose, 2006 - 2026	19
Appendix: Biology.....	19
References	19

Table	Page
Table 1. Summary of Estimated Moose Values and Costs, Annual Basis, 2005.	2
Table 2. Discounted Net Present Value of Alaska Moose, Twenty Years, 2006 - 2026	3
Table 3. Summary Table, Consumptive Moose Value.....	12
Table 4. Moose harvest per year, 2000-2004	12
Table 5. Net Economic Value of Moose Hunting (ADF&G 1994).....	13

Table 6. Resident vs. Non-resident Economic Value of Moose Hunting (USFWS 2001)..... 14
Table 7. Net Economic Value of Moose Hunting (2001) 14
Table 8. Net Economic Value of Moose Viewing 18
Table 9. Alaska Moose/Automobile Accidents, 1999-2002 19
Table 10. Cost of Bodily Injury 19
Table 11. Total Cost of Moose/Vehicle Collisions..... 19
Table 12. Discounted Net Present of Alaska Moose..... 19

Figure	Page
Figure 1. Detailed Benefit and Cost Centers, Alaska Moose Values.	1
Figure 2. Alaska Moose Benefit and Cost Variables.....	6
Figure 3. Typical Anchorage Hillside Moose Habitat.....	8
Figure 4. Moose Browsing, Anchorage Hillside Habitat.....	9

Abbreviations

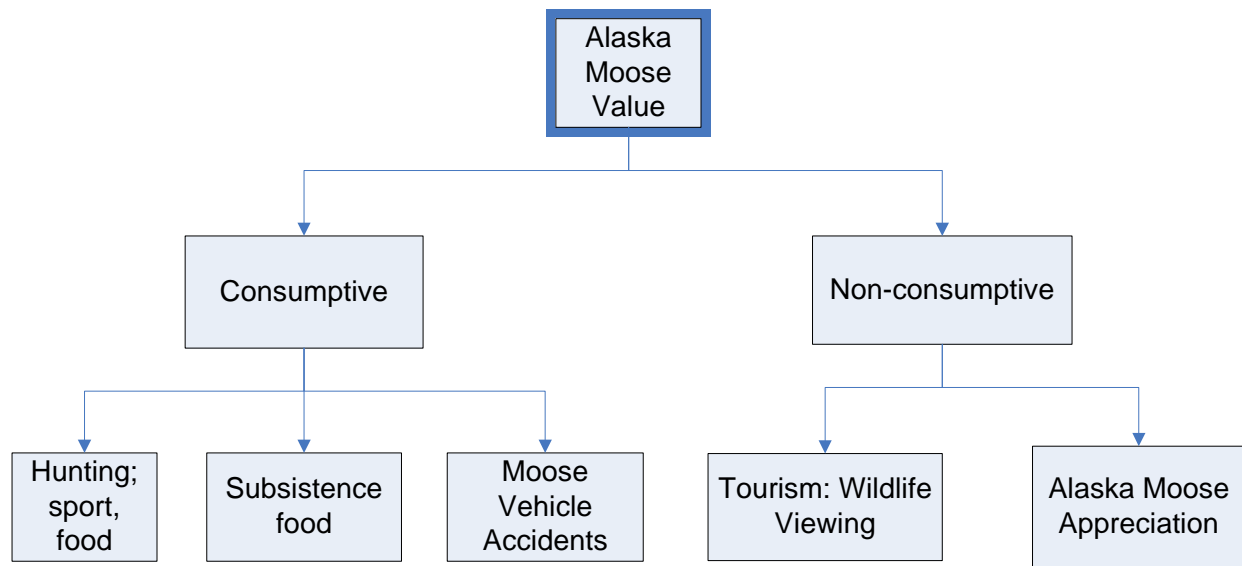
ADF&G	Alaska Department of Fish and Game
AKSWCD	Alaska Soil and Water Conservation District
ARRC	Alaska Railroad Corporation
ASWCD	Anchorage Soil and Water Conservation District
CPI	Consumer Price Index
DNR	Alaska Department of Natural Resources
FHA	Federal Highway Administration
NRCS	National Resources and Conservation Service, U.S. Department of Agriculture
SCS	Soil Conservation Service
USDOT	U.S. Department of Transportation

1 Moose Benefits and Costs, Summary

The Anchorage Soil and Water Conservation District (District) asked Northern Economics Inc., based in Anchorage, Alaska, to analyze the value of Alaska moose. This report provides information on the background, methodology, and results of that project. This section (Section 1 of 5) provides summary information for two time periods: a single year—2005—and a 20-year period, from 2006 to 2026. For both time periods, consumptive and non-consumptive uses were considered as the two main valuation categories.

Consumptive and non-consumptive costs are further separated into the benefit (value) and cost centers shown in Figure 1.

Figure 1. Detailed Benefit and Cost Centers, Alaska Moose Values.



Source: Northern Economics Inc.

There are additional values, discussed in the main body of this report, that are not market-based or that were not readily available in the literature reviewed. The values presented in this report should be considered estimated benefits (or costs), based on the best available information. Different groups of resource users will place different emphasis on these values; different regions of Alaska (e.g., rural versus urban) will hold different views on the value of a moose or a moose population.

1.1 Net Value of a Moose, 2005

This section outlines project results for 2005. Benefits and costs are discussed in report sections 2 through 5 and, where available and appropriate, market values and costs are applied. Section 1.2 provides information on the current value of Alaska’s moose resource, given a 20-year forecast (2006 – 2026).

Table 1 summarizes the values, benefits, costs, and number of moose evaluated by category. These values are rounded to the nearest thousand dollars, for mid-year 2005.

Table 1. Summary of Estimated Moose Values and Costs, Annual Basis, 2005.

Benefit or Cost	Total Value (Benefit) or Cost 2005\$
Consumptive Use Value	
Hunting Value, Food	\$15,158,000
Hunting Experience	\$13,418,000
Subsistence Value	\$9,020,000
Meat Salvage	\$726,000
Total Consumptive Use	\$38,322,000
Non-Consumptive Use Value	
Wildlife Viewing, Photos	\$3,846,000
Existence Value	Unknown
Total Moose Value	\$42,168,000
Less: Moose Costs	
Property Damage	(\$2,953,000)
Bodily Injury	(\$10,939,000)
Total Moose Costs	(\$13,892,000)
Net Moose Value	\$28,276,000

Source: Northern Economics Inc.

The first column displays line-item benefits or costs, by consumptive and non-consumptive use, as well as major moose costs. The second column shows total costs from more detailed analysis in other report sections. These summary benefits and costs are discussed in greater detail within the following report sections. Total moose benefits (value) are estimated in 2005 as \$42.2 million with \$13.9 million of costs, for a net moose value of \$28.3 million.

Many values and costs related to these value centers (such as money spent on hunting Alaska moose) are based on work from different time periods. For ease of comparison and consistency, benefits and costs were adjusted to 2005 dollars, using the following methodology.

Inflation Adjustment

The adjustment to 2005 dollars was based on the Consumer Price Index (CPI) for Anchorage, as published by the Alaska Department of Labor and Workforce Development. Given costs or values from 1991 (\$100), CPI index numbers were used to adjust 1991 dollars to 2005 dollars. The most-current index number from 2005, 196.6, was divided by the CPI for 1991, 124.0, or $196.6/124 = 1.368$, and $1.368 * 100 = \$138$. For example, a 1991 value (or cost) of \$100 is the same as \$138 in 2005 dollars.

Report sections 2 through 5 provide greater detail on moose benefits and costs.

1.2 Current Net Value of Moose, 2006 – 2026

The value of a cow moose's offspring (or population growth) is included in Table 2 and is consistent with a 20-year forecast period, assuming Alaska's moose population is projected to remain generally stable at 175,000 animals overall. The number of moose harvested by hunters in the state should also stay relatively constant, as the Department of Fish and Game will continue to manage the annual allowable harvest on the same basis as today's management regime.

Table 2. Discounted Net Present Value of Alaska Moose, Twenty Years, 2006 - 2026

Benefit or Cost	Total
Harvest Value	\$363,994,100
Moose Viewing	\$62,887,332
Total	\$426,881,432
Less:	
Collision Costs	\$251,747,364
Net Present Value	\$175,134,068

Source: Northern Economics Inc.

Harvest Value

Under these assumptions, the total annual harvest value (subsistence and non-subsistence) per year for moose will remain at \$24,240,480 in 2005 dollars, assuming a constant harvest of 6,890 for hunters and 4,128 for subsistence users. Projecting this value forward for 20 years, and using a real discount rate (no inflation) of 2.9 percent (from the Office of Management and Budget), a discounted total harvest value for the next 20 years is \$363,994,100.

Moose Viewing

The value derived from moose viewing will likely increase in the future, as Alaska's population increases, leading to more people who will want to view moose, and thereby increasing the total value of moose viewing. The growth of tourism within the state is projected to be the same as the population growth rate. Totaling the 20-year value of wildlife viewing, and using the 2.9 percent discount rate, the discounted total value of moose viewing for the next 20 years is \$62,887,332.

Moose-Vehicle Collisions

The cost associated with moose-vehicle collisions is also projected forward over the 20-year window. Moose collisions directly correlate with the number of miles driven by all vehicles on Alaska's road systems. The total cost of moose collisions is estimated to increase with the growth rate in the number of vehicle miles traveled (VMT) per year in Alaska. Totaling the 20 year cost of moose-vehicle collisions, and using the same 2.9 percent discount rate, the current total cost of collisions for the next 20 years is \$251,747,364.

2 Introduction

The Anchorage Soil and Water Conservation District (ASWCD) is one of twelve Alaska districts formed by State Charter in 1997. It operates under Alaska Statute 41.10 (The Alaska Soil and Water Conservation Law) and is a legal subdivision of the State Department of Natural Resources (DNR). The twelve Alaska Districts are overseen by the Natural Resources Conservation and Development Board, which is appointed by the Governor.

Soil and Water Conservation Districts grew out of the “Dust Bowl” years of the 1930s. Congress created the Soil Conservation Service (SCS) to support sustainable land development on private lands. The SCS evolved into the Natural Resources Conservation Service (NRCS), within the U.S. Department of Agriculture. The NRCS was founded with the mission to “provide leadership in the partnership effort to help people conserve, maintain, and improve our natural resources and environment.”

Districts serve as an intermediary, non-regulatory agency, between private property owners and state, local and federal agencies. The entire United States is divided into more than 3,000 Districts.

2.1 Objective

The Anchorage District asked Northern Economics, Inc. to provide an overview of Alaska moose benefits and costs. This overview was designed to provide economic information on Anchorage-based moose (from Girdwood to Eagle River) and help illustrate how potential fuel reduction and habitat enhancement would reduce costs (e.g., vehicle accidents) and possibly increase benefits (redirect moose to safer browse areas, or complete relocation).

A recent proposal submitted to the District suggested moose could be re-directed from busy highways and public places (such as schools, the University of Alaska, etc.) by mechanically creating browse and feed in critical areas. This habitat enhancement would also reduce dead spruce fuel loading and help meet a critical District objective. Developing economic information would help frame potential projects.

2.2 Project Scope

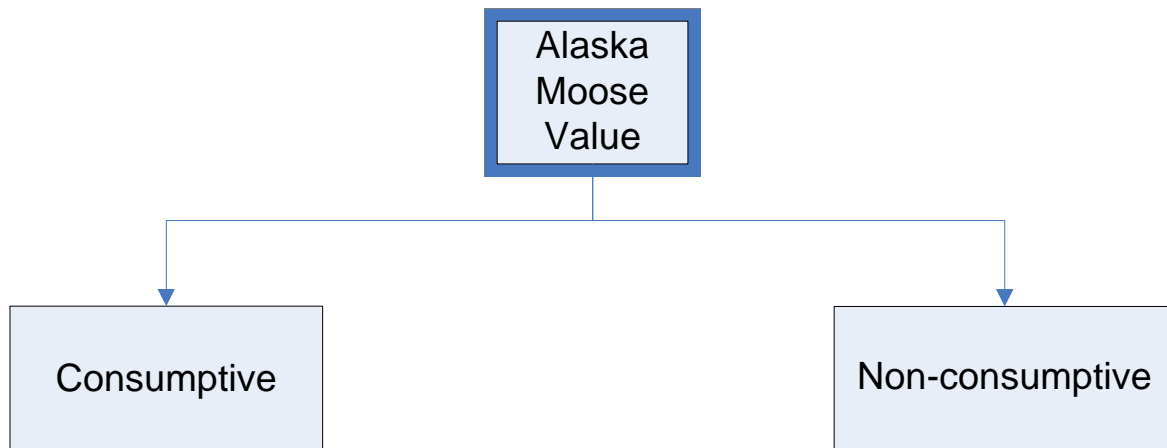
Geographic scope for this project was centered on Anchorage, because that is the local District’s area of concern. However, the economic and biological scope of the project extended to all of Alaska’s moose population, currently estimated by the Alaska Department of Fish and Game (ADF&G) at 175,000 animals.

2.3 Methodology

Two key tasks were proposed: collecting existing literature and analyzing that information. As noted in the December 2005 proposal accepted by the District, both consumptive and non-consumptive values were explored. The project schedule and budget did not permit primary data collection (e.g., surveys and extensive interviews with users).

Figure 2 illustrates valuation centers developed for this project.

Figure 2. Alaska Moose Benefit and Cost Variables



These general benefit and cost centers are discussed briefly in the following sections; they are discussed, with projected values and costs, in more detail within Sections 3 through 5 of this report.

2.4 Consumptive Uses, Values, Costs

Market-based valuations in the consumptive category are relatively straightforward; hunting expenditures, for example, can be relatively easy to develop and they can approximate market values for food, on either a per moose or per pound basis. Subsistence values as food can be estimated through the cost of surrogate foods, such as beef.

A key assumption, one that seems reasonable for most rural Alaska communities, is that a pound of moose meat displaces a pound of other meat; for this analysis, the value of beef was projected at \$4 per pound and used for subsistence valuation.

Salvage values for moose are also based on the surrogate value of beef. A significant amount of moose meat is salvaged from both vehicle and railroad collisions; non-profit corporations within a reasonable distance of each road-killed moose are on a list maintained by the Alaska State Troopers and others. These non-profit groups are called when a road-killed moose is found.

Finally, consumptive uses of by-products such as antlers, bones, hides, and feces (in the form of moose nuggets) are harder to value in a market economy, much like the cultural values of moose. All are important but are outside the current project scope.

2.5 Non-consumptive Uses, Values

Non-consumptive moose values include wildlife viewing, photography, and the vicarious knowledge that Alaska has wildlife, such as moose. Wildlife viewing is a major tourism market segment, with ADF&G projecting moose as the sixth most desired species to see.¹

Information on the value of moose in the context of wildlife viewing was identified and is presented in this report. Citizens in the rest of the United States have a vicarious interest in the existence of Alaska moose, and they are often vocal in their support of Alaska's wildlife (e.g., Alaska National Wildlife

¹ References are listed separately, at the end of the report.

Refuge, aerial wolf hunting). This existence value, like cultural values, is important and has an impact on Alaska's moose benefits and costs but no references were found in the literature and conducting an extensive survey was outside of current project scope.

2.6 Costs

Moose and human interactions, especially for urban moose within the Municipality of Anchorage, can result in negative outcomes. Moose are large animals with little fear of humans; their primary cost impact in Anchorage is tied directly to collisions between moose and vehicles. Secondly, they eat vegetation, from summer vegetables, such as cabbage, to alder, willow, and other ornamental shrubs and trees. Mountain ash, for example, is a preferred tree species.

Moose-human interaction occasionally leads to injury, or, rarely, death. Anchorage's school children are cautioned regularly about avoiding moose, especially females with calves or moose that have been harassed and stressed by dogs.

2.7 Current Value of Future Moose Population

Consumptive and non-consumptive uses (and costs) are presented for two different time frames. The first period is an annual valuation, based on the year 2005.

2.8 Typical Habitat

Figure 3 illustrates a typical Anchorage hillside area; it is relatively undeveloped, with a mixed overstory of hardwoods and spruce. Shrubs such as willow and alder dominate the brush layer and groundcovers include grass, ferns, and bare mineral soil in some areas.

Figure 3. Typical Anchorage Hillside Moose Habitat



Source: Northern Economics Inc.

Moose feed on vegetation found in almost all Anchorage neighborhoods. Figure 4 illustrates an adult moose browsing typical summer vegetation.

Figure 4. Moose Browsing, Anchorage Hillside Habitat



Source: Northern Economics Inc.

Scarred tree stems in the background are willows; moose will gnaw and eat willow bark when there is no other vegetation available, generally in late winter and early spring. As bare wood is exposed, it turns silver and may eventually heal with scar tissue.

Most recently, there have been efforts developed to address moose-human interactions such as vehicle collisions through habitat manipulation and animal removal and relocation.

More detailed cost estimates for Alaska's moose are listed within the following report sections.

3 Consumptive Benefits, Costs

This report section outlines the major consumptive uses and benefits of Alaska moose, by the separate topics listed below.

Sport Hunting

Market-based valuations in the consumptive category are relatively straightforward; hunting expenditures, for example, can be relatively easy to develop and can approximate a market (food) value. The top-ranked resource use is hunting for food purposes, a consumptive use that is popular with residents and non-residents alike. Subsistence moose values are similar, as far as food values are concerned.

Subsistence Hunting

Subsistence hunting by rural (mostly Alaska Native) Alaskans plays a vital role in their everyday livelihood and survival. Rural Alaska is often characterized as having low population, high costs (especially for goods that must be transported by air), and little economic potential when compared to more populated communities such as Anchorage and Fairbanks, and regional centers such as Bethel and McGrath.

A key assumption—one that seems reasonable for most rural Alaska communities—is that a pound of moose meat displaces a pound of other meat; for this analysis, the value of beef was projected at \$4 per pound² and used for subsistence valuation. The nutritional values of moose meat are considered superior to beef but, for economic purposes, these were ignored. Actual costs will vary from store to store.

Cultural Values

Cultural values of Alaska's moose resource are less well-defined within a market. As discussed by social scientists, many in Alaska's rural communities value moose for cultural, social, and, perhaps, spiritual reasons. These values and valuation are outside current project scope and were not used to value moose; they are, however, a very real and prominent value for many in Alaska.

Moose Meat Salvage

A significant amount of moose meat is salvaged from both vehicle and railroad collisions; non-profit corporations volunteer for placement on a list maintained by the Alaska State Troopers and other public safety personnel. As dead moose are located, organizations are called to salvage the animal and recover as much meat as possible. The actual amount of salvaged meat, per average animal, is unknown, but a percentage was estimated, based on discussions with experienced moose hunters and those responsible for salvage within non-profit organizations.

By-Product Values

By-products, such as hide, antlers, fur, and sometimes manure (in the form of moose "nuggets") are often exchanged within a non-market context, similar to subsistence values discussed earlier. No attempt was made to value moose by-products for this analysis; whether market based or not.

² Based on February 2006 prices, two markets in Anchorage, quantities and types from University of Alaska, Fairbanks, Weekly Food Cost, plus a 15 percent increase for freight.

Table 3 summarizes the major consumptive values of Alaska’s moose.

Table 3. Summary Table, Consumptive Moose Value.

Consumptive Use	Total Value, 2005, \$
Hunting Value, Food	\$15,158,000
Hunting Experience	\$13,418,000
Subsistence Value	\$9,020,000
Meat Salvage	\$726,000
Total Value	\$38,322,000

Source: Northern Economics Inc., 2006.

3.1 Sport Hunting

Hunting is a popular activity for Alaskans and non-Alaskans alike. While there are many potential game animals, moose is a preferred species. In a 1994 study published by the Alaska Department of Fish and Game (ADF&G), 54 percent of Alaskan hunters who responded to the survey indicated that their primary target was moose (McCollum B-9). Obviously, moose are a major hunting resource, and the species provides a significant societal and economic benefit.

There are two main market-based components used to calculate the benefits of moose hunting. These include the meat harvested and the value of the hunting experience. According to the ADF&G annual harvest reports and as shown in Table 4, the average number of moose harvested per year, from 2000 to 2004 was 6,890 animals or approximately four percent of the total moose resource (175,000 animals).

Table 4. Moose harvest per year, 2000-2004

Year	Moose Harvested
2000	7,034
2001	6,650
2002	7,046
2003	6,955
2004	6,767
Average	6,890

Source: ADF&G Harvest Reports, 2000-2004

The average Alaska moose yields between 400 and 700 pounds of useable meat (ADF&G). For this project, an average of 550 pounds of meat per moose was used for food valuation. Assuming a price of \$4 per pound of meat, a price that can vary in many parts of Alaska, the average moose is worth \$2,200 of food value.

The average annual harvest from 2000 to 2004, 6,890 animals, was multiplied by \$2,200 to generate a total food value of moose meat harvested via hunting of \$15,158,000.

3.2 Hunting Experience

The value an individual is willing to pay for a moose hunt can be classified as the value of the hunting experience. This value varies depending whether or not the hunter is an Alaska resident. For non-

residents, a chance to come to Alaska and hunt for any animal is likely a once-in-a-lifetime experience, and generally out-of-state hunters are willing to pay substantially more for their hunt than residents. A number of different studies have been conducted in an attempt to value the hunting experience.

Alaska Department of Fish and Game, 1994

An extensive study published by the Alaska Department in Fish and Game in 1994 calculated the economic and social values that residents and non-residents placed on Alaska’s wildlife resources. In this study, surveys were sent to resident hunters and to those non-residents who had recently been hunting in Alaska. They were asked to determine the net economic value of their overnight hunting trip (Table 5).

Using this survey data, the number of overnight trips taken in 1991 by resident and non-resident hunters was estimated so that net economic value for the year could be calculated. There were 49,210 estimated moose hunting trips taken by Alaskans and 2,319 estimated trips taken by non-residents. Trip estimates were calculated from the estimated number of hunters. For comparison, the study estimated that there were 26,416 nonresident moose hunters in 1991 while the actual number reported to ADF&G was 23,619. Multiplying the net economic value of each trip by the number of trips taken derives a net economic value, of \$12,172,311 for resident and \$1,245,303 for non-resident hunters, for a combined total of \$13.4 million dollars (2005 basis).

Table 5. Net Economic Value of Moose Hunting (ADF&G 1994)

Value Component	Residents	Non-Residents	Total
Net Economic Value of Trip (mid 2005 \$)	\$247	\$537	\$255
# of trips taken (1991)	49,210	2319	51,529
Total Value (mid 2005 \$)	\$12,172,311	\$1,245,303	\$13,417,614

Source: Alaska Voters, Alaska Hunters, and Alaska Non-resident Hunters.

U.S. Fish and Wildlife Service 2003

For comparison, a different study conducted by the U.S. Fish and Wildlife Service and published in 2003, measured the net economic value of certain wildlife-related recreational activities in 2001. This study placed the net economic value, in 2001 dollars, of moose hunting by Alaska residents at \$579 per year, or \$633 in mid-2005 dollars. This estimate was based upon a very small sample size of only 10-29 respondents. No direct value was determined for out-of-state residents, as the sample size was too small to report data reliably.

However, a value estimate for out-of-state moose hunters was calculated from values placed on elk hunting, a comparable large animal, by the aggregate total of out-of-state values for five different states: Colorado, Idaho, Montana, Oregon, and Wyoming. By comparing the percentage differential of the aggregate out-of-state versus in-state resident economic value for elk, an assumed value for non-resident Alaska moose hunters was determined by multiplying this percentage difference by the Alaska resident economic value. The aggregate out-of-state value for elk hunting was 146 percent higher than resident value; multiplying that percentage by the Alaskan net economic moose hunting value of \$633 generated an out-of-state value estimate of \$926, shown in Table 6.

Table 6. Resident vs. Non-resident Economic Value of Moose Hunting (USFWS 2001)

Resident or Non-Resident Economic Value	Value
Alaska Resident Moose Hunting Economic Value (2005 \$)	\$633
Aggregate State resident value for Elk Hunting (2001 \$)	\$380
Aggregate Out-of-State value for Elk Hunting (2001 \$)	\$556
Out-of-state value for Alaska Moose hunting (2005 \$)	\$926

Source: Northern Economics Inc. as derived from U.S. Fish & Wildlife Service

As shown in Table 7, the average number of resident hunters from 2000-2004 was 26,129 (for the entire state) and the average number of non-resident hunters was 2,515. Multiplying these numbers by their estimated net economic value yields a total of \$16,532,131 for residents and \$2,327,483 for non-residents, for a combined total of \$18,859,614.

Table 7. Net Economic Value of Moose Hunting (2001)

Hunting Value Component	Residents	Non-Residents	Total
Net Economic Value per year, per hunter (2005 \$)	\$633	\$926	-
Average # of Hunters (2000-2004)	26,129	2,515	28,644
Total Value (2005 \$)	\$16,532,131	\$2,327,483	\$18,859,614

Source: U.S. Fish & Wildlife Service; ADF&G Harvest Data 2000-2004.

For purposes of this report, the ADF&G report values are used, given the larger sample and more detailed analysis; the USFWS values suggest there is variation about the estimates, perhaps as much as 30 percent.

3.3 Subsistence Hunting

Subsistence hunting plays a vital role in Alaska’s rural communities. For many rural residents, it is their primary source of food and a major economic activity. The Alaska Department of Fish and Game, Subsistence Division, tracks the harvest of animals for subsistence purposes. The division has produced data that represents a typical moose harvest for each village or area in a given year. The total number of moose harvested for subsistence purposes in a typical year is 4,128 (Subsistence 2005).

Multiplying this harvest number by the average value of a moose’s meat, \$2,200, gives a total subsistence meat value of \$9,081,600.

This estimated market value does not take into account the significant social and cultural importance of moose and moose hunting; these are beyond the scope of this overview project.

3.4 Moose Meat Salvage

When a moose is involved in a car or train collision, it is usually killed in the incident, or it is put down soon thereafter, as these animals are not likely to survive. Non-profit organizations on a pre-approved list are notified and asked to collect the moose, in an effort to harvest any usable meat. If the organization is not able to send someone, the next non-profit on the list is contacted, and so on.

According to an experienced moose hunter from Sutton, Alaska who has also participated in salvage operations, about 50 percent of a road-killed moose’s meat will be salvageable, for an average of

approximately 275 pounds per moose. The actual amount varies widely, depending on the size and age of the animal, the impact, and subsequent damage. Another hunter (and licensed guide) from Moose Pass also agreed with this estimate, noting, as well, there is wide variation.

In the Anchorage area, a total of 198 moose were salvaged from a total of 205 moose collisions for the 12 months from December 2004 to Dec. 2005. For the same period in 2004, 146 out of 149 moose were salvaged (Allison Barkhurst, 2006). This is a very high recovery rate of 98 percent. An average of the two years indicates 172 moose are salvaged per year. At the projected 50 percent recovery rate, 275 pounds per moose, valued at \$4/lb, this generates a benefit of \$1,100 per salvaged moose. The average number of moose salvaged suggests a total salvage meat benefit of \$189,200 for the Anchorage area.

There are 674 moose-vehicle impacts per year in Alaska, an average based on the period 1999 to 2002. For purposes of this analysis, the Anchorage animal salvage ratio (98 percent) was applied statewide, along with the estimated 275 pounds of recovered meat per animal and the \$4 per pound valuation. Total estimated salvage value for the state is \$726,000.

3.5 Moose By-products

Moose by-products are more difficult to value in a market economy. The State of Alaska restricts the sale of wild game and their by-products; moose hides may not be sold (though final products, such as moccasins or leather jackets, may be sold). There are reports of moose antlers purchased for artists (carvers) at an estimated \$2 per pound; moose antlers must be detached from the head or skull before such sale.

The value of a moose's hide to the hunter is also difficult to determine, primarily because it is illegal to buy or sell moose hides in the State of Alaska. A retailer in New York, Chichester Inc., sells fully tanned, fur-on, hides for \$800 a piece. This by-product value is likely the maximum upper limit of the hide's value, as not all hides are tanned and used in this fashion. Also, shipping raw moose hides from bush Alaska is expensive; experienced hunters suggest wet, green hides weigh between 125 and 300 pounds, depending on the moose's size.

Moose feces, or nuggets, are collected, processed and sold as curios such as earrings, swizzle sticks, and tie clasps. These were considered a novelty and no market values were projected for them.

Overall, for purposes of this analysis, no moose-by-product values were estimated.

4 Non-Consumptive Benefits and Costs

Along with consumptive uses outlined in the prior section, Alaska's moose also provide a number of non-consumptive uses. Tourism is a major industry that provides wildlife tours (viewing) and wildlife photography opportunities, often on the same trip. Another non-consumptive use is wildlife appreciation (existence values) by those in Alaska, as well as citizens who live elsewhere.

The total estimated value of tourism, tied to moose viewing and photography, was \$3,846,063 in mid-2005 dollars.

For this report, no value is assigned to wildlife appreciation (apart from those uses already stated), either from Alaska's citizens or other residents of the United States. This is a very real value, however, as proponents of aerial wolf control well know. The proposed drilling in Alaska National Wildlife Refuge (ANWR) is another topic with strong feelings, many related to animals, expressed by those who live outside the state.

Both tourism and wildlife appreciation are discussed in the following two sub-sections.

4.1 Tourism

Tourism is one of Alaska's major industries and wildlife and nature viewing is a reason many tourists come to Alaska. ADF&G lists moose as the sixth most desired species to see of its top ten animal species:

1. Bald eagle
2. Bears, both brown and black
3. Caribou
4. Dall sheep
5. Humpback whale
6. Moose
7. Muskoxen
8. Horned and tufted puffin
9. Sea otter
10. Wolf

The direct monetary benefit generated by moose (only) through tourism has not been directly captured, but a study has been completed that estimates the net economic benefit of moose wildlife viewing by Alaskan voters.

The Alaska Department of Fish and Game published a report in 1994 titled *Alaska Voters, Alaska Hunters, and Alaska Non-resident Hunters: Their Wildlife Related Trip Characteristics and Economics*, which estimated the economic and social values placed on Alaska's wildlife resources by residents and non-residents. The study focused on three groups, Alaska voters, Alaska hunters, and non-resident hunters who had recently hunted in the state. Report findings related to hunting were discussed in section 3.4.

The Alaska voting group was used to examine the social and economic values that Alaska voters place on wildlife viewing; a survey was sent to 4,725 residents who were registered to vote in the 1990 election. These voters were asked to help estimate the value of a selected overnight wildlife viewing trip. Of those

who responded, 33 percent said the primary wildlife they were hoping to see was moose (McCollum A-10). Survey results from those whose primary goal was moose viewing are shown in Table 8.

Table 8. Net Economic Value of Moose Viewing

Value Component	Value
Net Economic Value trip (2005 \$)	\$138
# of Moose viewing trips taken (1991)	27,924
Total value (2005 \$)	\$3,846,063

Source: Alaska Voters, Alaska Hunters, and Alaska Non-resident Hunters.

Respondents said they took 27,924 moose viewing trips in 1991, generating a total value, in 2005 dollars, of \$3.8 million. Non-residents who visit Alaska seek wildlife viewing that is inclusive; there are no known sources of data about non-residents who come to Alaska solely for moose viewing.

4.2 Wildlife Appreciation

Citizens in the rest of the United States have an appreciation of Alaska’s wildlife, including moose, and they are often vocal in their support of Alaska’s wildlife (e.g., Alaska National Wildlife Refuge, aerial wolf hunting). However, secondary data on the existence value of moose were not found, and measuring these values, on a contingency basis, or willingness-to-pay, is beyond the scope of this overview study.

4.3 Moose-Automobile Accidents

Moose-vehicle collisions are both dangerous and expensive. Accidents between moose and motor vehicles are likely more dependent upon environmental conditions, such as snowfall and hours of daylight, than other collisions, which are more dependent upon road conditions, traffic volume, and driver error (2002 Alaska Traffic 41). Moose are more likely to be forced onto roadways (road and rail) during times of heavy snowfall, causing more accidents during these times.

Moose visibility also plays a major role in the number of motor vehicle accidents, as 46 percent of collisions with moose in 2002 occurred between 6 p.m. and midnight, while only about six percent occurred between 10 a.m. and 4 p.m. (2002 Alaska Traffic 42). The moose’s dark hide makes it difficult to see in the dark, particularly along the unlit roads which typify Alaska. Sixty percent of all moose collisions occurred in darkness (2002 Alaska Traffic 43).

Data from the Alaska Department of Transportation and Public Facilities from 1999 to 2002 are presented in Table 9. There were approximately 675 moose-automobile accidents per year, with 560 of those accidents having property damage only. On average, there were 104 minor injuries, approximately 9 major injuries, and 1-2 deaths per year as a result of moose-vehicle collisions.

Table 9. Alaska Moose/Automobile Accidents, 1999-2002

Year	Collisions	Property Damage Only	Minor injury	Major injury	Fatality
2002	557	465	83	8	1
2001	785	661	118	3	3
2000	660	532	115	12	1
1999	693	580	100	12	1
Average	673.75	559.5	104	8.75	1.5

Source: Alaska Department of Transportation and Public Facilities, 1999-2002

Property Damage

According to the Insurance Information Institute, the average amount of damage caused by a collision with a deer nationally is \$2,800 (Insurance Institute). Given that moose are considerably larger than deer, this national average is likely to be less than cost of a moose.

According to the American Association of State Highway and Transportation Officials, the average property damage caused by an accident of any type is \$3,900 in 2000 dollars, or \$4,383 in 2005 (p. 5-45). This cost of \$4,383 per accident, multiplied times 674 accidents per year, suggests a total moose-vehicle cost of \$2,953,046.

Bodily Injury

According to the Federal Department of Transportation Federal Highway Administration, the average minor injury crash costs \$5,000 in 1994 dollars or \$6,281 in 2005. The cost of a severe injury was \$490,000 in 1994 dollars or \$615,585 in 2005. Fatal automobile accidents cost \$2,600,000 in 1994 or \$3,266,370 in 2005.

As shown in Table 9, there were an average of 104 minor injuries, 8.75 major injuries, and 1.5 fatalities between 1999 and 2002 due to moose-vehicle collisions.

Table 10 shows the total estimated costs of bodily injury for an average year, caused by moose-vehicle accidents.

Table 10. Cost of Bodily Injury

Severity	Description	# of Occurrences (99-02 average)	Cost per incident (2005 \$)	Total Cost
AIS 1	Minor	104	\$6,281	\$653,274
AIS 4	Severe	8.75	\$615,585	\$5,386,370
AIS 6	Fatal	1.5	\$3,266,370	\$4,899,556
	Total	-	-	\$10,939,200
	Per Alaska moose	-	-	\$63

Source: Northern Economics Inc., USDOT FHA – Motor Vehicle Accident Costs

The total costs associated with moose-vehicle collisions are listed in Table 11, with the overall cost estimated at \$13.9 million.

Table 11. Total Cost of Moose/Vehicle Collisions

Type of Damage, Injury	Total Cost	Cost per Moose
Property Damage	\$2,953,046	\$17
Bodily Injury	\$10,939,200	\$63
Total	\$13,892,246	\$79

Source: NEI, 2006

4.4 Moose-Railroad Accidents

Moose-railroad incidents are fairly common, with 183 such incidents between January 2004 and March 11th 2005 (Tim Thompson, ARRC). Moose search for the easiest path between food sources, whether on roads or railroad rights-of-way, due to deep snow and the energy required for maneuvering in it.

Current costs associated with moose-train accidents are minimal, according to the Alaska Railroad. At this time, when a moose is hit by a train, it is just flung aside, due to locomotive speed and V-shaped deflectors on the trains. After the collision, moose are pushed sideways and off the rails. Very few incidents cause any significant damage to the train.

This was not always the case, as in years past the corporation spent money to reduce the number of moose on the tracks and the moose-caused damage. The railroad undertook measures such as plowing an area on either side of the tracks, giving moose a snow-free area to walk. Also, the railroad sent pilot cars down the track in front of trains to clear moose away. Moose deflectors have been perfected, according to the railroad, to the point where no direct costs are projected. As dead moose are collected, however, they are being processed for salvage to the maximum extent feasible. In January 2006, moose were hauled to the Point MacKenzie correctional center for processing by inmates. Salvaged meat has been consumed at the center as well as distributed to other public institutions throughout the state.

4.5 Other Costs

There are also other costs associated with moose that are difficult to quantify. In the summer, moose are likely to eat vegetables and fruits from gardens. This loss of time and money is difficult to calculate since individual losses are usually minor in nature and are not reported to any one group. Moose foraging causes considerable annoyance but little in the way of direct, recorded costs.

In other parts of the world with moose, damage to forests is a major cost. Moose eat small seedlings and saplings, damaging forest crops. Alaska's mixed forests (hardwoods and conifers) generally mean moose-preferred food such as willow, birch, and cottonwood are consumed in preference to conifers.

Quantifying these costs is outside of current project scope, but they are real costs that must be considered, especially as moose are drawn further into Anchorage by their need for browse.

5 Current Net Value of Moose, 2006 - 2026

The value of a cow moose's offspring (or population growth) is included in this economic analysis. Because of ongoing management, Alaska's moose population is projected to remain generally stable at 175,000 animals overall. There are population controls and checks in place, such as hunting and predator management by ADF&G, which will keep the population near this biological level. While some regional areas may experience population fluctuations due to habitat changes or a sharp reduction in car collisions, the population should stay relatively constant for the state as a whole.

The number of moose harvested by hunters in the state should also stay relatively constant, as the Department of Fish and Game will continue to limit the number of moose harvested. Under these assumptions, the total moose harvest value (subsistence and non-subsistence) per year will remain at \$24,240,480 in 2005 dollars. Projecting this value forward for 20 years, and using a real discount rate (no inflation) of 2.9 percent (from the federal Office of Management and Budget Circular A-94), a discounted total value of harvest for the next 20 years is \$363,994,100.

The value derived from moose viewing will likely increase in the future, leading to more people who will want to view moose, and thereby increasing the total value of moose viewing. The increase in annual value is based upon the projected growth rate of the state's population, obtained from the Alaska Department of Labor and Workforce Development. The growth of tourism within the state is projected to be generally the same as Alaska's population growth rate. Totaling the 20 year value of wildlife viewing, and using the 2.9 percent discount rate, the discounted total value of moose viewing for the next 20 years is \$62,887,332.

The cost associated with moose-vehicle collisions is also projected forward over the same 20-year window. Moose collisions directly correlate with the number of miles driven by all vehicles on Alaska's road systems. The total cost of moose collisions is estimated to increase with the growth rate in the number of vehicle miles traveled (VMT) per year in Alaska. The VMT projection to 2024 is based upon a regression analysis with population as the independent variable. The equation has an R-squared value of 0.95.

Using this equation, ($VMT = -7019.26 + 0.01858 * \text{population}$) the projected number of VMT can be calculated for a given year. Totaling the 20 year cost of moose-vehicle collisions, and using the 2.9 percent discount rate, the discounted total cost of collisions for the next 20 years is \$251,747,364. The net present value of Alaska moose, based upon these projections, is shown in Table 12.

Table 12. Discounted Net Present of Alaska Moose

Benefit or Cost	Total
Harvest Value	\$363,994,100
Moose Viewing	\$62,887,332
Total	\$426,881,432
Less:	
Collision Costs	\$251,747,364
Net Present Value	\$175,134,068

Source: Northern Economics Inc.

Appendix: Biology

This is a brief analysis of moose biological characteristics, particularly in the State of Alaska, but also in the northern portions of Canada (the Yukon Territory and the former Northwest Territory).

Why are there so many moose in the Anchorage bowl? The most likely answer is habitat; moose eat up to 40 pounds of vegetation per day and Anchorage is a salad bowl for moose. This section provides an overview of moose biology and how that biology directs moose to mountain ash, willows, alders and other hardwood browse.

Moose (*Alces alces*) are the largest members of the deer family and are found in the northern hemisphere. Moose are located throughout areas where boreal forests are located and fire is a prominent characteristic (Daniel). Fires stimulate the re-growth of preferred moose browse.

The Alaskan subspecies, the tundra moose (*Alces alces gigas*) is the largest of the species in size and antler development. Approximately 175,000 moose are found throughout Alaska, with the exception of the northern coastal plain. They are primarily associated with the northern forest, lakes, and swamps; moose prefer open country including recently cleared or burned areas that contain willow and birch shrubs (Daniel).

Characteristics which are of importance to moose habitat are an abundance of high quality browse, especially in winter, areas suitable for shelter which also provide access to food, aquatic feeding areas, places of isolation for calving, young forest which contain deciduous shrubs for summer feeding, and the presence of mineral licks (Daniel). Moose habitat selection is primarily based upon forage availability although it varies depending upon the season and their activity cycle. Critical areas in the summer months include open upland and aquatic areas which provide the best foliage. During winter, closed canopy areas are sought when forage is at its lowest quantity (and quality) for the year. The heaviest forest cover is used for protection from snow and weather conditions, as this is the period of least activity for moose (Daniel).

Moose Characteristics

In Alaska, moose range from the Stikine River in Southeast Alaska to Interior Alaska (ADF&G, 1994). Originally thought to have crossed the Bering Strait, perhaps 40,000 years ago, the Alaska subspecies is the largest of the species in size and antler development. Newborn calves weight approximately 30 pounds and grow to over 300 pounds in five months. Males in prime condition weight from 1,200 to 1,600 pounds while adult females weigh 800 to 1,300 pounds. The largest moose antlers are found in Alaska, the Yukon Territory, and the former Northwest Territories of Canada. Antlers are grown at 10 to 12 years of age, with moose rarely living beyond 16 years in the wild (ADF&G, 1994).

Moose Habitat

As stated by the Alaska Department of Fish and Game (1994):

Because moose range over so much of Alaska, they have played an important role in the development of the state. At one-time professional hunters supplied moose meat to mining camps. Historically, moose were an important source of food, clothing, and implements to Athabaskan Indians dwelling along the major rivers. Today, Alaskans and non-residents annually harvest approximately 6000 to 8000 moose -- some 3.5 million pounds of meat. Moose are an important part of the Alaskan landscape, and tourists photograph those animals that feed along the highway.

Man's developments in Alaska include many alterations upon the face of the land. These activities create conflicts between man and moose as moose eat crops, stand on airfields, eat young trees, wander the city streets, and collide with cars and trains.

Man's removal of mature timber through logging and careless use of fire has, in general, benefited moose as new stands of young timber have created vast areas of high-quality moose food. The future for moose is reasonably bright because man is learning how to manipulate habitat with wildfire and is becoming more skilled at managing factors that limit moose populations, such as predation and hunting.

References

- Aiken, Richard and Genevieve Pullis La Rouche. *Net Economic Values for Wildlife-Related Recreation in 2001*. Washington D.C.: U.S. Fish and Wildlife Service, 2003.
- Alaska Department of Labor and Workforce Development. *CPI for Anchorage*. Available: <http://almis.labor.state.ak.us/?PAGEID=67&SUBID=241>. 1/19/06.
- Alaska Department of Transportation and Public Facilities. *1999 Alaska Traffic Accidents*. Juneau, AK: State of Alaska, 2000.
- Alaska Department of Transportation and Public Facilities. *2000 Alaska Traffic Accidents*. Juneau, AK: State of Alaska, 2002.
- Alaska Department of Transportation and Public Facilities. *2001 Alaska Traffic Accidents*. Juneau, AK: State of Alaska, 2003.
- Alaska Department of Transportation and Public Facilities. *2002 Alaska Traffic Collisions*. Juneau, AK: State of Alaska, 2004.
- Alaska Department of Transportation and Public Facilities. *Moose-Vehicle Accidents on Alaska's Rural Highways*. Juneau, AK: State of Alaska, 1995.
- American Association of State Highway and Transportation Officials. *User Benefit Analysis for Highways*. August 2003. Washington DC.
- Barkhurst, Allison. Admin Clerk, Alaska State Troopers Office. Telephone interview. 1/18/06.
- Chichester, Inc. *Hair-on Moose Skins*. 1/13/06. Website. Available: <http://www.chichesterinc.com/MooseSkins.htm>.
- Daniel, Laurie. "Moose." *Ecosystem Description - Species of Kachemak Bay*. Alaska Department of Fish and Game. 17 Jan. 2006
http://www.habitat.adfg.state.ak.us/geninfo/kbrr/coolkbayinfo/kbec_cd/html/ecosys/species/moose.htm
- Division of Wildlife Conservation, Alaska Department of Fish and Game. *General Harvest Reports*. Available: <http://www.wc.adfg.state.ak.us/index.cfm?fuseaction=harvestreports.main>. 1/13/06 2006.
- Franzmann, Albert W. and Charles C. Schwartz, ed. *Ecology and Management of the North American Moose*. Washington D.C.: Smithsonian Institute Press, 1998.
- Insurance Information Institute. *Avoiding Deer/Car Collisions*. Available at: <http://www.iii.org/individuals/auto/lifesaving/deercar/>. 1/13/06.
- Kelleyhouse, Dave. *An Introduction to Moose Hunting in Alaska*. Website. Alaska Department of Fish and Game. Available: <http://wildlife.alaska.gov/index.cfm?adfg=hunting.moose>. 1/10/06 2006.
- McCollum, Dr. Daniel W., SuzAnne M. Miller. *Alaska Voters, Alaska Hunters, and Alaska Nonresident Hunters: Their Wildlife Related Trip Characteristics and Economics*. Anchorage, AK: Alaska Department of Fish and Game, 1994.
- Subsistence Division, Alaska Department of Fish and Game. *Community Profile Database*. Available: <http://www.subsistence.adfg.state.ak.us/geninfo/publctns/cpdb.cfm>. 1/12/06.
- Thompson, Tim. Public Affairs Office, Alaska Railroad Corporation. Telephone interview. 1/11/06.
- U.S. Department of Transportation Federal Highway Administration. *Technical Advisory – Motor Vehicle Accident Costs*. 1994. <http://www.fhwa.dot.gov/legregs/directives/techadvs/t75702.htm> 1/19/05.