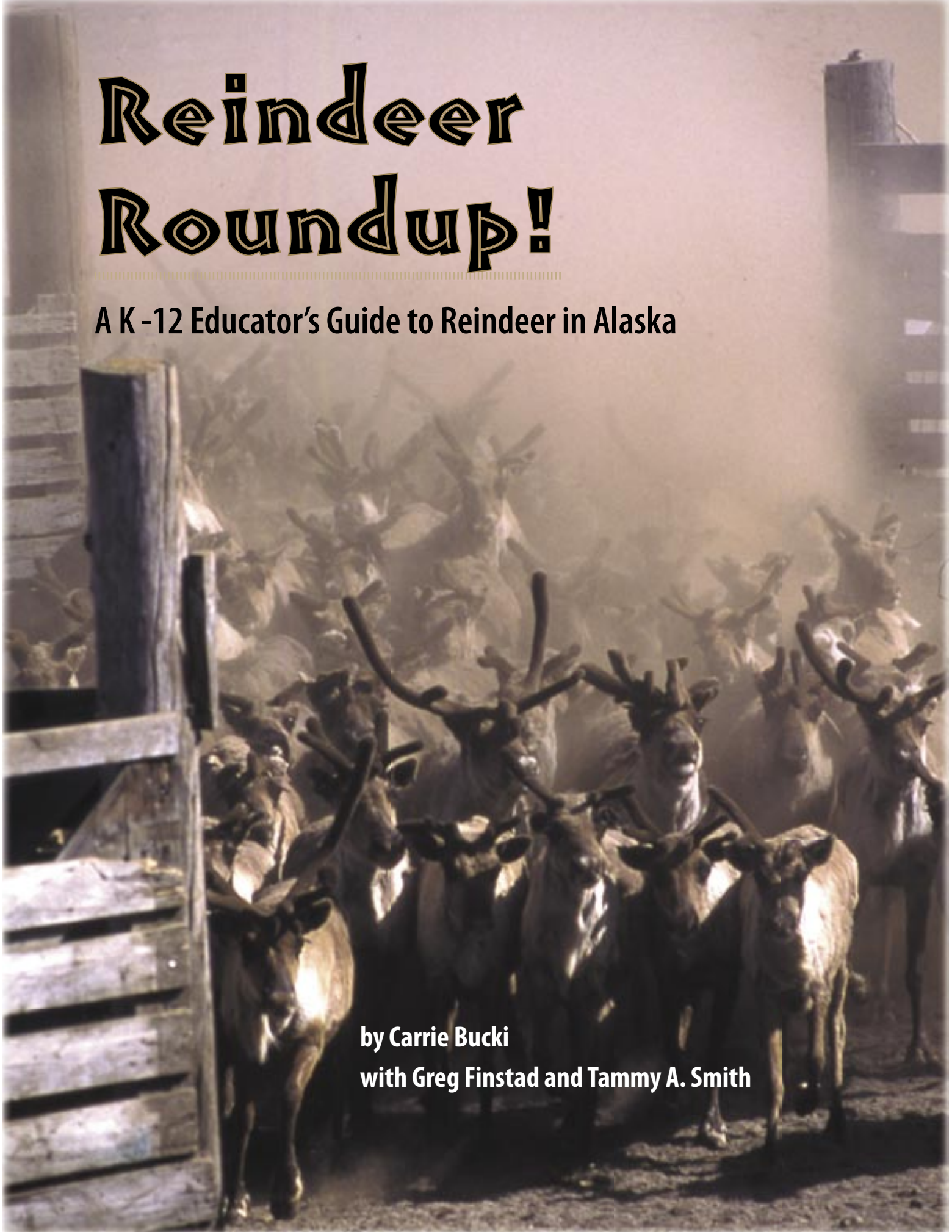


Reindeer Roundup!

A K -12 Educator's Guide to Reindeer in Alaska

by Carrie Bucki
with Greg Finstad and Tammy A. Smith



Cover photo by
Roy Corral.



At 2 a.m., Seward Peninsula herders wait for the reindeer to be driven into the corral.



© 2004 by the Reindeer Research Program, University of Alaska Fairbanks

AFES Publication MP 2004-07, published in Fairbanks, Alaska, U.S.A.

AFES Publications Office
P.O. Box 757200
Fairbanks, AK 99775-7200

School of Natural Resources and Agricultural Sciences, and
the Alaska Agricultural and Forestry Experiment Station

Copies of this publication may be downloaded from the AFES Publications website
at <http://www.uaf.edu/snras/afes/pubs/misc/index.html>

Reproduction allowed for educational purposes only
not for resale

For information on obtaining a Reindeer Roundup! Educational Kit, please contact
the Reindeer Research Program at:

<http://reindeer.salrm.uaf.edu>
fyrrp@uaf.edu

907.474.5449 (phone)
907.474.7175 (fax)

or write to the attention of:
Rhonda Wadeson, Reindeer Research Program,
P.O. Box 757200 Fairbanks AK 99775-7200.

Reindeer Roundup!

A K-12 Educator's Guide to Reindeer in Alaska

Project Manager:

Greg Finstad, Reindeer Research Program, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks.

Author:

Carrie Bucki, Reindeer Research Program, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks.

Consultant:

Tammy A. Smith, M.Ed., Fairbanks North Star Borough School District, Fairbanks, Alaska.

Editing and Publication:

Doreen Fitzgerald and **Deirdre Helfferich**, AFES Publications Office, School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks.

Table of Contents

iv Acknowledgements

v Preface

vi Introduction

1 Reindeer, People, and Land

2.....Where do Reindeer Come From?

3.....Reindeer and Humans

8.....Adaptations to the Arctic

12.....What do Reindeer Eat?

16.....Reindeer Behavior

20.....Reindeer vs. Caribou

21.....Concerns for Reindeer

27.....Reindeer Research: Working to Preserve Alaska's Reindeer Industry

31 Lesson Plans

32.....1. Reindeer Herding in Alaska

49.....2. Website Scavenger Hunt

53.....3. Reindeer vs. Caribou

58.....4. History of Reindeer in Alaska

61.....5. Reindeer Numbers

64.....6. Traditional Uses of Reindeer

74.....7. Eskimo Ice Cream

77.....8. Velvet Antlers

86.....9. What Do Farmed Reindeer Eat?

93.....10. How Much Do Reindeer Eat?

99.....11. Hair Identification

104.....12. Reindeer Rumen

107.....13. Building a Radio and Transmitter

117.....14. Creating a Reindeer Brochure

119.....15. Reindeer Alphabet Book

123.....16. Reindeer Bingo

137.....17. Creating an Arctic Food Web

147 Extensions

148.....18. Rangifer Tag

149.....19. Thermal Regulation and Insulation

ii Reindeer Roundup!

- 151.....20. Reindeer: Cattle of the Arctic?
- 153.....21. Reindeer Diorama
- 154.....22. Recording Herding Culture

156 Glossary

160 For Further Study

- 160.....Books
- 161.....Children's books
- 162.....Audiovisual materials
- 163.....Other reindeer- and education-related resources

164 Cross-Reference Indexes

- 164.....Grade Index
- 166.....Subject Index
- 167.....Topic Index

168 Appendix A. Reindeer Roundup! Educational Kit Materials

170 Appendix B. Slide Indexes for PowerPoint Slide Shows on the Reindeer Visual Aids CD-ROM

- 170.....Adaptations of Reindeer to Life in the Arctic
- 177.....History of Reindeer in Alaska
- 184.....Radio and Satellite Telemetry

Acknowledgements

This project is the culmination of years of hard work and dedication by many individuals. Their efforts are appreciated and do not go unnoticed. The author and project manager thank the staff at the University of Alaska Fairbanks Reindeer Research Program for support and assistance with materials collection: Rob Aikman, Darrell Blodgett, Robert van Buuren, Randy Fulweber, Rhonda Wadeson, and Suzanne Worker.

Thanks go to Larry Davis, Carl Emmons, Rose Fosdick, Dan Karmun, Knut Kielland, Heather Oleson, Kumi Rattenbury, William Schneider, Tim Smith, and Suzanne Worker for workshop lectures presented to educators in Fairbanks and/or Nome. Your specialized knowledge and expertise was vital for the workshops' success.

The participants in the UAF Reindeer Curriculum Development Workshops held in both Fairbanks and Nome developed many of the ideas and some of the individual lesson plans presented in this book. Their enthusiasm motivated us to incorporate many of their ideas in this product. The participants included: Linnea Baker, Josephine Bourdon, Lisa Carlson, Annie Conger, Leslie Disbrow, Karen Dullen, Bruce Gard, Paula Gelineau, Heidi Imhof, Marilyn Janke, Urtha Lenahr, Mary Maisch, Robert Marok, Joe Ortis, Julie Ortis, Dixie Ostland, Janice Ott, Mike Lee, Jim Lokken, Jane Sandstrom, Besty Smith, Rita Smith, Tim Smith, Eric Stone, Jeanne Turner, Richard Wolf.

Special thanks are due to Dr. Carol Lewis, director and dean of the University of Alaska Fairbanks School of Natural Resources and Agricultural Sciences; her support for our vision of a reindeer educational outreach program has been tremendous.

An extra handful of lichen goes to the reindeer Elsa, who has assisted her caretakers in sharing the wonders of reindeer with students of all ages over the past five years.

Unless noted, all photos and graphics in this book were taken or created by the UAF Reindeer Research Program. The historical photos presented here were taken from the following publications: *Arctic Exodus: The Last Great Trail Drive* by Dick North; *Where Did the Reindeer Come From? Alaska Experience, the First Fifty Years* by Alice Postell; *The Yukon Relief Expedition and the Journal of Carl Johan Sakariassen* edited by V.R. Rausch and D.L. Baldwin; *Longest Reindeer Herder* by Chester Seveck; and *Reading, Religion, and Reindeer: Sheldon Jackson's Legacy to Alaska* by Elizabeth Tower.

This material is based upon work supported by the National Science Foundation (project number OPP-9979473) and the Cooperative State Research, Education, and Extension Service, U.S. Department of Agriculture, under special project number 2001-38426-11488, and supported by the University of Alaska Fairbanks, and the UAF College of Rural Alaska.

Preface

Reindeer have played a strong role in shaping Alaska history, particularly along the western coast. Alaska Natives and others have been raising reindeer for over one hundred years, both behind fence and on large, remote grazing areas. Reindeer are well adapted to thrive in northern climates and have provided meat, hides, antlers, and many other useful products to Alaskans. As an economic resource for rural Alaska, this industry has largely been obscure, even to many Alaska residents.

The Reindeer Research Program (RRP), School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks has a mission to further develop and promote the production of reindeer in Alaska through research and collaboration with producers and local communities. The RRP Educational Outreach Program began in 1998 in local schools in Nome and Fairbanks for all grade levels. The program is designed to teach students science and math, along with Alaska history, Alaska Native culture, economics, renewable resource use, and sustainable agriculture, using the context of the reindeer industry. By integrating region-specific information and knowledge with conventional disciplines, the program augments conventional school curriculums.

Reindeer Roundup! is the response to countless requests received by the RRP to visit classrooms and present information on reindeer in Alaska. It was developed in part using lesson plans written by Nome and Fairbanks teachers who attended our reindeer education workshops. We wanted to produce a unit that uses Alaska's reindeer industry as a working model to study the management of a sustainable natural resource in a northern ecosystem, a model that would broaden the curriculum and expose students to applied science. Reindeer are an excellent medium to study the characteristics of tundra ecosystems and adaptations of animals living in the Arctic.

There are many excellent educational materials available on caribou, but ***Reindeer Roundup!*** is unique to the culture and history of Alaska. Through this educator's guide, we hope that regional knowledge will be incorporated into the Alaska curriculum and the pedagogic scope of Alaska schools expanded.

Throughout this project we have realized the benefit of university researchers and scientists working with local educators and people in the community to teach future generations to preserve and continue a traditional way of life in rural Alaska.

Greg Finstad, Program Manager

Carrie Bucki, Educational Outreach Coordinator

Reindeer Research Program, University of Alaska Fairbanks

Introduction

We hope that you, the educator, will find this book interesting, informative, and user-friendly. This section describes the features of this book and the **Reindeer Roundup! Educational Kit**.

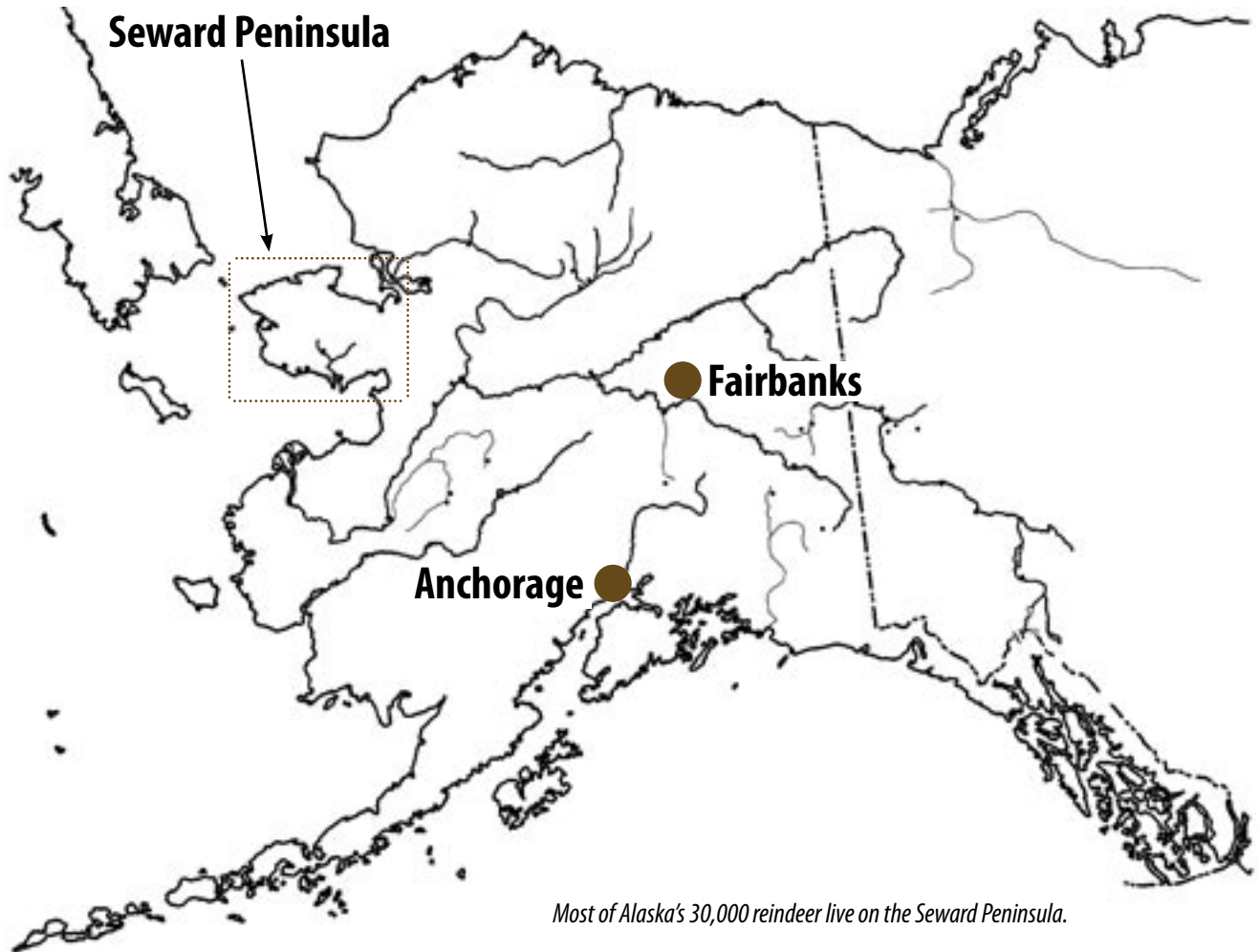
The *Reindeer, People, and Land* section contains factual background information about reindeer and how they interact with their Alaska environment. It is an overview that can be used for some basic research. Topics include arctic ecology, reindeer history, biological adaptations, behavior, disease, current research, and applied programs.

The *Lesson Plans* and *Extensions* sections contain twenty-two activities that cover a wide range of subjects and grade levels. While most lessons were written for elementary and middle school students, many lessons can be used as an introductory lesson for older students, or be enhanced and developed for more rigorous study. Each lesson contains information on grade level, subject, duration, and performance objectives. For a quick reference, refer to the *Cross-Reference Indexes* on page 164 to find the desired grade level, subject, or topic. Each lesson correlates to Alaska State Standards and Alaska Cultural Standards for Students and Educators.

The *Glossary* lists words used in this guide that we hope will be helpful to both the educator and the students. The *For Further Study* section contains a list of adult reference books, children's books, videos, and other resources.

An array of other materials and props are provided to augment the lessons. Refer to *Appendix A: Reindeer Roundup! Educational Kit Materials* list on page 168. These supplemental materials can be used while teaching the lessons provided, or used to create your own lessons. The props, photos, and slide shows in each kit are important for hands-on learning and will enable you to adapt this package to your teaching needs. Also, the staff at the UAF Reindeer Research Program can assist you with presenting the lecture material, developing advanced lesson ideas, coordinating a live reindeer visit to your classroom, or planning a field trip to the UAF Reindeer Research Program's facility.

Reindeer, People, and Land



Where Do Reindeer Come From?

Reindeer and caribou are the same species sharing the same genus and species name (*Rangifer tarandus*). Reindeer are a semidomesticated subspecies of *Rangifer*. They are thought to have been domesticated along the Russian-Mongolian border five to seven thousand years ago. They were probably first used as decoys to help hunters catch wild game. Once they were domesticated by the nomadic tribes of this region, they supplied meat, clothing, milk, and pulled sleds. Their domestication spread throughout Russia and Scandinavia, where raising and herding reindeer is still a way of life today. Reindeer did not arrive in North America until the 1890s.

Reindeer and caribou taxonomic chart:

Kingdom	<i>Animalia</i>
Phylum	<i>Chordata</i> (backbone with spinal cord)
Class	<i>Mammalia</i> (milk producing)
Subclass	<i>Ungulata</i> (hooved)
Order	<i>Artiodactyla</i> (even-toed)
Suborder	<i>Ruminantia</i> (true ruminant)
Family	<i>Cervidae</i>
Genus	<i>Rangifer</i>
Species	<i>tarandus</i>

Different subspecies of reindeer and caribou exist throughout the Circumpolar North. The subspecies name is an additional name added to the genus and species name to further classify the animal. In Eurasia, reindeer are classified as either domesticated or wild. Only in North America are indigenous (wild) *Rangifer* referred to as caribou.

The seven subspecies of *Rangifer* are:

Rangifer tarandus tarandus

Eurasian tundra reindeer found in Alaska and in parts of Eurasia

Rangifer tarandus fennicus

Eurasian forest reindeer found in the forested areas of Russia

Rangifer tarandus platyrhyncus

Svalbard reindeer found on Svalbard Island north of Norway

Rangifer tarandus granti

The caribou subspecies found in Alaska and the Yukon

Rangifer tarandus groenlandicus

Barren ground caribou found in Greenland and northern Canada

Rangifer tarandus caribou

Woodland caribou found in central and southern Canada

Rangifer tarandus pearyi

Peary caribou found in the far northern arctic islands of Canada

Reindeer and Humans

History

Throughout the mid to late 1800s, whaling ships moved up and down the Bering Sea coast of Alaska. Traders from these ships came ashore to trade with Alaska Natives. They traded guns, ammunition, tobacco, alcohol, and foods like sugar and flour for pelts, meat, and hides. The whalers decimated local populations of marine mammals, then left the Bering Sea when the production of plastics and petroleum replaced whale products, causing the industry to be unprofitable. The whalers left the Alaska Natives without a food source (marine mammals) and dependent upon the food and goods they could not replace.



The U.S. Revenue Cutter, the Bear, commanded by Captain Healy. This ship brought reindeer to Alaska.

—photo from *Where Did Reindeer Come From?* by Alice Postell, p. 45

By 1888, captains of the U.S. Revenue Cutter Service ships that patrolled the waters of western Alaska became concerned for the wellbeing of the Native Alaskans living in villages along the Bering Sea coast. Captain Healy of the U.S. Revenue Cutter *Bear* was one of these captains. He was a mulatto ex-slave, born on a Georgia plantation, who ran away from home at the age of sixteen. He became an officer on a merchant vessel and worked his way up to captain.

Reports of starvation among Alaska Natives reached Dr. Sheldon Jackson, the Commissioner of Education in Alaska and a Presbyterian minister. Dr. Jackson devoted the last half of his life to serving the people of Alaska, establishing schools and missions throughout western Alaska. Jackson's goal was to broaden the resource base of Alaska Native populations and provide economic development where none was available. It was Captain Healy who first suggested the idea to Jackson of transporting domestic reindeer from Siberia to western Alaska as a solution to the food shortages among Native Alaskans. Healy had traveled extensively throughout the Bering Sea, and had witnessed first hand the Native people of eastern Siberia and their success at raising reindeer.

Jackson received approval from Congress to introduce reindeer into Alaska from Siberia, but received no funds for the project. He appealed to the women of the Presbyterian Church and they raised \$2,000 to purchase reindeer. In Washington Jackson had many critics of his plan, so he decided to perform a trial run by purchasing sixteen reindeer the first year and shipping them to Amaknak Island to see if they would survive the voyage and the winter. The reindeer did both and produced two calves the following spring.

During the summer 1892, Captain Healy made five trips to Siberia. He brought 171 reindeer to the Teller Reindeer Station established at Port Clarence, along with five Siberian herders who were employed as herding instructors. After clashes with Native Alaskans, the Siberian herders returned home. In 1894, Scandinavian families, along with dogs and sleds, were brought to Alaska to teach reindeer herding.

From 1896 until 1902 Congress appropriated funds to purchase more reindeer from Russia. Under Jackson's direction, small reindeer herds were distributed to mission schools on the Seward Peninsula and throughout western Alaska to teach herding to Native Alaskans. In 1898 more herds were established along the route to Point Barrow when Jackson ordered a drive of over 400 reindeer to an ice-bound ship of starving sailors.



Reindeer were used to pull sleds of gear for herders and miners.
—photo from *Arctic Exodus: The Last Great Trail Drive* by Dick North

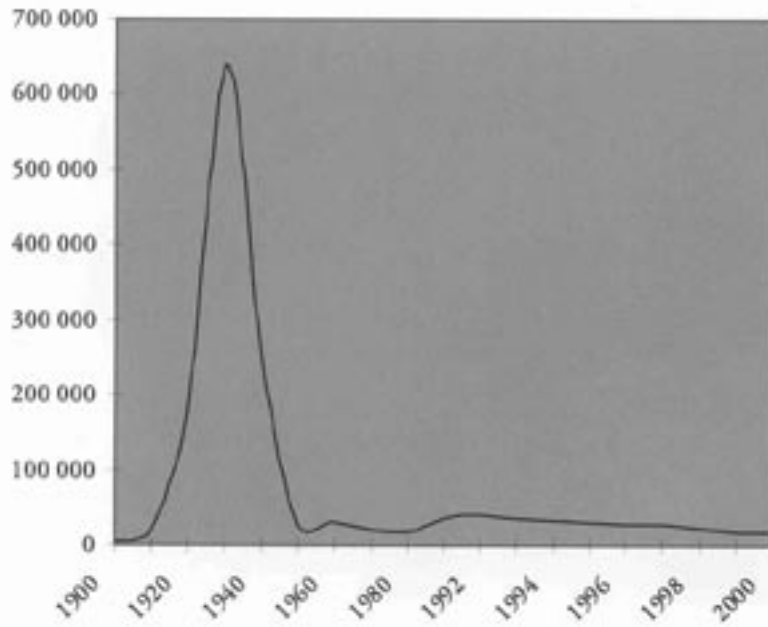
With the discovery of gold in Nome in 1898, reindeer were used to their full potential. There was a large demand for meat, and reindeer also were used to pull sleds of gear for the miners. The first postal reindeer route was established between St. Michael and Kotzebue in 1899. Reindeer were preferred to dogs for carrying supplies, as they were less expensive and they could graze freely, whereas food had to be carried for the dogs.

Jackson continued to use reindeer as a means for teaching Native Alaskans English so they could do business with white people. Girls were

taught sewing and housework, while men and boys continued to apprentice as reindeer herders. A reindeer apprentice required five years of schooling with room and board. Each year, an apprentice earned two female reindeer and their calves. After five years, the new herder was loaned enough reindeer to increase his herd size to fifty animals.

A 1905 government investigation by the Department of the Interior found that Scandinavians and mission schools, rather than Native Alaskans, owned a majority of the reindeer in Alaska. As a result, Jackson was asked to resign and a new government policy was established with the goal of placing more reindeer into Native ownership. By 1913, Alaska Natives owned over 30,000 animals, sixty-five percent of the reindeer in Alaska. By the late 1920s there were over 400,000 reindeer in western Alaska, and the population peaked at 640,000 reindeer in the 1930s. In 1937, the Reindeer Act was passed that restricted ownership to Native Alaskans. This act is still in place today.

By the 1950s, approximately 50,000 reindeer were present on the Seward Peninsula. Reasons for the sharp decline are the harsh winter of 1938-39, losses to migrating caribou, predation by wolves, and the lack of attendance to herds. During the 1960s there was a gradual selection of Native Alaskan owners to become private reindeer herders with designated ranges. In 1968, the Bureau of Indian Affairs (BIA) became responsible for range management by issuing grazing permits and monitoring range condition. Soon after, modern range management techniques were applied to reindeer herding. Reindeer herding in Alaska has been a cultural and traditional mainstay in many western villages. The traditions surrounding reindeer herding and the use of reindeer products continues today.



The number of reindeer in Alaska, 1900–2000.

Currently, there are approximately twenty reindeer herders and 20,000 reindeer in western Alaska. These herders belong to the Reindeer Herders Association, which is part of the Kawerak, Inc. Natural Resources Division. This group provides assistance with improving herd management and developing a viable reindeer industry to enhance the economic base for rural Alaska. Elsewhere, 10,000 reindeer exist in herds on Nunivak, St. Paul, Umnak, and other Aleutian islands, and in a few fenced herds along Alaska’s road system. In the Lower 48 states, about 1,000 reindeer are owned by private farms and zoos.

Sections of this narrative were taken from the UAF Reindeer Research Program website. See <http://reindeer.salm.uaf.edu/html/reinhist.html> for more details. Also refer to the **For Further Study** section at the end of this book for additional resources.

Traditional uses of reindeer

Reindeer herding has a rich history and is an important part of the Alaska Native culture on the Seward Peninsula. Reindeer have provided peoples with a year-round source of food and other products essential for survival.

In addition to eating the meat, many of the organs are valued and eaten as well, such as the tongue, kidneys, brain, eyes, heart, and liver. The blood is drunk in some cultures. The tallow or fat is eaten and used in recipes such as Eskimo ice cream. The tallow can also be burned as a light source. Hard antlers and bone are used to fashion utensils, tools, and decorative objects. Bone is boiled and the



Herders and their dog with reindeer corralled using a burlap fence. Burlap is all that is needed to contain these gentle animals.

—photo from *Where Did Reindeer Come From?*, by Alice Postell, p. 45, reproduced from

marrow is extracted for food. Velvet antler is harvested in the summer during roundups and sold to Asian markets. The back sinew makes excellent thread. Reindeer milk is high in fat and is used in some cultures to make butter and cheese.

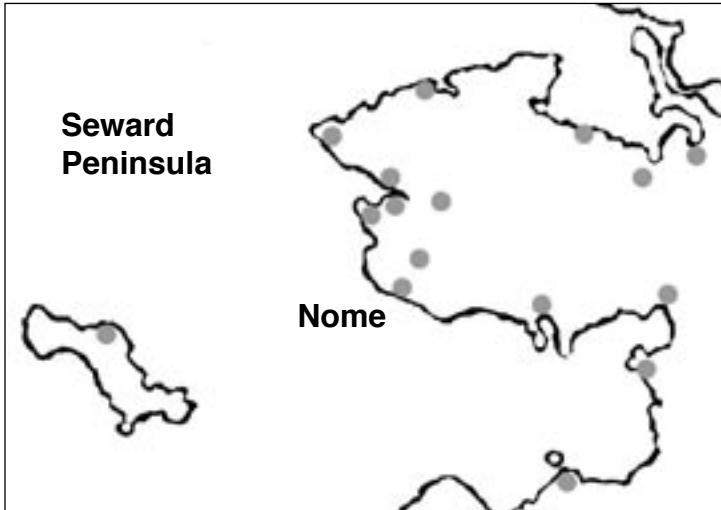
Reindeer hides provide a raw material that can be fashioned into clothing, mukluks, blankets, mittens, tents, boat coverings, sleeping bags, house coverings, and used as an insulating material. Hides from fawns are most desirable for making mukluks, while adult hides are often used for parkas. The hair can be removed from the hide and eaten, a practice that has saved some groups from starvation when food was short. The skin is also used for drum coverings and as a canvas for drawings and art.

Seward Peninsula Range Permits



Reindeer herders' last names label the reindeer grazing areas assigned to each herder on which his reindeer freely graze.

Reindeer Handling Locations



Reindeer corrals are located across the Seward Peninsula and Saint Lawrence Island. Some corrals are near remote villages while others are in more remote locations and only accessible by boat or snowmachine.

Seward Peninsula herding

Reindeer on the Seward Peninsula are free ranging, meaning they are allowed to freely forage across the treeless landscape. Each reindeer herder must obtain grazing permits from the land management agencies on which their range boundaries lie (state, federal, tribal, etc.). Herders allow their reindeer to roam across the tundra range, but they often spend much time with their herd to ensure its health and profitability. Factors such as overgrazing, poor weather, disease, wolf and bear predation, and poor slaughtering decisions can affect a herd's success. A well-educated herder takes all of these factors into consideration when making management decisions.

Herders keep track of their reindeer year-round, but like to round them up twice a year. These are called reindeer roundups or reindeer handlings, in which hundreds and sometimes thousands of reindeer are herded up and moved into a large wooden corral system with a series of smaller pens, or pockets. Reindeer herders used to move their animals by walking behind them to the corrals. Today herders often use four-wheelers, snowmachines, and sometimes helicopters to move the animals from as far as thirty miles away. During the winter, reindeer are slaughtered for their meat and hides. They are also given a de-worming shot to keep them healthy. In the summer, new fawns are given an ear tag



Herders often use a helicopter to move reindeer into a corral for a handling.

with a number that identifies the specific animal and an ear notch that is specific to each herder. The ear notch shows who owns the reindeer. Ear notches are used because a reindeer's fur is too thick for branding. Velvet antlers are harvested from the adult males and females and sold to Asian markets. Some reindeer bulls are castrated to keep body condition and meat quality high by eliminating the yearly rut. Yearling reindeer are given a one-time vaccination for brucellosis, a close-contact disease that can cause female reindeer to abort their young. It takes the help and hard work of many people from the herders' family and villagers to process all of the reindeer in the corral. Work often continues throughout the night to reduce the time animals must spend in the corral without food and water. The University of Alaska Fairbanks Reindeer Research Program works closely with the herders to develop and conduct research projects that have practical applications for Alaska's reindeer industry.

The main purpose of reindeer herding is economic. Reindeer provide many products to the consumer, most commonly meat, velvet antler, and hides. Reindeer meat is high in protein (22%) and low in fat (3.5%), compared to 19.2% protein and 9.5% fat in lean beef. Reindeer are field slaughtered during winter. The meat (carcass weight) sells for about \$2.50 per pound, and each carcass weighs approximately 120 pounds. Most of the meat is sold locally. Velvet antlers from both males and females are harvested each summer for Asian markets. Velvet antler is frozen immediately after harvesting and processed later for consumption. It is made into teas, soups, and has many medicinal uses. Buyers from Asia attend the summer handlings to purchase the antler, which usually sells for approximately \$20 per pound. In 1996, velvet antler sales in western Alaska generated approximately \$564,000 for local economies.

The reindeer owner is an important contributor to village economies. He puts money into the local economy by hiring men and women to work at the handlings. Local pilots are hired to scout for reindeer or to herd them toward the corral. The reindeer herder is often active in local and regional politics and is considered wealthy, a status defined by his herd, snowmachines, boats, etc. Even though herders may be considered wealthy, they often engage in subsistence activities and hold other jobs to make ends meet.

Adaptations to the Arctic

What is the Arctic?

The Arctic is usually defined as the region north of the Arctic Circle, centering on the North Pole. The Arctic falls into the tundra biome. Tundra comes from the Finnish word *tunturia*, meaning treeless plain. It is one of the coldest of all biomes, with a short growing season and receiving low amounts of precipitation. Temperatures range from -40°C to 18°C (-40°F to 64°F). There are two types of tundra, alpine tundra and arctic tundra. Alpine tundra is on high-altitude mountains where trees cannot grow. Arctic tundra is found in the regions just below the ice caps of the Arctic. Much of Alaska and the northern half of Canada are a part of the arctic tundra biome.



The tundra is one of the coldest biomes, characterized by long, dark arctic winters.



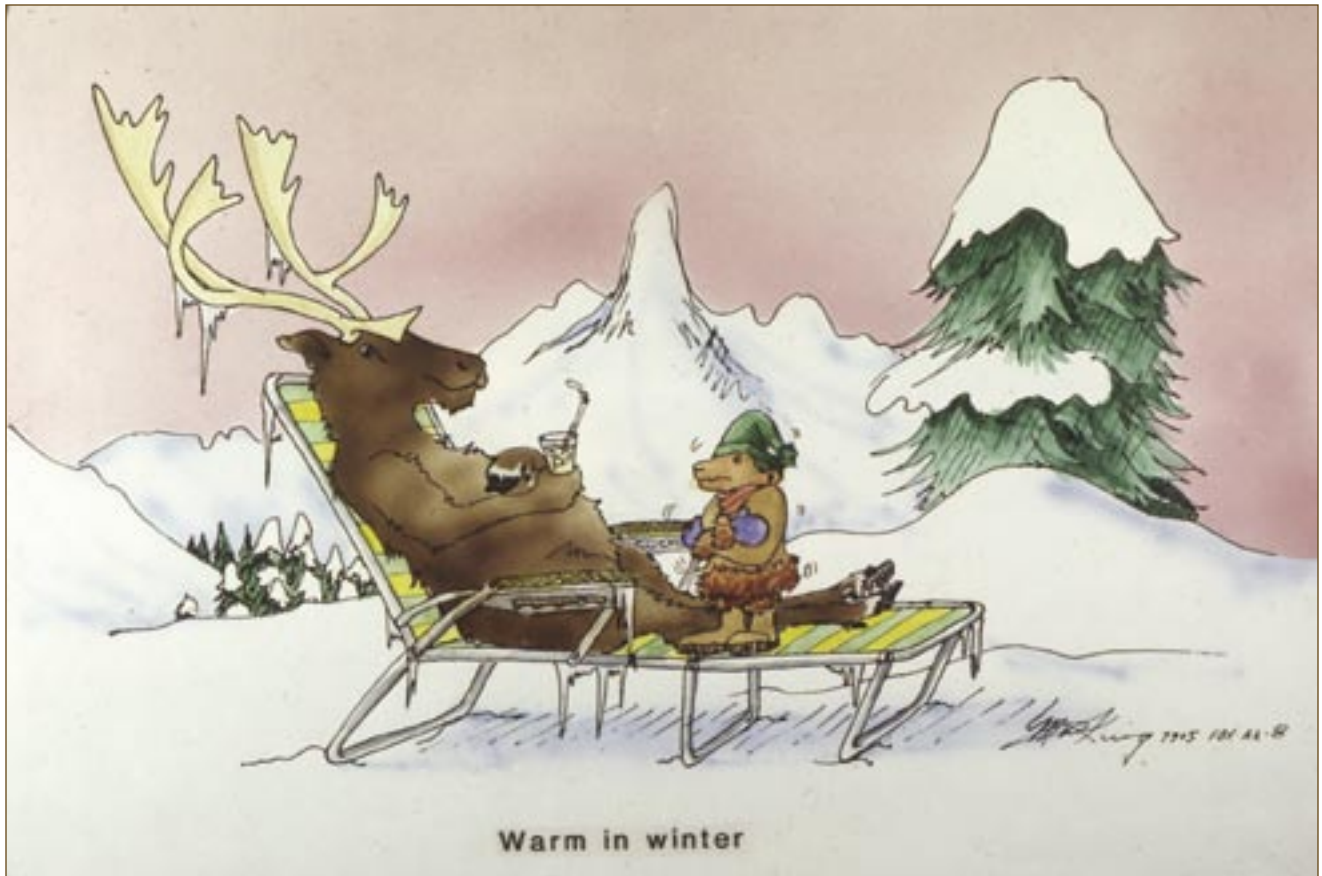
Reindeer digging for lichens on the arctic tundra.

Precipitation in the arctic tundra only totals 150 to 250 mm a year (6 to 10 in), which is less than some of the world's deserts! Arctic tundra winters are long, dark, and cold, and temperatures are below freezing for six to ten months of the year. The temperatures are so cold that there is a layer of permanently frozen soil below the surface called permafrost. Permafrost is a defining characteristic of the arctic tundra biome. Soils here form slowly and there is very little water drainage. In the summer, only the top layer of soil thaws just a few inches, providing a growing surface for the roots of

vegetation. Tundra vegetation is adapted to the cold and the short growing season, and can carry out photosynthesis at low temperatures and low light intensities. There are few trees, but mosses, sedges, and lichens are common. Trees that do manage to grow stay close to the ground so that they are insulated by snow during the long winters.

Animals on the tundra are adapted to survive winter and to breed and raise young quickly during the short summer. Some species hibernate during winter; some birds migrate south. Animal and bird species that remain on the tundra year round rely on insulation from fat that they gain during the summer. Although more than 1,700 species of plants and animals live in the arctic tundra, this biome is characterized as having low biotic diversity compared to other biomes of the world.

Reindeer are just one species that is well adapted to this environment. They have several physical features that allow them to survive the cold winters, feed on the tundra vegetation, and raise young during the short summers.

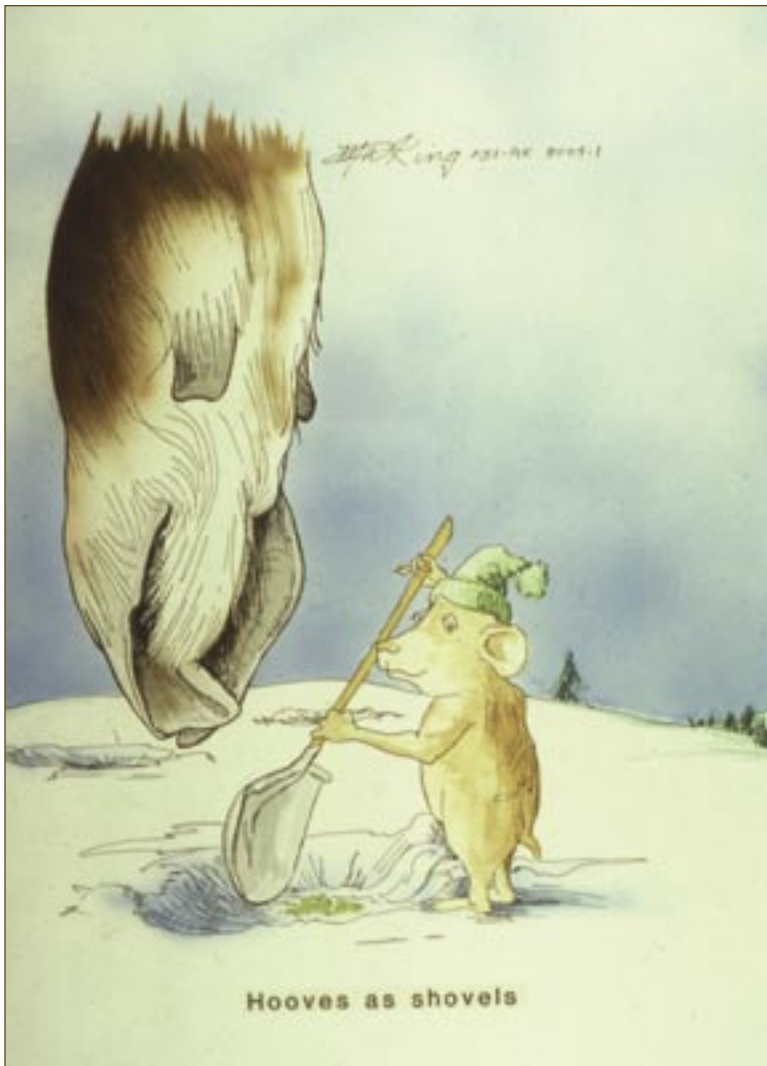


With their thick fur coat reindeer are able to stay warm during the arctic winters.

Specialized hair coat

The furry pelage (or hair) of reindeer consists of two types of hairs: the long coarse guard hairs that have hollow cores and number about 5,000 per square inch, and the very fine wool hairs that are as dense as 13,000 per square inch. Together the hollow guard hairs and fine wool hairs form a thick insulating mesh that traps air within and between the hairs. The insulating quality of reindeer hair prevents heat loss through the skin and is so great that reindeer can rest comfortably for long periods of time on cold snow. In fact, if you examine a reindeer 'bed' carefully, you will see that the surface of the snow did not melt or ice over while the animal was resting. When a reindeer runs in very cold weather, you can see that the moisture in its breath freezes on the surface of its shoulder. However, when the animal stops, the moisture does not remain as caked ice. It is more like a very dry frost on the coat surface that soon falls off or blows away. This is due to the insulating quality of the reindeer's coat, which is so great that the body cannot eliminate heat. Heat cannot be eliminated by sweating because reindeer do not have sweat glands (except for a few around the nose). In fact, only panting can eliminate significant amounts of heat. When heat begins to accumulate in the body, body temperature rises. This can result in heat stress, which for reindeer can be deadly.

In winter, reindeer hair is multicolored. The mane is white; the underbelly, rump, legs, and face are generally dark brown; the shoulders and ribs are light tan. In summer when the long guard hairs fall out and the fine downy hairs are exposed, reindeer are dark colored, often black with white socks. This is thought to conceal them from predators while they are in vegetation, or on snow with where there are hills and mountains in the background. Unfortunately, it also makes it more difficult



Reindeer have shovel-shaped hooves that allow them to dig through deep snow in search of food.

for the herders to find and follow the herd. Therefore, experienced reindeer herders usually include a few white or spotted reindeer in their herd to increase its visibility on the dark-colored tundra.

Hooves

The reindeer's broad hooves and dewclaws act as snowshoes, enabling them to travel across deep snow more easily than other members of the deer family. When snowfalls are heavy, the small pointed hooves of other deer may restrict them to small grazing areas called yards, which can result in heavy losses from starvation.

The snowshoe-like hoof enables the reindeer to dig through snow in search of food. Researchers have found that reindeer can dig feeding craters when snow is as deep as three feet. Their shovel-like hooves also enable the reindeer to chip through hard and crusted snow. However, under severe icing conditions, digging becomes impossible and the reindeer must move, often several miles, to more favorable feeding areas.

Look closely at the underside of a reindeer's hoof and you will see hairs that extend down and across the pad. These hairs are thought to enable the reindeer to better control the movement of its feet, for example, to prevent slipping on ice.

Summer appetite

It is a curious fact that reindeer eat more food in summer than in winter. In summer when food is abundant, reindeer eat large quantities of highly nutritious green vegetation. It is during this time that reindeer put on muscle mass and deposit large pads of fat beneath the skin of the rump and back. These fat pads enable the reindeer to survive the long cold winter when food supplies are scarce.

Winter appetite

Reindeer eat less food in winter than in summer. This is true even when reindeer have access to an abundance of nutritious and preferred foods. Reindeer expend less energy during the winter and they almost always lose body weight and body substance (mostly fat). Reindeer have evolved to survive the winter by lowering their metabolic rate and movements and by using their body tissues for the essential functions.

Winter preference for snow

During winter, the only source of water available to reindeer is snow, which is little more than solidified, pure water. It contains almost no dissolved minerals and is very cold. Although reindeer must use precious body heat to melt and warm snow when they eat it, reindeer almost always choose snow when given the opportunity to select different kinds of water while on winter diets. If fresh snow is present, they refuse to drink seawater, warm water, or cold water.

The explanation for this observation is complex. How does the reindeer's preference for snow contribute to winter survival? Our current hypothesis is based on the fact that snow is a very pure form of water that contains no minerals. The intake of minerals over and above the amount needed for normal functioning requires that excess minerals be eliminated in the urine, which increases the body's demand for water. In winter, mineral-rich water would be very cold. It would require more



During winter, reindeer prefer eating snow over drinking water to reduce their intake of minerals, which minimizes their daily water requirements.

body heat to warm than snow because more water would be necessary for the excretion of un-needed minerals in urine. Because snow contains no minerals, we think it is a more efficient water source, requiring less body heat than would a larger amount of water.

No chapped lips

Hairs on the face extend down to and almost completely cover the lips. This protects the muzzle from frostbite during winter when reindeer obtain their daily food as frozen vegetation from beneath the snow. The lips of a reindeer are very fleshy and mobile. Reindeer have no upper front teeth or incisors. Both of these characteristics facilitate the harvesting of northern food plants such as lichens, grasses, and willow shrubs.

Nose

The nostrils of reindeer are highly developed for water and heat conservation. When seen in cross-section they look like a rolled newspaper. Scientists call this a rolled scroll or nasal turbinate bones. These are specialized structures that vastly increase the surface area within the nostrils. While the explanation of the biological function of this tissue is complex, we know that incoming air is warmed before it reaches the lungs and that heat in the expired air is collected and returned to the body before it is exhaled. Also, water in the expired air condenses in the cooler portion of the nostrils, where it is used to moisten the incoming air, or is absorbed back into the blood. This explains why you seldom, if ever, see the reindeer's breath when it grazes in deep winter.



Reindeer have a broad nose that is highly developed to conserve heat and water during winter.

High-nutrient milk

Reindeer milk is extremely high in fat and protein. Only sea mammals, such as seals, produce more concentrated milk. Newborn reindeer calves start to nurse almost immediately after birth. The highly nutritious milk enables the calves to grow and develop very rapidly during the short arctic summer. It provides the energy needed to follow the mother as she constantly moves, searching for food, seeking shelter from wind and cold, or escaping from predators.

What do Reindeer Eat?

Reindeer, like all members of the deer family, are herbivores, or plant-eating animals. More specifically, they are considered concentrate selectors, meaning they select higher quality forage. Cattle and bison are considered generalist grazers because they eat large amounts of lower quality forage.

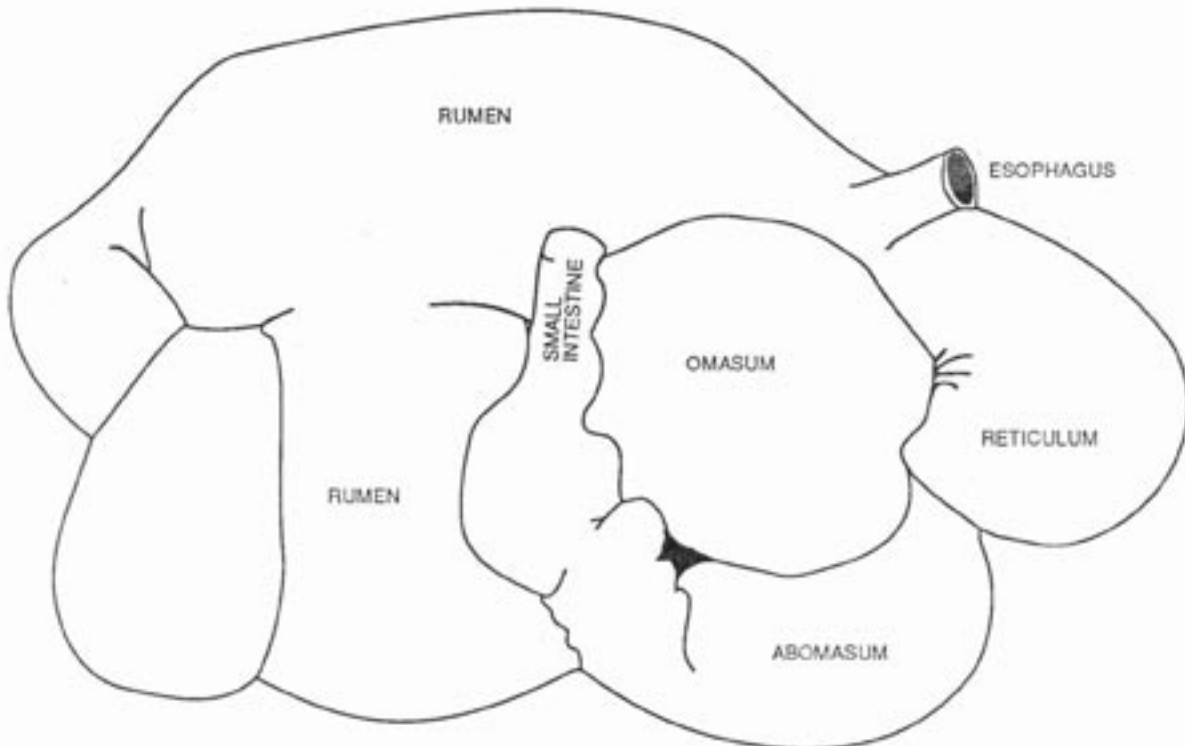
For example, when given long stem hay, reindeer will only eat the more palatable leafy parts. During spring, free-ranging reindeer dig for rhizomes and search for emerging buds, leaves, and flowers. During summer they feed on willow leaves, forbs, and mushrooms. During winter reindeer primarily eat lichen. Captive reindeer must be fed a balanced diet of commercial grains, forage, and supplements. When feeding captive reindeer, a working knowledge of the rumen's function and physiology and the seasonal growth pattern is important for a successful farming operation, because reindeer are very different from cattle or other traditional livestock species.

What is a ruminant?

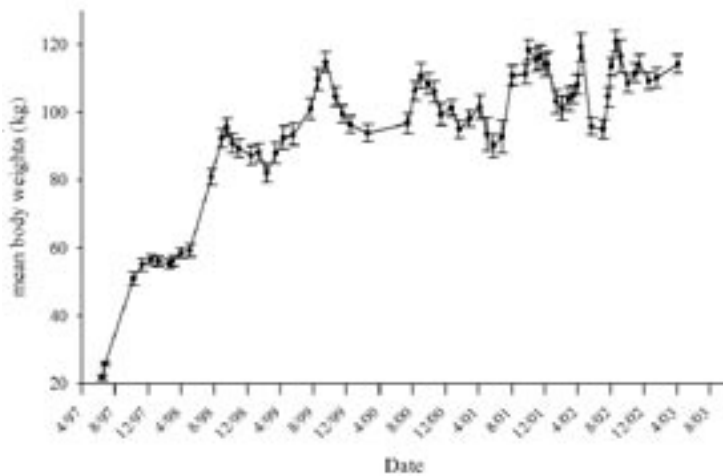
Reindeer are ruminants. They have a four-chambered stomach, each with a special digestive function. Food enters the first chamber (reticulum), then the rumen, the omasum, and finally the abomasum before entering the small intestine. Each of the four chambers performs a different function. The rumen is unique to animals that eat grasses, plants, and lichen. These food items contain a material called cellulose that is indigestible to animals, including humans. Bacteria



During summer reindeer seek out willow leaves, which are high in protein.



The four chambers of a reindeer stomach.



Body weights of captive female reindeer from 4 months to 6 years of age. After their first year, the reindeer lose weight during the winter and gain weight during the summer.

the protein they will need for the whole year. They are also putting on fat and muscle mass for the upcoming winter months. During the long winter, the only thing available for reindeer to eat is lichen. Lichen contains no protein, fat, or minerals, just carbohydrates. Reindeer dig through the snow for lichen and live off of the fat reserves they built up during the summer. Reindeer are less active during winter, because they are trying to conserve heat and energy. Interestingly, the reindeer that live at the UAF reindeer research farm also exhibit this same weight gain and loss cycle, with appetite increasing in summer, decreasing in winter. This is amazing because the farm reindeer are fed a high-energy diet and are given as much to eat as they want.

Lichens

Perhaps the most important adaptation of reindeer for life in the north is the reindeer's fondness for lichens, which are also called reindeer moss. In fact, of all the many kinds of range plants, grasses, and livestock feeds tested to date, reindeer most often select lichens first. This unique physiological adaptation is of crucial importance. The sustained uses of tundra rangeland, as well as calculations for maximum herd size, are based on the availability of lichens for winter grazing.

Lichens are formed by a symbiotic relationship between algae and fungi. Both are mutually dependent on each other for survival. There are thousands of lichen species growing on trees, rocks, and on the ground.

living inside the rumen break down cellulose compounds into a form usable by the body. Reindeer could not survive on plants and lichen without this bacteria in the rumen.

Seasonality of diet

All *Rangifer* species (reindeer and caribou) exhibit an annual weight-loss, weight-gain cycle in which they gain weight during summer and lose weight during winter. They have a large appetite in summer and a small appetite in winter. This is an adaptation to arctic life. In the summer, there is much green, protein-packed vegetation available out on the tundra.

During summer they must acquire all of



Lichens are high in carbohydrates and are a preferred food of reindeer.



Lichen availability during winter is an important factor in determining reindeer range carrying capacity.

Lichens grow slowly and are long lived: up to tens, even hundreds of years. Lichens, which are commonly found in temperate and arctic climates, live in dry environments, but can readily absorb water and accumulate atmospheric contaminants. They are very sensitive to changes in their environment and have been used by scientists to monitor air contaminants in northern climates that have migrated from industrial regions of the world.

There are at least two reasons why reindeer's preference for lichens has enabled them to survive in the north. First, lichens usually constitute a major part of the vegetative biomass (food supply) on winter tundra pastures. Because other grazing mammals do not eat lichens (except for caribou), the reindeer is guaranteed a supply of food for winter survival.

The second reason for the importance of lichens in the reindeer's diet is more complex. From a nutritionist's viewpoint, lichens are extremely deficient in protein, fat, minerals, and vitamins. In fact, lichens, like candy, pancakes, and potatoes, contain mostly carbohydrates. How can a high-carbohydrate diet have survival value for reindeer? We know that lichens, like most carbohydrate-rich foods, are highly digestible in reindeer. That means that almost all the nutrients in lichens become immediately available (mostly as energy) to the reindeer for the maintenance of body functions. Lichens also contain only small amounts of protein and minerals, so there are fewer metabolic wastes to be eliminated in urine, which reduces the excretion of water. This is important, because a reindeer has to use body heat to warm the snow it eats to replace any water excreted.

Does this mean that lichens are the best of all possible rations for the winter survival of reindeer? Not at all. Reindeer do very well on highly nutritious livestock feeds, but such feeds are not usually



Reindeer bulls in velvet.

available to free ranging reindeer in winter. Reindeer have adapted to an ecological niche of lichen pastures, in which there are no competitors for this preferred winter food resource.

Reindeer Behavior

Herd behavior

A herd is defined as a group of animals of the same species that remain together. Living in a herd is advantageous to individual reindeer because while some are eating, some are looking out for predators. Reindeer are also gregarious, meaning that they are social animals and like the companionship of other reindeer. When reindeer are in a fenced situation, for example, they do not like to be alone in a pen.

Reindeer are docile creatures that are easily raised and well adapted to the presence of humans. People can train reindeer relatively easily, especially when they are young.

Because of their docile nature and gregarious behavior, reindeer are easily herded and tend to stay in cohesive groups. When herded or chased, they form a tight group and move in a circular fashion, while caribou often scatter. Reindeer will form this circular group when herded on the range and when placed into a corral.



Female reindeer with antlers are dominant over antlerless reindeer.

Antlers

Reindeer and caribou are the only species in which both males and females grow antlers. Antlers are different from horns in that they fall off and re-grow each year. Antler tissue is some of the fastest-growing tissue in the animal kingdom. Reindeer bulls usually lose their antlers sometime in December or January. Pregnant female reindeer lose their antlers about five days after they give birth and nonpregnant females and castrated males lose their antlers in early spring. Even new calves grow a small set of antlers their first summer of life. As the new antlers are growing they are covered in a soft fuzzy tissue called velvet. Blood is pumped up into the growing antler until it begins to ossify, or harden into bone, which occurs in June for bulls and in July for females. Once the antler completely hardens, the velvet falls off. Reindeer will rub their antlers on trees, posts, fences, or anything sturdy they can find to help get that velvet tissue off. Each reindeer's set of antlers is unique in shape, with the size usually getting bigger each year.

Antlers serve many important functions in the life of a reindeer. Male reindeer use their antlers to establish dominance prior to the breeding season. These tests of strength enable the largest and strongest male reindeer to attract and gather a harem of females during the breeding season. Females also use their antlers to establish dominance within the herd. Females with antlers are dominant over all other reindeer that have lost their antlers. An animal retaining its antlers can feed in prime areas because it can easily ward off a reindeer without antlers. This is beneficial for pregnant females during late winter, because access to good food sources is important for the unborn calf.

The long forward section on each antler is called a brow tine, although reindeer may not have brow tines on each antler. These brow tines help protect the reindeer's eyes when they are sparring with another reindeer, scraping their antlers on a shrub, or feeding in tall willows in the summer. Reindeer may also use their antlers for defense to fend off predators, such as wolves.

Breeding season

For members of the deer family, the breeding season is often called the rut. For reindeer, rut begins in mid to late August and extends into November. During the rut, bulls produce increased levels of testosterone and the females enter into estrus. The increased testosterone levels cause bulls to become aggressive toward other reindeer bulls and toward humans as well. This can be a challenge for people trying to raise and breed reindeer in a fenced situation, as rutting bulls often try to destroy feeders, fences, water troughs or anything in sight. Rutting bulls become a different animal during this time and should not be trusted. The increased hormone levels also cause them to produce a strong odor, their necks to swell, and the white mane under their neck to grow longer and thicker. They rub their antlers vigorously to remove all of the velvet and they will spar with other bulls to gain dominance and control over a harem (a group of females). Once the bull has a harem, he will work continuously throughout the rut to keep all other males away. Bulls in rut rarely eat and lose a significant amount of weight. In the wild, reindeer bulls do not live very long, because they often begin the winter with depleted body resources and are often susceptible to starvation and predation. The meat quality of a rutting bull is poor. Since herders slaughter their animals during winter, a bull that went through the rut the previous fall will have low amounts of fat and muscle mass. Castration is a common practice on the Seward Peninsula, because a castrated male will not produce excess testosterone, and will maintain its weight and meat quality for the winter slaughter.



During the rut, reindeer bulls will spar with each other to gain control over a harem.

Calving

Most female reindeer conceive as yearlings, but well-nourished reindeer can conceive at only five months of age. Females produce just one calf (twinning is extremely rare) after about a 224-day gestation period, and give birth between mid April and mid May. It usually takes about an hour for a female reindeer to give birth. After the calf is born, the mother licks it clean. Calves weigh about ten to sixteen pounds at birth. They begin nursing and walking around within a few hours. Reindeer calves are born with teeth and they begin supplementing their mother's milk with some solid food in about a week. Reindeer calves are born with dark, chocolate-brown fur. This dark-colored fur can absorb warm spring sunshine. In the Arctic, when the calves are born in April, winter temperatures may still prevail. They will begin to grow their first set of antlers within their first few weeks. The calf will remain with its mother and will be weaned in late summer or early fall.



A female reindeer with her newborn calf.

Communication

Reindeer generally do not make many sounds. Most of the communication with members of the herd is through body language, antlers, and smell. Reindeer mothers and calves do grunt to each other when they are separated or in danger. Rutting bulls also frequently grunt and snort. Reindeer do make a clicking sound with their feet when they walk. A tendon that slips on the bones in the reindeer's wrist each time it is flexed produces this sound. The function of this clicking sound has puzzled biologists. The best explanation to date is that it helps herd members locate each other and stay together on the tundra when it is dark and during blizzards or blowing snow.

Reindeer senses

Reindeer use their sense of smell to detect danger and find food. They are able to smell lichens under more than three feet of snow. A female reindeer can recognize the individual scent of its calf.

Reindeer have a good sense of sight and excellent night vision. They are sensitive to violets, blues, and yellows, but cannot distinguish between red and green. The location of a reindeer's eyes on the side of its head allows for a broad peripheral view of its surroundings. Reindeer are excellent at detecting movements at long distances.

A reindeer's sense of hearing is excellent and its sensitivity to sound is better from behind than in front.

Reindeer vs. Caribou

A commonly asked question is what is the difference between reindeer and caribou? Reindeer and caribou are the same species and have many similarities, but they are different enough to be classified as two subspecies. The biggest difference between reindeer and caribou is domestication. Reindeer are a semidomesticated *Rangifer*. In Alaska, most of the reindeer are free ranging on the Seward Peninsula and face the same dangers as wild caribou, such as predators, disease, and bad weather conditions.



When herded, reindeer often bunch up and circle together, whereas caribou scatter.

Reindeer are shorter, stouter, and more sedentary than caribou. The longer legs of the caribou are made for migrating.

Although reindeer may migrate within their grazing range, they do not migrate long distances between wintering grounds and calving areas like caribou do. Reindeer bulls are smaller than caribou bulls, but cows may weigh the same as caribou cows. Antlers are grown by both male and female reindeer and caribou, the only two members of the deer family in which this occurs. Female reindeer grow larger antlers than female caribou.



Reindeer may be pinto or have a mottled or light coloration, a result of domestication.

Coloration differences may be too subtle to notice between many reindeer and caribou, although reindeer tend to be lighter, with occasional pinto or white hair coats. Reindeer have thicker, denser fur than caribou, although both have hollow guard hairs that keep them warm in northern climates. The nose bridge, or face, of reindeer is flatter than caribou. Reindeer begin the breeding season about two to four weeks earlier than caribou. This results in reindeer calves being born at the end of April, while caribou calves are born at the end of May. Both reindeer and caribou have hooves that can be used as snowshoes for walking on the snow and for digging. Reindeer tend to stay in more cohesive groups. When herded or chased, they tend to run in a tight group, whereas caribou often scatter. These traits are the result of domestication. It is believed reindeer have been domesticated in Eurasia for at least 5,000 years, which is longer than the horse.

Concerns for Reindeer

Predators

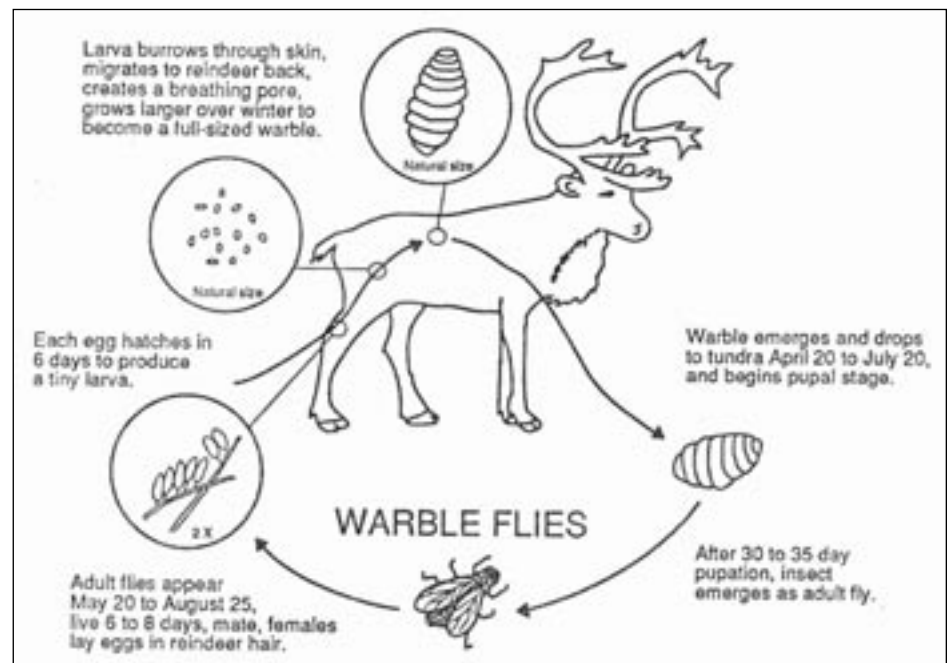
Free-ranging reindeer face the same array of predators as their wild cousins, caribou. Grizzly bears can catch young reindeer calves. Reindeer calves are a great source of protein for bears as they emerge from their dens in spring when the vegetation has not yet emerged. The wolf population has increased in recent years on the Seward Peninsula. Reindeer can be easy prey for wolves, because they are slower and fatter than their long-legged relatives. In Scandinavian countries, golden eagles and wolverines are the primary predators of reindeer. Golden eagles can attack calves and kills of adults by wolverines have been documented.

While mosquitoes do not kill reindeer, they do act as a type of predator, harassing reindeer herds during the summer months. Mosquitoes, persistent in their search for blood in which to lay eggs, will force reindeer to seek out windblown and snow-covered slopes for relief. This may use valuable energy and prevent reindeer from feeding, resulting in a lower nutritional status when winter arrives.

The warble fly life cycle.

Parasites

Parasites are organisms that live either inside or outside an animal and take their nourishment from the host. Parasites living inside are called internal parasites, such as worms. Parasites living outside are called external parasites, such as ticks. There are a few parasites on the Seward Peninsula that can infect reindeer.

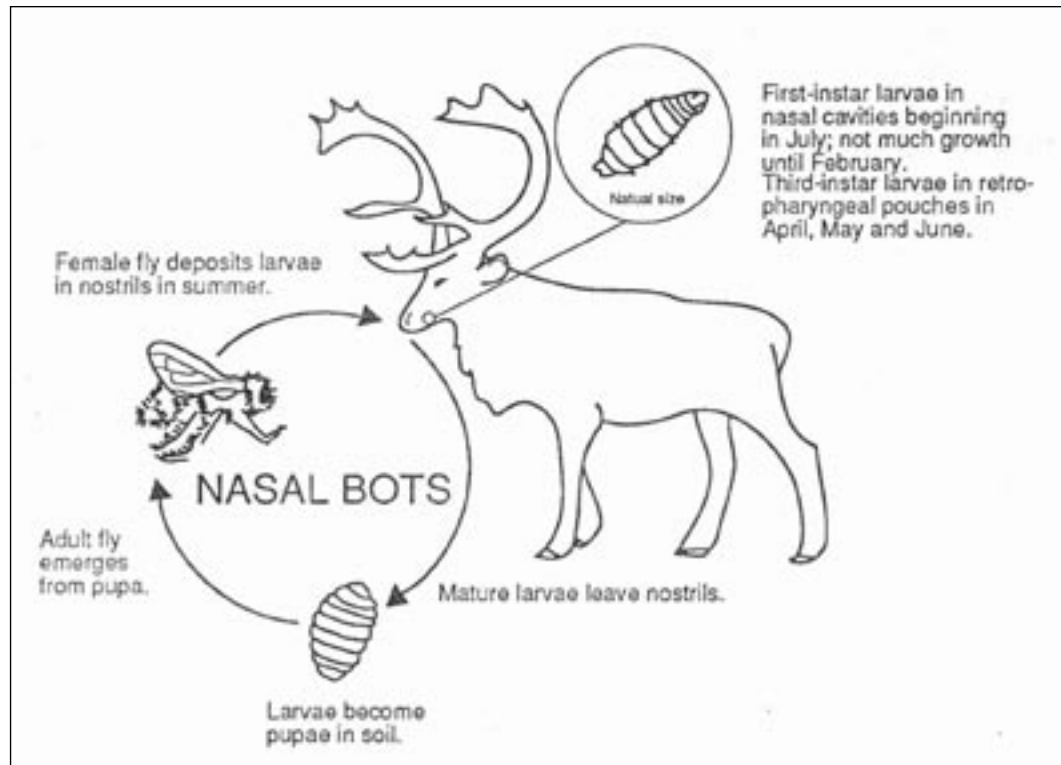




The back of a reindeer infected with warble larvae.

Warbles are a major pest to Alaska reindeer and can impair their health. The adult warble fly is not parasitic to reindeer, but the larvae are. During the summer months, female warble flies lay their eggs on the shaft of reindeer hairs, most often near the base where it is the warmest. Reindeer will expend a lot of energy trying to escape the buzzing flies during summer. Once the eggs are laid, they hatch into worm-like larvae. This larva borrows underneath the reindeer's skin and travels to its back to feed on the reindeer's blood. When autumn arrives, the adult flies die, but the larvae continue to feed on the reindeer's body fluids, growing into inch-long grubs. In spring, they emerge from the under the reindeer's skin, fall to the ground, transform into an adult fly, and the cycle continues. Infected reindeer have been found to have from 200 to 2,000 warbles living beneath their

The nose bot life cycle.



skin. Warbles can weaken reindeer and make them more susceptible to infection and disease, poor weather, predators, and other parasites. The holes made by the warbles can decrease the quality of a reindeer's hide, making it less warm for the reindeer and of less economic value to the herder. The drug, Ivermectin, has been proven to be more than 98% effective in killing warble fly larvae in reindeer. Ivermectin is given by injection once a year just after the first hard freeze. This is to ensure that none of the adult flies are still living and able to lay additional eggs. Ivermectin is not toxic to humans, but there is a withdrawal period of 56 days before the animal can be slaughtered. Ivermectin is commonly used in many other domesticated animals to treat parasites.

The nose bot life cycle and treatment is similar to warble flies. The adult flies deposit their larva in the nostrils of reindeer during the summer months. This is very irritating to the reindeer and it causes them to behave erratically as they try to avoid the flies. The larvae travel up the reindeer nasal cavity where they live for most of the winter. During the spring, the larvae travel to sacs located at the upper end of the nasal cavity, which is very uncomfortable and irritating for the reindeer. Reindeer will snort and sneeze in attempt to rid themselves of the nose bots. The larvae expelled from the reindeer fall to the ground, transform into pupae, and then a fly, hence completing the cycle. Besides being irritating for the reindeer, nose bot larvae sometimes migrate to the lungs and can cause pneumonia. Ivermectin also kills nose bots in reindeer.

Reindeer may have internal parasites that live in the small intestine and stomach, such as roundworms and tapeworms. The worms lay eggs, which are excreted by the reindeer and fall to the ground, hatch as larvae and attach themselves to vegetation eaten by the reindeer. The adult worm develops inside the reindeer. Internal worms can cause poor growth, diarrhea, and anemia.

Diseases

Brucellosis is a bacterial disease that infects wild animals such as elk, bison, caribou, reindeer, moose, bears, wolves, and fox. There are many different brucellosis species that affect different animals. *Brucella suis* type 4 is the brucella strain that infects reindeer and caribou in Alaska. It is not known whether brucellosis was introduced into Alaska from the reindeer that were imported from Siberia or if it was already present in the North American caribou herds. Because brucellosis is not found in reindeer herds on isolated Alaska islands, it is now believed that reindeer in Alaska first became infected with brucellosis from the existing North American caribou herds.

Brucellosis can cause females to abort their young and males to become



A large abscess caused by brucellosis.

sterile. Both males and females can have swelling of the joints that results in lameness. The bacterium is spread sexually and by contact with the aborted tissues. Reduced reproduction in the herd is the primary effect of this disease. Lameness in individual animals can increase reindeer losses to predation and weather mortality.

A brucellosis vaccination has been developed at the University of Alaska Fairbanks specifically for reindeer and is approved for use throughout the state. The vaccination stimulates the animal's immune system to produce antibodies to the brucella bacteria.

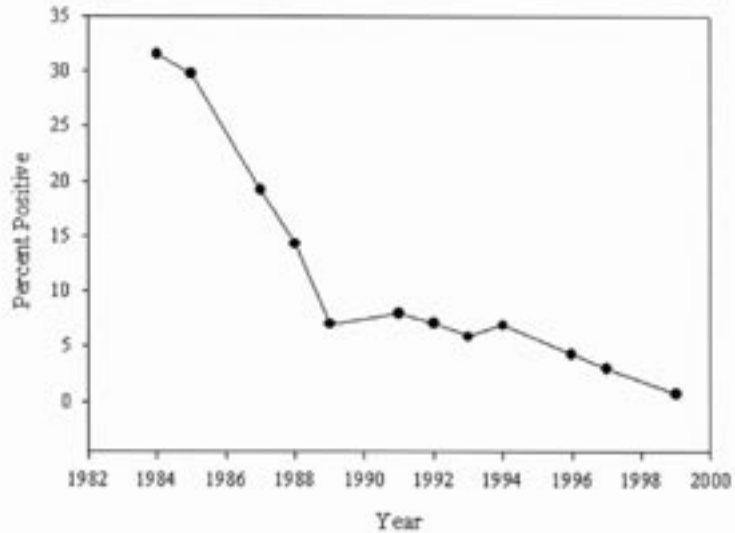
Reindeer herders now give their reindeer a one-time vaccination, usually as yearlings during the summer roundups. The vaccination is given as a shot under the skin in the side of the neck.

Foot rot can also cause lameness in reindeer and may be more commonly seen in fenced herds. Bacteria enter a damaged area of the foot, causing an open sore to form. Sometimes mineral deficiencies can cause development of large, abnormal hooves. Penicillin injections and chemical baths are used to treat this disease. Dry, clean ground cover for fenced reindeer may help to prevent this disease.

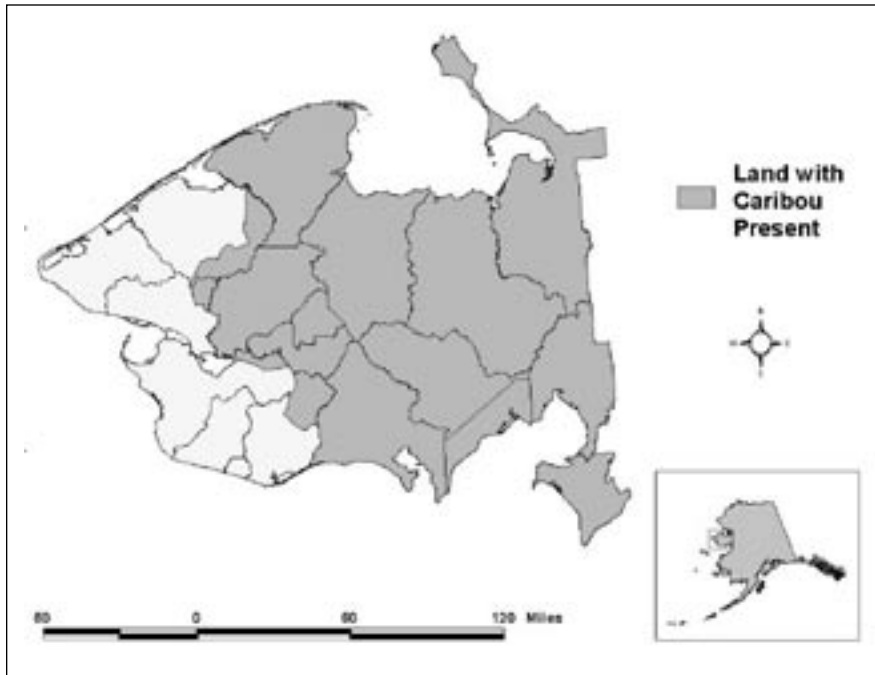
White-eye or keratitis is an infection of the eye. The affected eye will appear cloudy or white. Redness in the white of the eye and around the edges may occur. White-eye can be treated with penicillin and cortisone, but it may lead to blindness.

When the antlers are growing during the summer, they are very sensitive and soft and can be broken easily. Broken antlers should be cut off whenever possible. Reindeer are very distracted and will 'go crazy' with a broken antler hanging down. The antler should be cut at the break and then sprayed with an antiseptic. Sometimes a rubber band applied just below the break is required to control bleeding. The growing antler is a highly vascular area with lots of blood pumping to the new tissues. Care should always be taken when handling reindeer with velvet antlers.

Recently, the increased spread of diseases like chronic wasting disease and West Nile virus in some ungulate species in the Lower 48 have caused reindeer herders in Alaska to make preparations in case these diseases spread north. While they have not been detected in Alaska yet, some fear that it is only a matter of time before they arrive. Learning about the disease and taking a proactive approach is the best defense that herders have. Officials and biologists are working with reindeer herders to develop an assessment and monitoring program for these diseases.



The percent of positive brucellosis tests on the Davis reindeer herd have dramatically declined since this herd began receiving brucellosis vaccinations.



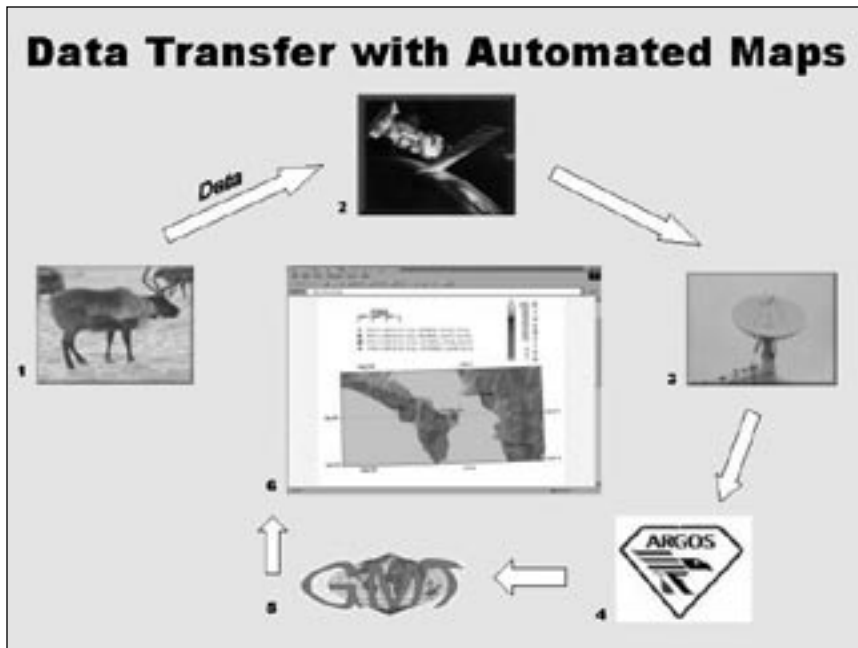
Most of the shaded area is considered unavailable for reindeer herding until caribou numbers decrease or they change their winter migration patterns.

Caribou threaten Seward Peninsula reindeer herds

The Western Arctic Caribou Herd (WACH) has expanded from 250,000 animals in the 1970s to over 400,000 animals in the 1990s. This trend has been observed in many caribou herds across the north. The WACH normally summers in the Brooks Range, the area south of Wainwright and east of Point Hope, and they migrate south to winter in the Nulato Hills and Koyukuk River drainages. The recent increase in herd size has resulted in an unprecedented shift in the caribou's winter migratory patterns. Beginning in 1996, members of the WACH began spilling onto the Seward Peninsula's rich reindeer range, as they outgrew and overgrazed their traditional wintering areas. The Seward Peninsula has not seen caribou on its prime reindeer ranges for over eighty years. The winter range expansion of the WACH and the vast lichen ranges on the Seward Peninsula have kept the caribou returning to this area each winter.

Once the caribou arrive on the reindeer range, there is little reindeer herders can do to prevent their reindeer from joining up with the larger caribou herds. Once the reindeer join the caribou, it is virtually impossible to separate them out of the group. Reindeer begin to act much more like caribou once they join them. Because reindeer are slower and fatter than their lean cousins, they often fall prey to wolves while trying to keep up with the migrating caribou. In an attempt to save their remaining animals, reindeer herders have developed safe areas that caribou have not yet entered. Herders can drive their reindeer to these areas to keep them safe from the advancing caribou. This encroachment of caribou on reindeer range has been detrimental to Alaska's reindeer industry and the long-term effects on the winter lichen range are still being investigated.

The Reindeer Research Program at the University of Alaska Fairbanks has developed an innovative way to prevent herders from losing more animals. Satellite collars have been placed on individual animals in various herds. The satellite collars can give biologists and herders real-time location data. Information is gathered from the satellite passing overhead and downloaded to the Reindeer Research Program's computer, where the information is logged and a map is made. Herders can access



A satellite collar is placed on a reindeer (1), the collar's location is acquired by a satellite passing overhead (2), the location data is transmitted to a satellite receiver on Earth (3), the data is then sent to Argos, a data management company, that converts it to a latitude and longitude and e-mails the information to the Reindeer Research Program computers (4), the data is automatically entered into a mapping program called GMT (5), which creates a map of the collared reindeer's location that is posted on the Internet for the reindeer herders to access (6).

their reindeer's location on maps via the Internet and instantly know where their herd is. Herders also have access to the satellite collar location data of the WACH provided by the Alaska Department of Fish and Game. Reindeer herders can take this information and determine if they need to move their reindeer, based on the advancement of the caribou. Having access to this valuable information will allow herders to make crucial management decisions in order to save their herds, without having to waste valuable resources and effort to locate animals by snowmachine out on the tundra.

Heavy metals in the environment

The Seward Peninsula has been extensively mined for the last 100 years. Heavy metals such as cadmium and lead-bearing ores have been mined here and have had widespread use in industry worldwide, causing environmental contamination. These elements are readily absorbed by plants and are then eaten by ungulates, concentrating in liver, kidney, and muscle tissue. Radionuclides, such as cesium, have been found in lichens throughout northwestern Alaska, having migrated there from pollution centers in the south.

There is concern among the local people who live a subsistence lifestyle that contaminants are being introduced into the food chain and compromising their health. During a recent study, the Reindeer Research Program detected high levels of cadmium and lead in several reindeer forage species at specific locations. If similar concentrations were found in reindeer meat, the consumption of just two ounces of meat per week would exceed the recommended intake rate for these heavy metals. Currently, the Reindeer Research Program is collecting meat and tissue samples from reindeer and caribou on the Seward Peninsula to determine possible contamination by cesium and heavy metals.

Climate change

There has been a warming trend throughout the Arctic. Over the past twenty years, temperatures in the north have increased by 2°C. It is predicted that northern climates will see a stronger effect of global warming than areas further south. It is also predicted that the north could see an increase

in snowfall, or with warmer temperatures, freezing rain. How could a slightly warmer north affect reindeer? Warmer temperatures could lead to an earlier spring, causing vegetation to sprout just when reindeer need it most. But a long, warm summer may cause the vegetation to dry up earlier, while reindeer need that protein-packed vegetation to put on fat for the upcoming winter.

Increased snowfall will make it difficult for reindeer to dig under the snow for lichen. Freezing rains would create an impenetrable barrier, locking up forage that reindeer need. Warmer summer-

time temperatures could increase insect harassment, leaving reindeer with less time to gather important summer forage plants. The potential for an increase in tundra fires during summer exists, which could wipe out valuable lichen patches that take decades to grow. There is also the possibility that warmer temperatures could lead to an invasion of parasites previously unknown in the Arctic.

No one knows for certain how climate change will affect the north and Alaska's reindeer industry. Being able to foresee the possible effects of climate change on reindeer herding will give reindeer herders a chance to plan and adapt for this inevitable change.



An increase in tundra fires would wipe out valuable lichen patches that take decades to grow.

Reindeer Research: Working to Preserve Alaska's Reindeer Industry

Even though the reindeer has been domesticated for thousands for years, there is still much to be learned about this northern ungulate. Established in 1981, the University of Alaska Fairbanks Reindeer Research Program takes an active role in developing and promoting the reindeer industry in Alaska. The program collaborates with reindeer producers and local communities to determine



The Reindeer Research Program's research herd is at the Agricultural and Forestry Experiment Station on the UAF campus.



Elsa, a reindeer, accompanies Reindeer Research Program staff members to local schools as part of the Educational Outreach Program.

Tundra Joe, a member of the research herd, is being held in a squeeze chute mounted on weigh bars to obtain his body weight.



industry needs, performs research, and develops applied programs in many areas.

To provide reindeer herders with as much knowledge as possible about promoting the growth and success of their herds, the Reindeer Research Program studies reindeer nutrition, health, diseases, record keeping systems, meat quality, predation, antler growth, heavy metal levels and containments, forage quality, range management, land use patterns, corral design, husbandry techniques, and provides reindeer location maps on the Internet. The program performs its research with free ranging herds on the Seward Peninsula and with the captive research herd at the Fairbanks Experiment Farm of the Agricultural and Forestry Experiment Station on the UAF campus. The program also has implemented an educational outreach program for K - 12 students, which offers tours of the research reindeer herd and facilities. Program staff often visit classrooms and give presentations on various reindeer-related topics, accompanied by a live reindeer. This booklet and the accompanying kit are also a product of the Educational Outreach Program.

Current ongoing research projects:

Investigating the effects of barley-based diets and various protein sources on body mass and intake rates of captive reindeer during summer and winter

Determining meat quality and production of free ranging and farmed reindeer

Determining heavy metal concentrations in reindeer, caribou, and plants of the Seward Peninsula

Determining the relationship between trace mineral levels in reindeer tissue and reindeer diet

Using satellite telemetry and the Internet to obtain near real-time locations of reindeer to prevent losing reindeer to the Western Arctic Caribou Herd

Educational outreach and curriculum development

Determining the ecology and economics of changing patterns of land use in western Alaska

Determining soil and plant relationships affecting reindeer productivity

Applied research projects, all of which have been utilized by reindeer producers:

Estimated trends in nutrient concentration of reindeer forages during the growing season

Measured the effect of long-term antibiotics on calf survival

Determined the causes of mortality in reindeer calves

Determined the factors that affect velvet antler weight

Developed a brucellosis vaccine for reindeer

Conducted research on Ivermectin leading to its approved use in reindeer

Developed a herd record keeping system to improve herd management

Designed improved corral systems and reindeer husbandry techniques

Developed a model to estimate herd growth and income



Scientists have measured the long-term effects of antibiotics on reindeer calf survival.



Scientists collect reindeer forage plants on the Seward Peninsula throughout the growing season to determine their concentrations of nutrients.



Improved corral systems and reindeer husbandry techniques have increased the efficiency of reindeer handlings and reduced animal injuries.

Lesson Plans



Reindeer calves learn the skills they need to survive through play.

1. Reindeer Herding in Alaska

Grade K - 6

Subject History, Geography, Science, Reading

Duration 1 hour

Alaska State Standards H.A.1, H.A.6, H.A.8, G.E.1, G.E.2, S.A.14, S.A.15

Cultural Standards for Students E.2

Cultural Standards for Educators A.4, B.3, E.5

Instructional Goal

Students will understand how a regional resource is developed and used, and how cultural elements influence interactions. They will use science to describe the local environment and the interdependence between living things and their environment.

Performance Objectives

Students will observe the history and biology of reindeer herding in Alaska through reading, observation, and discussion.

Materials

Copies of the *Reindeer in Alaska* story, **Reindeer Herding in Alaska Quiz**, **Reindeer Information Sheet**, and the **Label the Reindeer** worksheet (primary or intermediate) for each student (photo-copy masters begin on page 35)

Reindeer specimens (found in the **Reindeer Roundup! Educational Kit**)

Optional: Slides or photographs of a reindeer handling (images found on the *Reindeer Visual Aids* CD-ROM in the **Reindeer Roundup! Educational Kit**)

Background

Reindeer are domesticated members of the deer family that live in herds. Reindeer were introduced to Alaska in 1892 from Russia as a source of economic gain and as a protein source for the Inupiaq people living in western Alaska. Reindeer numbers grew to over 600,000 by the 1930s, but fell to merely 25,000 by the 1950s. Poor herd management, bad winter weather, out-migration with caribou, and predation by wolves all contributed to the reindeer decline. The Reindeer Act of 1937 allows only Alaska Natives to own reindeer in Alaska. Currently, there are about 20,000 reindeer in western Alaska and another 10,000 in other parts of the state. Herders on the Seward Peninsula still own and raise reindeer, allowing them to freely range across the tundra. They keep track of their reindeer year round, but like to round them up twice a year. These are called reindeer roundups or reindeer handlings, in which hundreds and sometimes thousands of reindeer are herded up and moved into



Hundreds of reindeer were driven into this corral for a handling.

—photo by Roy Corral

a large wooden corral system with a series of smaller pens, or pockets, and squeeze chutes, or an individual reindeer holding device. Reindeer herders used to move their animals by walking behind them to the corrals. Today herders often use four-wheelers, snowmachines, and sometimes helicopters to move the animals as much as thirty miles a day. During the winter, reindeer are slaughtered for their meat and hides. They are also given a de-worming shot to keep them healthy. In the summer, new fawns are given an ear tag and an ear notch that is specific to each herder. Velvet antlers are harvested off the adult males and females and sold to Asian markets. Some reindeer bulls are castrated to keep body condition and meat quality high by eliminating the rut. Yearling reindeer are given a one-time vaccination for brucellosis, an airborne disease that can cause female reindeer to abort their young. It takes the help and hard work of many people from the herder's family and village to process all of the reindeer in the corral. Work often continues throughout the night to reduce the time reindeer must spend in the corral without food and water. UAF Reindeer Research Program staff often work out on the Seward Peninsula to further develop and promote the production of reindeer in Alaska through research and collaboration with producers and local communities.

Procedure

1. Read the *Reindeer in Alaska* story as a class, discussing the history of reindeer and how reindeer are rounded up for reindeer handlings.
2. Have the students complete the **Reindeer Herding in Alaska Quiz** after reading the story, or on the following day for review.



: *Rangifer tarandus tarandus* is the species name for reindeer in Alaska.

3. Read the **Reindeer Information Sheet** as a class, discussing the biology of reindeer. Use the reindeer specimen props from the **Reindeer Roundup! Educational Kit** for hands-on learning.
4. Have each student complete the **Label the Reindeer** worksheet.

Extensions

1. Show either of the slide shows, *Adaptations of Reindeer to Life in the Arctic* or *History of Reindeer in Alaska* located on the *Reindeer Visual Aids* CD-ROM in the **Reindeer Roundup! Educational Kit**. Use the corresponding slide index in **Appendix B** on page 170 for assistance.
2. Have a researcher from the Reindeer Research Program visit your classroom with a live reindeer to discuss the biology of reindeer. Have them recount their experiences working at the reindeer roundups on the Seward Peninsula.
3. Have a Native elder or local reindeer herder visit your classroom and share their experiences at reindeer roundups and discuss how technology has changed the reindeer industry in Alaska. Have the students prepare questions in advance.
4. As a class or individually, have students view the *Reindeer Herding in Alaska* CD-ROM (located in the **Reindeer Roundup! Educational Kit**) and report on herding activities for an individual herder listed on the program.
5. Show the video, *High Tech on the Tundra* (located in the **Reindeer Roundup! Educational Kit**), and discuss how technology has changed reindeer herding on the Seward Peninsula.

Assessment

Students will be evaluated by their completion of the **Label the Reindeer** worksheet and correct responses to the **Reindeer Herding in Alaska Quiz**. Interest by the students and relevant questions asked should also be evaluated.

Answers to the Reindeer Herding in Alaska Quiz:

1. Sheldon Jackson
2. Assist at roundups, weigh reindeer, vaccinate, tag ears, track reindeer with radio and satellite collars, study the plants they eat, study the weather patterns
3. Helicopter
4. Squeeze chute
5. Each reindeer has an ear tag with an individual number imprinted on it and an ear notch.

Reindeer in Alaska

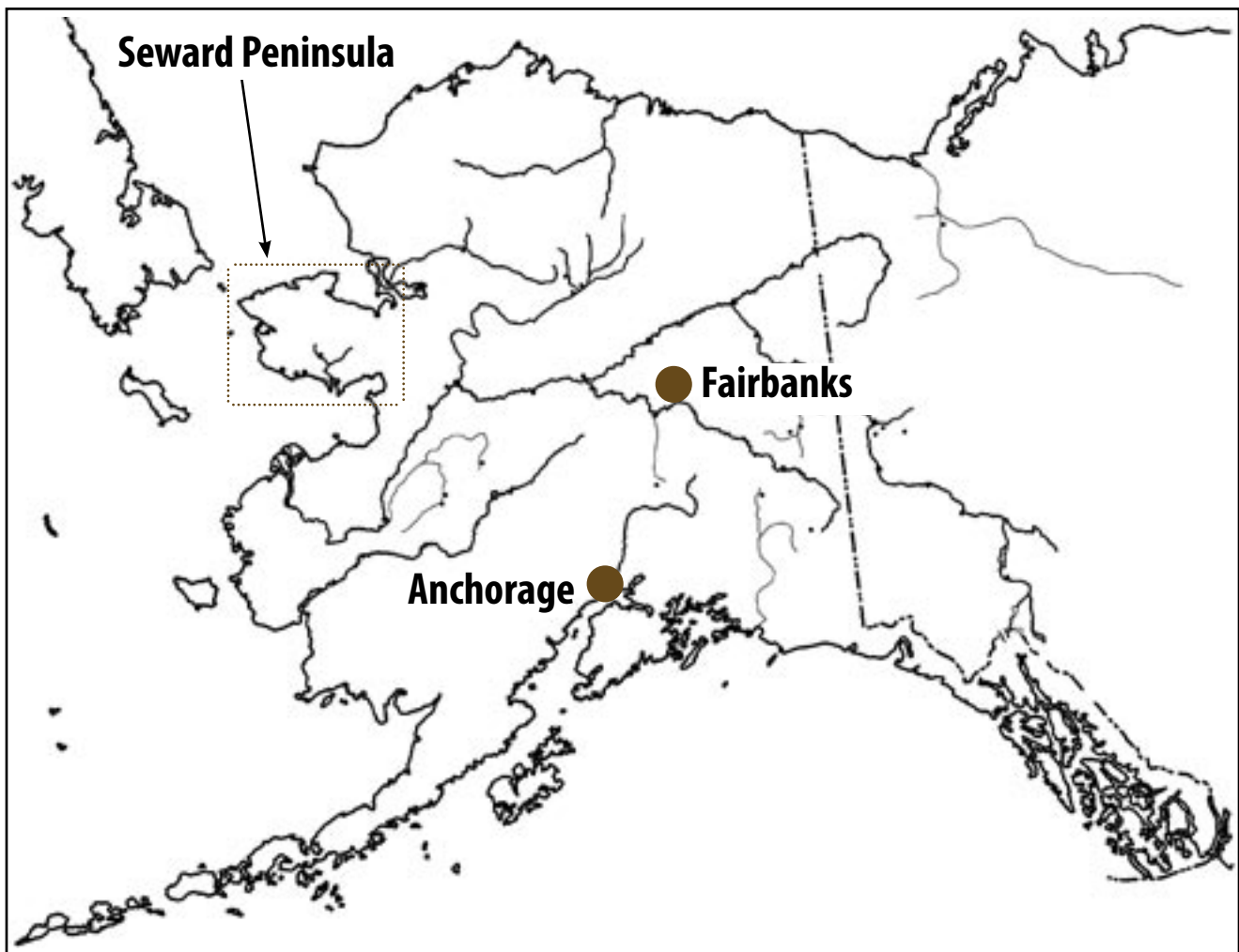
A story of reindeer herding
in Alaska



—photo by Roy Corral

History

Reindeer haven't always lived in Alaska. Their wild cousins, caribou, have lived here for many thousands of years. Reindeer were introduced to the Seward Peninsula in Alaska just over one hundred years ago.





—photo from *Reading, Reindeer, and Religion*, by Elizabeth Tower, 1988

In 1892, a missionary named Sheldon Jackson (shown in the picture) arranged to bring 171 reindeer on a boat from Russia to the Seward Peninsula. The Inupiaq people who have lived in this region for centuries were suffering from new diseases and a lack of food. These changes were caused by the increasing number of whaling ships and white explorers that came to the area. Sheldon Jackson wanted to help the Inupiaq people by having them learn to herd reindeer as a source of food and money. More reindeer were brought to Alaska over the next few years and have been part of Alaska's culture and history ever since.

The Alaska reindeer population grew to more than 600,000 during the next forty years. It seemed as if Sheldon Jackson's plan was working.

But the reindeer herds could not keep growing forever. They overgrazed the range and began to starve.



—photo by Roy Corral

Wolves preyed upon reindeer, and some reindeer joined the migrating caribou herds. Many herders abandoned their animals because they could no longer sell the meat. More changes came to western Alaska villages during World War II. Reindeer herding became less important to village life.



—photo by Roy Corral

During the past twenty years, scientists at the University of Alaska Fairbanks have worked together with Seward Peninsula reindeer herders to learn more about how best to help reindeer in Alaska. They team up at summer and winter roundups. They weigh the animals, protect them from diseases, track their movements, study the food they eat, and monitor



—photo by Roy Corral

weather patterns and other factors that affect the reindeer's environment.

Researchers and villagers are also interested in finding ways to keep the traditions of reindeer herding alive in

villages today. Reindeer herding is hard work, but it is also rewarding. People take pride in managing a healthy herd, and enjoy sharing the wealth that a profitable herd brings. They enjoy the sense of community that comes from working together. They are proud to take care of Alaska's reindeer and land for future generations.

What Happens at a Reindeer Roundup?



These reindeer are foraging on their open tundra range.

This is a reindeer corral and processing station.

A helicopter is used to herd the reindeer toward the corral, up to thirty miles away.



One helicopter in the air can do the work of many people on the ground.

Once the reindeer are in the corral, they are funneled into smaller and smaller pens.



—photo by Roy Corral



—photo by Roy Corral

Reindeer are herd animals and they like to stick together when nervous or frightened. They are not dangerous.

Reindeer are moved through the corral system, which separates them into smaller groups.



Finally, one reindeer comes into the squeeze chute. The reindeer is squeezed lightly in this soft chute and remains calm while the work is done.

This fawn is being ear tagged. Ear tags help herders and researchers identify individual animals.



Reindeer are vaccinated against brucellosis, just like you are vaccinated against measles.



Researchers are putting a satellite collar on a female. They can track her movements by satellite over the Internet.



—photo by Roy Corral

This reindeer calf is heading for the hills to rejoin his mother. He is happy to be released from the corral.

Reindeer Herding in Alaska Quiz

Your name: _____

1. Who introduced reindeer to Alaska?
2. Name two ways in which the UAF Reindeer Research Program assists the reindeer herders.
3. Reindeer herders sometimes use a _____
to push the reindeer into a corral for a handling.
4. What holds an individual reindeer in place so it can be vaccinated?
5. How do researchers identify individual reindeer?

Reindeer Information Sheet

Reindeer are members of the **deer family** (Cervidae). Their scientific name is *Rangifer tarandus tarandus*. Reindeer were domesticated about 5,000 to 7,000 years ago by people living in northern Eurasia. Today, reindeer live throughout the Arctic in Russia, China, Finland, Sweden, Norway, and Alaska. They live in **herds** and are owned by people who raise them for meat and their hides. Some people also raise reindeer in a farm setting in parts of Alaska and the Lower 48 states.

Reindeer are **herbivores** or plant-eaters. They eat a variety of tundra plants in the summer, including willow leaves, sedges, and grasses. In the winter they eat lichen. Their wide **muzzle** (nose) helps them forage.

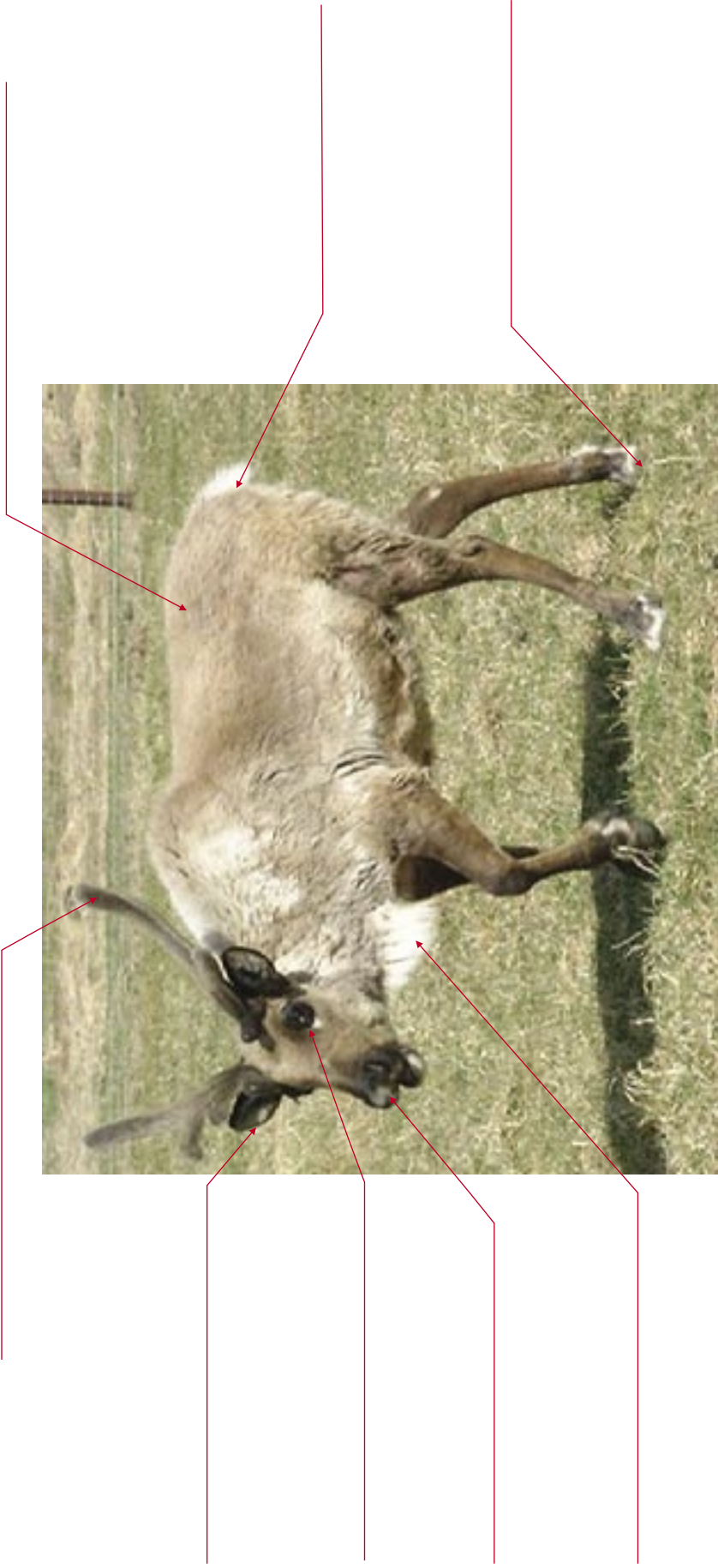
Reindeer are about four feet tall at the shoulder and about six feet long. Reindeer have a light brown and dark gray **pelage** (fur) in the winter that is very thick and warm. There are two types of pelage: **guard hairs** that are hollow to insulate the reindeer from the cold, and **wool hairs**, which are fine dense hairs growing close to the skin. In the summer they shed their guard hairs and have a dark brown pelage.

Reindeer are unique in the deer family because both males (**bulls**) and females (**cows**) grow antlers. The antlers are shed every year and a new set is grown. The growing antler is covered with **velvet**, a fuzzy skin tissue, which falls off once the antler is finished growing. Reindeer have large **hooves** that allow them to walk on the snow and dig in the ground and snow for food.

Now, label the reindeer!

Label the Reindeer

Primary



Antlers

Ear

Eye

White tail

Nose

Gray to brown fur

Hooves

White mane

Label the Reindeer

Intermediate



Velvet Antlers

Ear Tag

Dew Claws

Guard Hairs

Muzzle

Gray to brown pelage

Hooves

White mane

2. Website Scavenger Hunt

Grade 5 - 9

Subject Computer Science

Duration 30-45 minutes

Alaska State Standards T.A.1, T.B.1, S.A.15

Cultural Standards for Students E.2

Cultural Standards for Educators B.3, C.3

Instructional Goal

Students will explore a local science research program using a computer to retrieve and identify information.

Performance Objectives

Students will be introduced to the reindeer industry and the Reindeer Research Program website. Students will locate information necessary to complete and answer questions about reindeer in Alaska using a computer.

Materials

Internet access for each student or pair of students

Website Scavenger Hunt worksheet for each student (photocopy master on page 51)

Background

This exercise is designed to be an introductory lesson on Alaska's reindeer industry and the university's Reindeer Research Program. Students may find some unfamiliar terms and phrases on the website, but through further study they should become familiar with the words and topics.

Procedure

1. Pass out the **Website Scavenger Hunt** worksheet to each student (this activity may be completed in pairs or individually).
2. Have the students access the Reindeer Research Program's website: <http://reindeer.salrm.uaf.edu>



Two female reindeer. Both male and female reindeer grow antlers.



: Reindeer and caribou are the same species, but are different subspecies.

3. Have the students find the answers to the questions on the worksheet by scrolling through the website (Hint: scroll down to the General Information section and the Reindeer Facts and History links, where most of the answers can be found).

Extensions

1. Have a scientist or researcher from the University of Alaska Fairbanks Reindeer Research Program visit the classroom and discuss reindeer research projects or give an overview about reindeer and the Reindeer Research Program.

Assessment

Correct or complete the worksheet in the computer lab, if time allows. Have each student describe where they found the correct answers, allowing students to correct their work as they hear the answers given.

Answers to the Website Scavenger Hunt worksheet:

1. Antlers
2. Dr. Sheldon Jackson
3. As pack animals to carry supplies, mail, or passengers along the Yukon during the Nome gold rush; hides for shelter or clothing; antlers sold to Asian markets
4. Grizzly bears, foxes, wolves, wolverines
5. Restricted ownership of reindeer to Native Alaskans
6. Lichen
7. Protein and fat
8. 6.64 kg or 14.61 lbs
9. Reindeer are a semidomesticated Rangifer. Although similar, there are fundamental differences between reindeer and their wild cousins, caribou. Reindeer are shorter and stouter. Reindeer bulls are smaller than caribou bulls, but cows may weigh the same as caribou cows. Although coloration differences may be too subtle to notice between many reindeer and caribou, reindeer tend to be lighter with occasional pinto or white hair coats. The nose bridge, or face, of reindeer is flatter than caribou. Reindeer tend to stay in more cohesive groups. When herded or chased they tend to run in a tight group, while caribou often scatter. These traits are the result of domestication, which took place over 5,000 years ago.
10. 43 inches

Website Scavenger Hunt

Reindeer Research Program
<http://reindeer.salrm.uaf.edu>

Use the website above to find the answers to the following questions.

1. Reindeer and caribou are the only members of the deer family where males and females grow _____ each year.

2. Who introduced reindeer to Alaska?

3. Besides food, name another use for reindeer.

4. Name two predators of reindeer.

5. What did the Reindeer Act of 1937 do to change the policy of reindeer ownership in Alaska?

6. What is the largest part of a reindeer's diet on the Seward Peninsula?

7. Reindeer milk is high in _____
and_____.

8. On average, how much does a female reindeer weigh at birth?

9. Name two ways a reindeer is different than a caribou.

10. How tall is an adult male reindeer?

11. Write down three reindeer facts not covered in the above questions:

3. Reindeer vs. Caribou

Grade 3 - 6

Subject English, Science

Duration 1 hour

Alaska State Standards E.C.3, S.A.12

Cultural Standards for Students E.2

Cultural Standards for Educators B.3, C.3

Instructional Goal

Students will group items according to various characteristics and understand the similarities and differences between *Rangifer* species in Alaska.

Performance Objective

Students will compare and contrast reindeer and caribou using a Venn diagram.

Materials

Reindeer and Caribou Fact Sheet for each student or group of students (photocopy master on page 56)

Venn diagram for each student or group of students (photocopy master on page 57)

Overhead copy of Venn diagram (photocopy master on page 57), if desired

Background

Reindeer (*Rangifer tarandus tarandus*) are a semidomesticated *Rangifer*. Although similar, there are fundamental differences between reindeer and their wild cousins, caribou (*Rangifer tarandus granti*). In Alaska, most of the reindeer are free ranging on the Seward Peninsula and face the same dangers as wild caribou, such as predators, disease, and bad weather conditions. Reindeer are shorter and stouter. Caribou have longer legs made for migrating, whereas reindeer are more sedentary. Reindeer bulls are smaller than caribou bulls, but cows may weigh the same as caribou cows. Both reindeer and caribou have antlers; in fact, these are the only two members of the deer family in which both males and females grow antlers. Female reindeer grow larger antlers than female caribou. Although coloration differences may be too subtle to notice between many reindeer and caribou, reindeer tend to be lighter, with occasional pinto or white hair coats. Reindeer have thicker, denser fur than caribou, although both have hollow guard hairs that keep them warm in northern climates. The nose bridge, or face, of reindeer is flatter than caribou. Reindeer begin the breeding season about two to four weeks earlier than caribou. This results in reindeer calves being born at the end of April, while caribou calves are born at the end of May. Both reindeer and caribou have hooves that can be used as snowshoes for walking on the snow and for digging. Reindeer tend to stay in more cohesive



: Reindeer were domesticated over 5,000 years ago.



Reindeer are docile creatures and easily herded by humans.

groups. When herded or chased, they tend to run in a tight group, while caribou often scatter. These traits are the result of domestication. It is believed reindeer have been domesticated in Eurasia for at least 5,000 years, which is longer than the horse. In Eurasia, reindeer are classified as either domesticated or wild. Only in North America are indigenous (wild) *Rangifer* called caribou.

Procedure

1. Pass out a copy of the **Reindeer and Caribou Fact Sheet** and the Venn diagram to each student or group of students.
2. As a class, go over the fact sheet. Discuss and decide where each fact would be placed on the diagram. Write the facts in the appropriate space on the overhead.
3. Each group of students or individual student will read, cut out, and glue the reindeer and caribou facts in the appropriate category on their Venn diagram sheets.

Extensions

1. Have a researcher from the University of Alaska Fairbanks Reindeer Research Program visit the classroom with a live reindeer and talk about the differences and similarities of reindeer and caribou.

2. Use the reindeer props included in the **Reindeer Roundup! Educational Kit** to demonstrate similarities and differences between reindeer and caribou.
3. Have a Native elder or local reindeer herder visit the classroom and discuss how they perceive the differences between reindeer and caribou and their experiences with each.

Assessment

Each student or group of students will complete the following compare/contrast statements:

A reindeer _____ , but a caribou _____

A reindeer and a caribou both _____





Reindeer and Caribou Fact Sheet



Reindeer:

Caribou:

Domesticated

Group up when herded

Shorter legs

Round body

April born calves

Denser fur

Wild

Spread out when approached

Longer legs

Lean body

Late May born calves

Fur not as dense



Both:

Hooves like snowshoes

Hooves used for digging

Lose antlers every year

Males and females have antlers

Guard hairs provide insulation

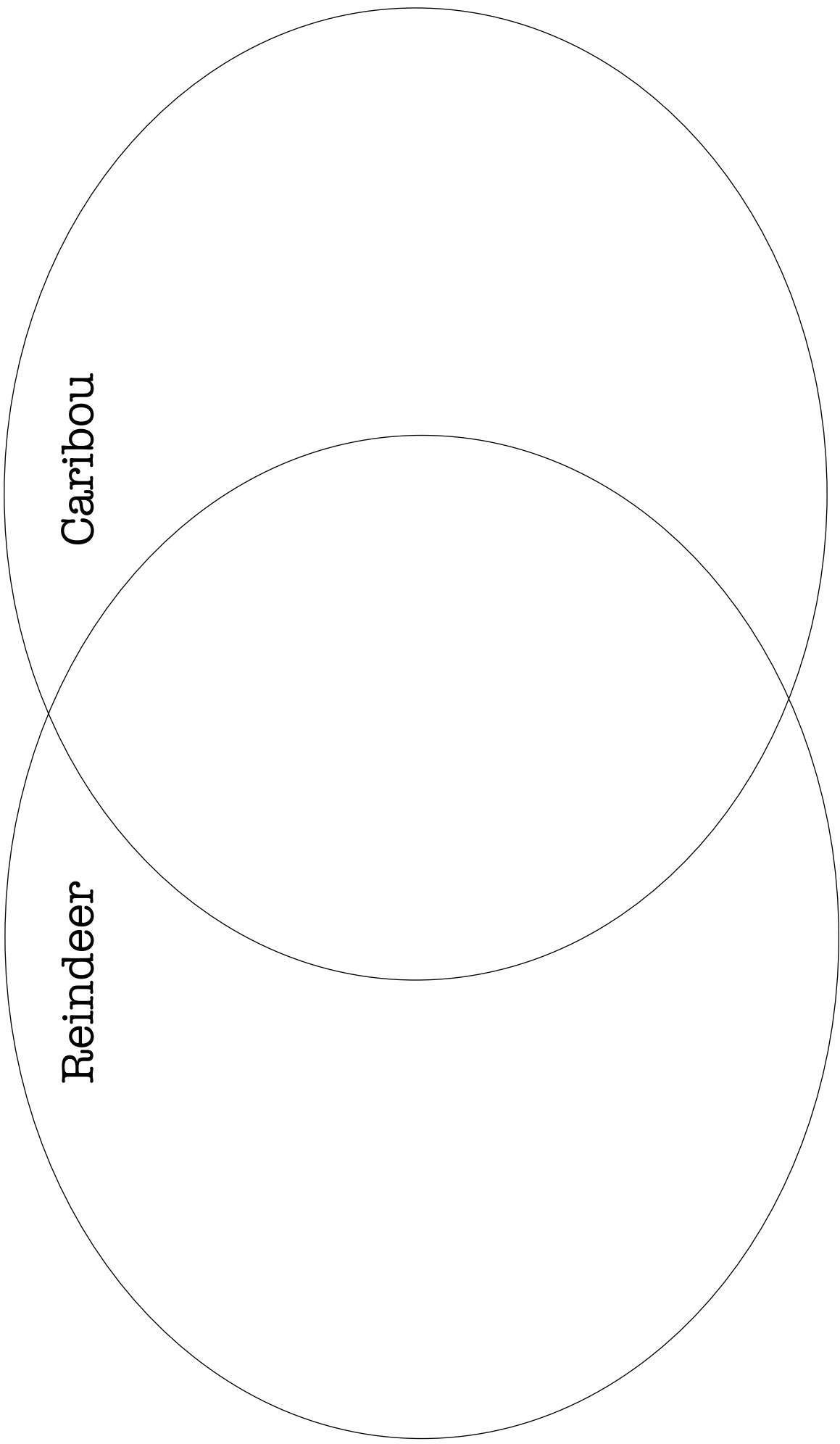
Eat lichen during winter

Hunted by bears and wolves

Northernmost member of deer family

Compare / Contrast Reindeer and Caribou

How are reindeer and caribou the same and different?



4. History of Reindeer in Alaska

Grade 5 - 9

Subject History

Duration 2 hours

Alaska Content Standards H.B.3, H.C.3

Cultural Standards for Students A.3, E.5

Cultural Standards for Educators B.3, B.4, E.5

Instructional Goal

Students will gain a historical understanding of the history of the reindeer in Alaska, explore various cultural lifestyles, and synthesize historical information in chronological order.

Performance Objective

Students will listen to or view an account of the history of reindeer in Alaska. Students will identify important events and complete a timeline.

Materials

PowerPoint slide show entitled *History of Reindeer in Alaska* (on the *Reindeer Visual Aids* CD-ROM)

Reindeer History Timeline worksheet for each student (photocopy master on page 60)

Video, *The Reindeer Queen* (included in this kit)

Background

By the late 1880s, there were reports of starving Alaska Native populations in western Alaska due to the decimation of marine mammals from the whaling industry and scarce numbers of caribou. Dr. Sheldon Jackson, a U.S. general agent for education and a Presbyterian missionary, lobbied for federal monies to assist Alaska Natives. He built mission schools and in the late 1800s introduced reindeer into Alaska from Russia as a source of protein and revenue. Reindeer were brought to Alaska on Captain Healy's U.S. Revenue Cutter, the *Bear*. Siberian herders and then Saami herders were brought to western Alaska to teach Native Alaskans



Mary Antisarlook, or "The Reindeer Queen," was the first Native Alaskan woman to own reindeer.

—photo from *Where Did Reindeer Come From?*, by Alice Postell, 1990, p. 33

how to herd reindeer. The reindeer industry grew until there were over 600,000 animals present in the 1930s. Mismanagement and losses to wolves and caribou sparked a dramatic decline to only 50,000 reindeer by the 1950s. The Reindeer Act of 1937 allows only Alaska Natives to own reindeer. Today there are approximately 30,000 throughout the state and 20,000 in western Alaska, with most living on the Seward Peninsula and in island herds.

Procedure

1. Show your class the *History of Reindeer in Alaska* slide show using the accompanying slide index in **Appendix B** on page 170 for assistance, or create your own slide show using the same pictures found on the *Reindeer Visual Aids* CD-ROM.
2. Pass out the **Reindeer History Timeline** worksheet and have the students complete it during the slide show presentation or afterward.
3. Discuss the historical significance of the events on the timeline worksheet.
4. Show the video, *The Reindeer Queen*.

Extensions

1. View the oral history Jukebox CD-ROM, *Reindeer Herding in Alaska*, included in this kit. Assign groups of students different reindeer herders listed on the CD. Have each group summarize the herders' history and involvement in the reindeer industry in a short report.
2. Use the oral history Jukebox CD-ROM, *Reindeer Herding in Alaska*, in other ways for further study and research.
3. Have a reindeer herder or Native elder visit your classroom and discuss their experiences with reindeer and reindeer herding.

Assessment

Accurate completion of worksheet—see answers below.

Quiz—from the events on the timeline, choose five and record them out of order on a paper or the board for the students. The students must number them in chronological order.

Answers to the history timeline worksheet:

- | | |
|---------------|----------|
| 1892 – K | 1930 – C |
| 1894 – E | 1937 – I |
| 1900 – D | 1950 – G |
| 1901 – H | 1968 – A |
| 1908-1914 – F | 1981 – J |
| 1914-1929 – B | |



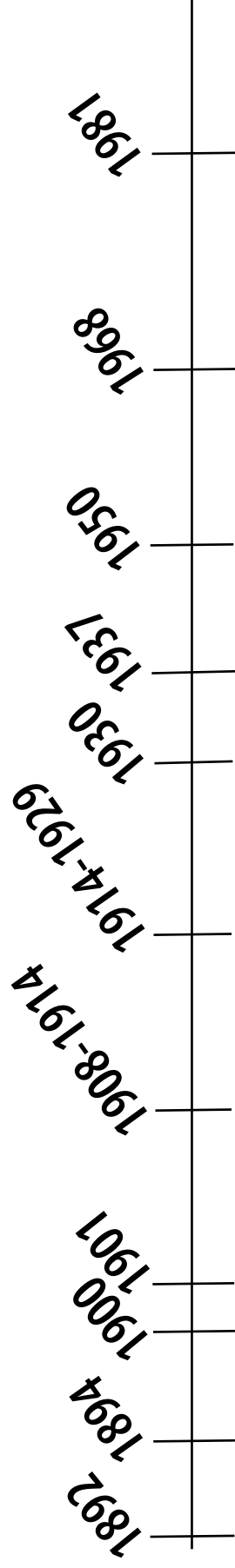
Reindeer History Timeline

Complete the timeline by placing the letter of each event below the correct year.

- A.** The Bureau of Indian Affairs takes over issuing range permits.
- B.** Lomen Brothers had successful reindeer business.
- C.** Over 600,000 reindeer in Alaska
- D.** Gold is discovered in Nome
- E.** Saami herders arrive in Alaska to assist Native Alaskan herders
- F.** Increase in Native reindeer ownership
- G.** 25,000 reindeer in Alaska due to wolves, caribou and disorganized herding.
- H.** Mary, the Reindeer Queen, has Alaska's largest herd.
- I.** The Reindeer Act is passed.
- J.** The Reindeer Research Program at UAF is formed.
- K.** Sheldon Jackson brings reindeer to Alaska.



—photo from *Where Did Reindeer Come From?*, by Alice Postell, 1990, p. 40



5. Reindeer Numbers

Grade 5 - 8

Subject Mathematics, History, Geography

Duration 45 minutes

Alaska State Standards M.A.6, M.C.1, H.A.1, G.A.1

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

The student will use graphs, charts, and tables to organize, record, and present data that is historically and geographically relevant.

Performance Objective

Students will demonstrate the ability to translate data into a circle, line, or bar graph, work cooperatively in a group setting, and accurately explain data in a graph form on historical and geographic reindeer information.

Materials

Large pieces of butcher paper or graphing paper for four groups of students

Graphing Data overhead (page 63)

Background

Scientists and researchers often use graphs to express information, and to look for patterns and relationships. Graphing and interpreting data and numbers is an important skill in many fields of study.

The population of reindeer in Alaska has dramatically changed over the last 100 years. With 1,000 reindeer arriving in Alaska by boat from Russia in the 1890s, the population expanded to over 600,000 animals by the 1930s. Changes in management, bad winters, predation by wolves, and the invasion of caribou contributed to the dramatic decline in reindeer numbers by the 1950s. Currently, there are about 30,000 reindeer in Alaska, with about 20,000 located on the Seward Peninsula. Reindeer also inhabit some islands (St. Lawrence, Nunivak, Adak, Umnak) and some live in fenced herds along the road system. Worldwide, reindeer live in Russia, China, Scandinavia, Alaska, and some privately owned fenced herds in the Lower 48. Most reindeer live in Russia and the Scandinavian countries (Norway, Sweden, Finland).



Alaska's reindeer population has fluctuated over the past 100 years. Currently, there are 30,000 reindeer living in Alaska.

Procedure

1. Review the purpose and use of line, circle, and bar graphs for expressing information.
2. Show the **Graphing Data** overhead and discuss which data would be appropriate for a line graph, circle graph, or bar graph. Note that the same data can be graphed in many different ways and still communicate the information. For example, the historical reindeer population data could be graphed as a line graph or a bar graph. The percentage of reindeer that live in various countries could be graphed as a circle graph or a bar graph.
3. Each group will be assigned a group of data and the type of graph to be created. Since there are only two data sets, two groups will be graphing the same data, but in different ways (either a line, bar, or circle graph).
4. Work with each group to create the appropriate scales and labeling for each graph.
5. When all the graphs are finished, have each group present their graph to the class.

Extensions

1. Graph the data on a computer using graphing software.
2. Have a scientist from the Reindeer Research Program visit the classroom and present some scientific graphs of reindeer data to the class for discussion and questions and answers.
3. Look up on a globe or atlas the different countries where reindeer live and research the reindeer herding cultures found there. How do they compare to reindeer herding in Alaska?

Assessment

Students will write a summary statement comparing the different types of graphs used to express the same data.

Graphing Data

Alaska Reindeer Population¹

Year	Number of Reindeer
1892	1,280
1900	3,320
1901	4,164
1902	6,505
1905	10,000
1913	47,266
1929	400,000
1932	640,000
1940	250,000
1948	24,529
1950	25,000
1958	35,704
1968	28,819
1977	17,800
2003	30,000

Worldwide Reindeer Distribution

Russia	74%
Norway	10%
Sweden	8%
Finland	6%
Alaska	1%
Greenland	0.5%
China	0.25%
Lower 48 states	0.25%

1. Stern, Richard, O., Edward, L. Arobio, Larry L. Naylor, and Wayne C. Thomas. *Eskimos, Reindeer, and Land*. Agricultural Experiment Station, School of Agriculture and Land Resources Management, University of Alaska, Bulletin 59. 1980.

6. Traditional Uses of Reindeer

Grade 3 - 12

Subject English, History, Geography, Art

Duration 1 – 3 hours

Alaska State Standards E.C.2, G.E.1, H.B.1, A.B.1,

Alaska Cultural Standards for Students D.1, E. 2

Alaska Cultural Standards for Educators A.2, A.4, B.3, C.3

Instructional Goal

Students will understand how humans and the environment interact through a regional resource use; they will comprehend and recognize the historical development of Native Alaskan culture as it relates to reindeer; they will apply strategies to organize and complete a project.

Performance Objective

Students will learn about the historical and traditional uses of reindeer. Advanced students will sew a mitten, traditionally made of animal fur and skin, based on a pattern similar to one used by Native Alaskans.

Materials

Primary level: **Traditional Uses of Reindeer** worksheet for each student (photocopy master on page 67), **Reindeer Skeleton** handout (photocopy master on page 68)

Advanced level: **Reindeer Skeleton** handout (photocopy master on page 68), **Mitten Sewing Instructions**, **Mitten Pattern**, and **Lining Pattern** for each student (photocopy masters beginning on page 69), fabric, scissors, needles, thread

Background

Reindeer and caribou have been an important resource for people of the circumpolar north for tens of thousands of years. Reindeer and caribou have provided people with a year-round source of food and other products essential for survival. Domesticated reindeer have also been used as pack animals and draft animals for pulling sledges.

Reindeer meat is very nutritious and tasty. In addition to eating the meat, many of the organs are valued and eaten as well, such as the tongue, kidneys, brain, eyes, heart, and liver. The blood is drunk in some cultures. The tallow or fat is eaten and used in recipes such as Eskimo ice cream (see lesson on page 74). The tallow can also be burned as a light source. Hard antlers and bone are used to fashion utensils, tools, and decorative objects. Bone is boiled and the marrow is extracted for food.

Velvet antler is harvested in the summer during roundups and sold to Asian markets for medicinal use (see lesson on page 77). The back sinew makes excellent thread. Reindeer milk is high in fat and is used in some cultures to make butter and cheese.

Reindeer hides provide a raw material that can be fashioned into clothing, mukluks, blankets, mittens, tents, boat coverings, sleeping bags, house coverings, and used as an insulating material. Hides from fawns are most desirable for making mukluks, while adult hides are often used for parkas. The hair can be removed from the hide and eaten; this has saved some groups from starvation when food was short. The skin is also used in drum coverings and as a canvas for drawings.

In addition to food and clothing, reindeer in Alaska were used to carry supplies, passengers, and mail along the Yukon River. Dog teams were more expensive, because food had to be carried for them, whereas reindeer could graze freely. The 1898 gold discovery in Nome brought large numbers of people to the area. Reindeer became an even more important source of meat and the demand grew. By 1900, additional reindeer meat had to be purchased from Siberia to feed the people in Nome. In 1899, Sheldon Jackson ran the first postal reindeer route, from St. Michael to Kotzebue. A route was also run from Eaton Station (near Unalakleet) to Nome. A reindeer could travel only 30-50 miles carrying 200-300 pounds, so relay stations were needed every 50 miles. The deer were harness trained and the Saami people in the area made the sleds used to carry the mail.



A practical resource is: Wilder, Edna. *Secrets of Eskimo Skin Sewing*. Fairbanks: University of Alaska Press, 1998 (reprint edition). This book contains clear, simple instructions for stretching, cutting, and sewing furs into a variety of useful garments. It contains patterns, black and white sewing diagrams, and color photos of completed objects. This book is used at the University of Alaska as the textbook for its skin sewing class.

Procedure

1. Short introduction on the traditional and historical uses of reindeer. Historical pictures can be found on the **Reindeer Visual Aids** CD-ROM located in the **Reindeer Roundup! Educational Kit**.
2. Use the reindeer specimens found in the **Reindeer Roundup! Educational Kit** to demonstrate how each part of the reindeer is or was used.
3. Have primary level students complete the **Traditional Uses of Reindeer** worksheet.
4. Have advanced level students make their own pair of mittens, or in the interest of time and resources, have each student make one mitten and decorate it for display.

Extensions

1. Have an experienced skin sewer and/or seamstress visit your classroom and demonstrate some clothing or other items made from reindeer or caribou or other skins.



: Reindeer don't migrate long distances like caribou.

2. Have a Native elder or reindeer herder visit your classroom to share how they use or have used various reindeer products.
3. Cook some reindeer meat for the class to sample.
4. Have students compare their modern clothing that they use to stay warm in winter with clothing made from reindeer.
5. View the *Reindeer Herding in Alaska* CD-ROM from the UAF Jukebox series located in the **Reindeer Roundup! Educational Kit** for historical accounts of traditional uses of reindeer.
6. Have students bring in any items from home made from reindeer or caribou or other animals to share with the class.

Assessment

Knowledge of the uses of reindeer and accurate completion of the worksheet and/or mitten.

Answers to the worksheet:

Fat – Eskimo ice cream

Tongue – Delicacy

Skin – Drum covering

Hide – Parka

Sinew – Thread

Bone – Boiled to extract marrow

Antler – Tools

Milk – Cheese

Fawn hide – Mukluks

Velvet antler – Sold to Asian markets for medicinal use

Traditional Uses of Reindeer

—photo from *Where Did Reindeer Come From?*, by Alice Postell, 1990, p. 74



Draw a line to match the part of the reindeer in the left hand column with its traditional use in the right hand column.

Fat

Sold to Asian markets
for medicinal use

Tongue

Tools

Skin with no hair

Eskimo ice cream

Hide

Cheese

Sinew

Mukluks

Bone

Drum covering

Antler

Thread

Milk

Boiled to extract marrow

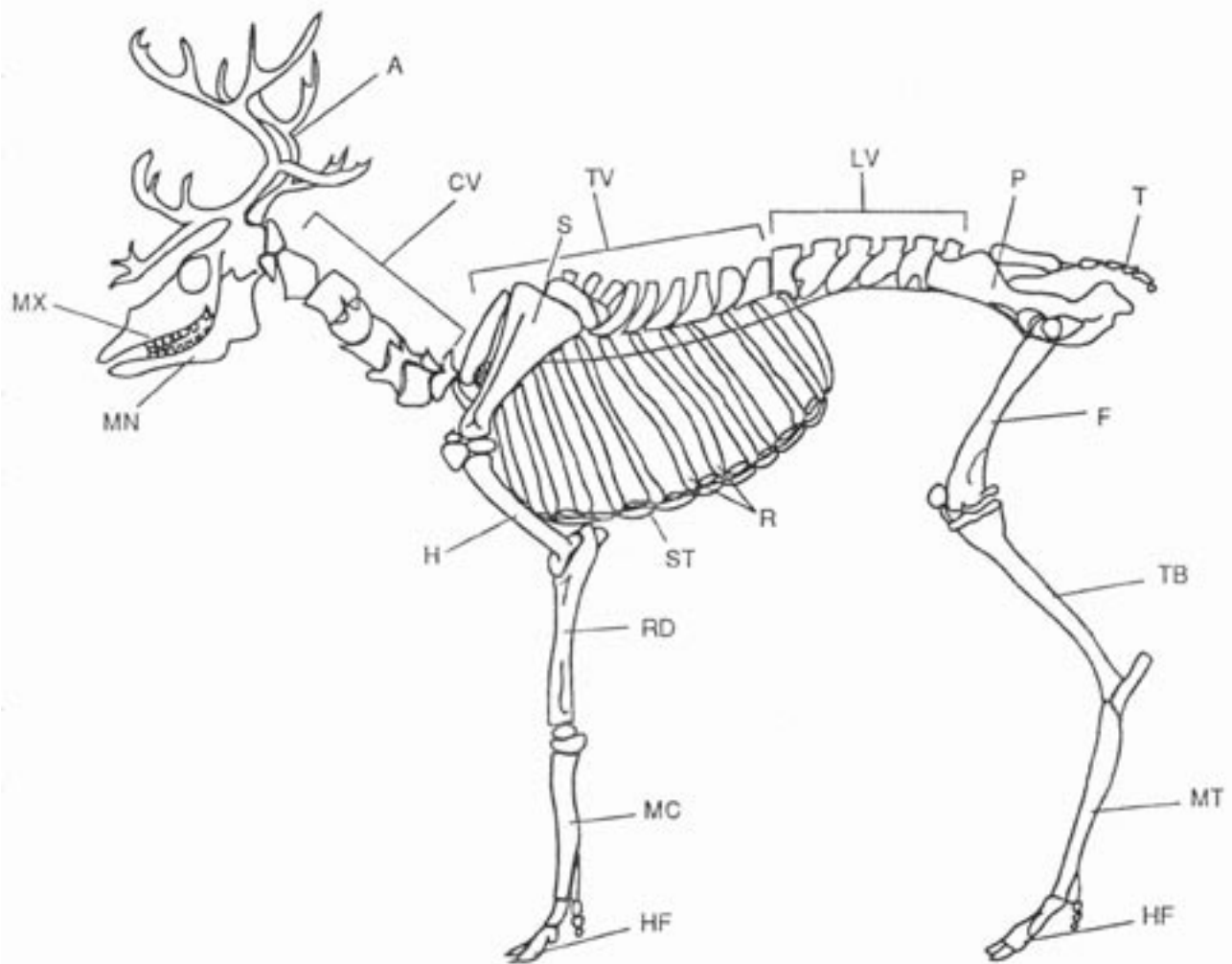
Fawn hide

Parka

Velvet antler

Delicacy

Reindeer Skeleton



KEY

A = antler	MX = maxilla
CV = cervical vertebrae	P = pelvis
F = femur	R = ribs
H = humerus	RD = radius
HF = hoof	S = scapula
LV = lumbar vertebrae	ST = sternum
MC = metacarpus	T = tail
MN = mandible	TB = tibia
MT = metatarsus	TV = thoracic vertebrae

Almost every part of the reindeer is used; even the bones are boiled to extract the marrow or carved into tools and decorative objects.

Mitten Sewing Instructions

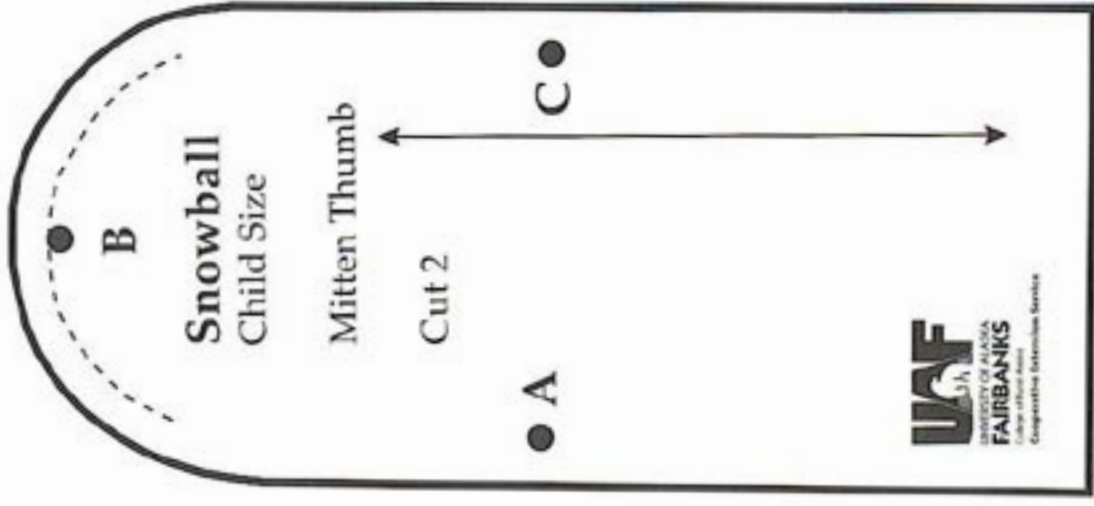
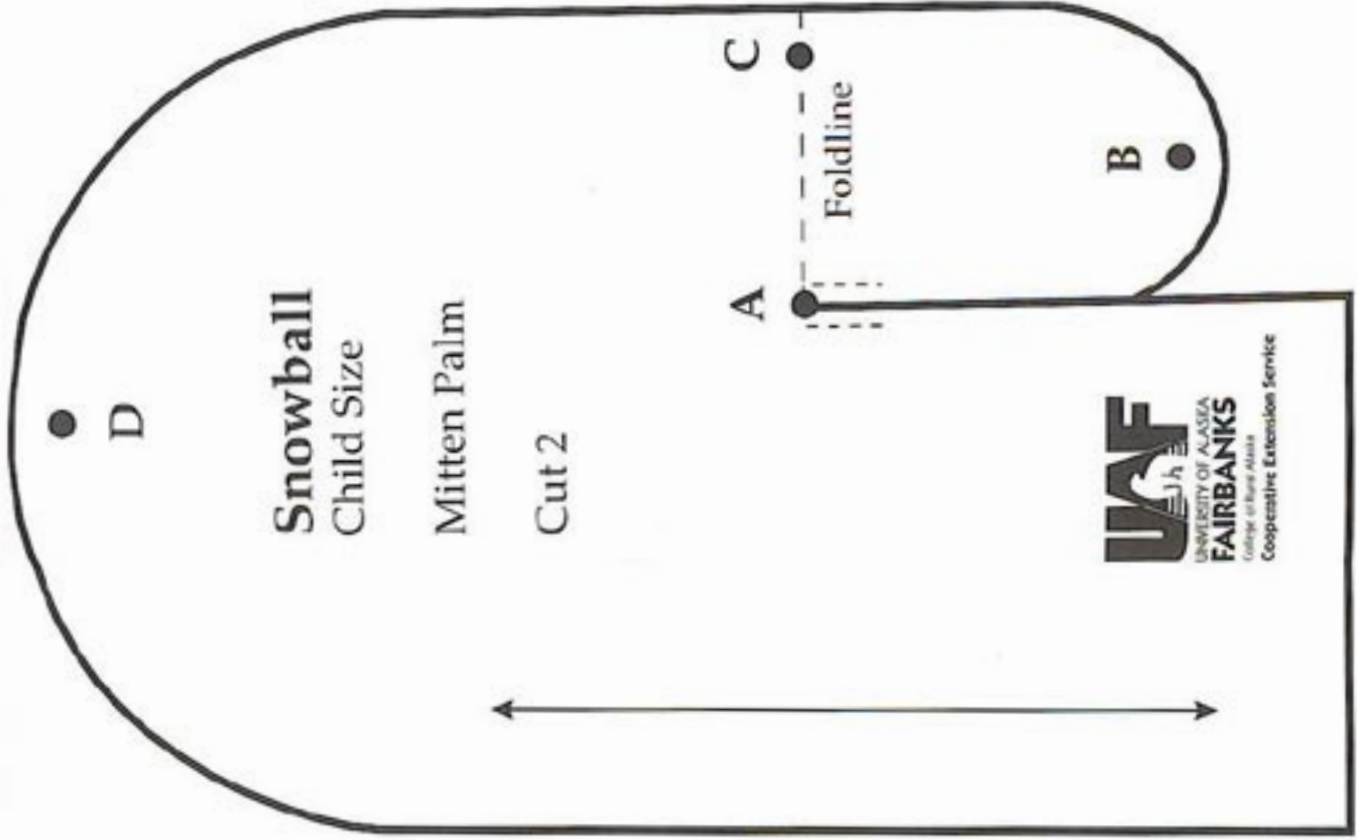
These instructions and sewing pattern are reprinted from the *Alaska Mittens* publication from the UAF Cooperative Extension Service. *Alaska Mittens* is available for purchase for \$3.00 from any UAF Cooperative Extension Service office and includes instructions and patterns for five different mittens.

1. Select your fabric. Some suggestions are listed below.

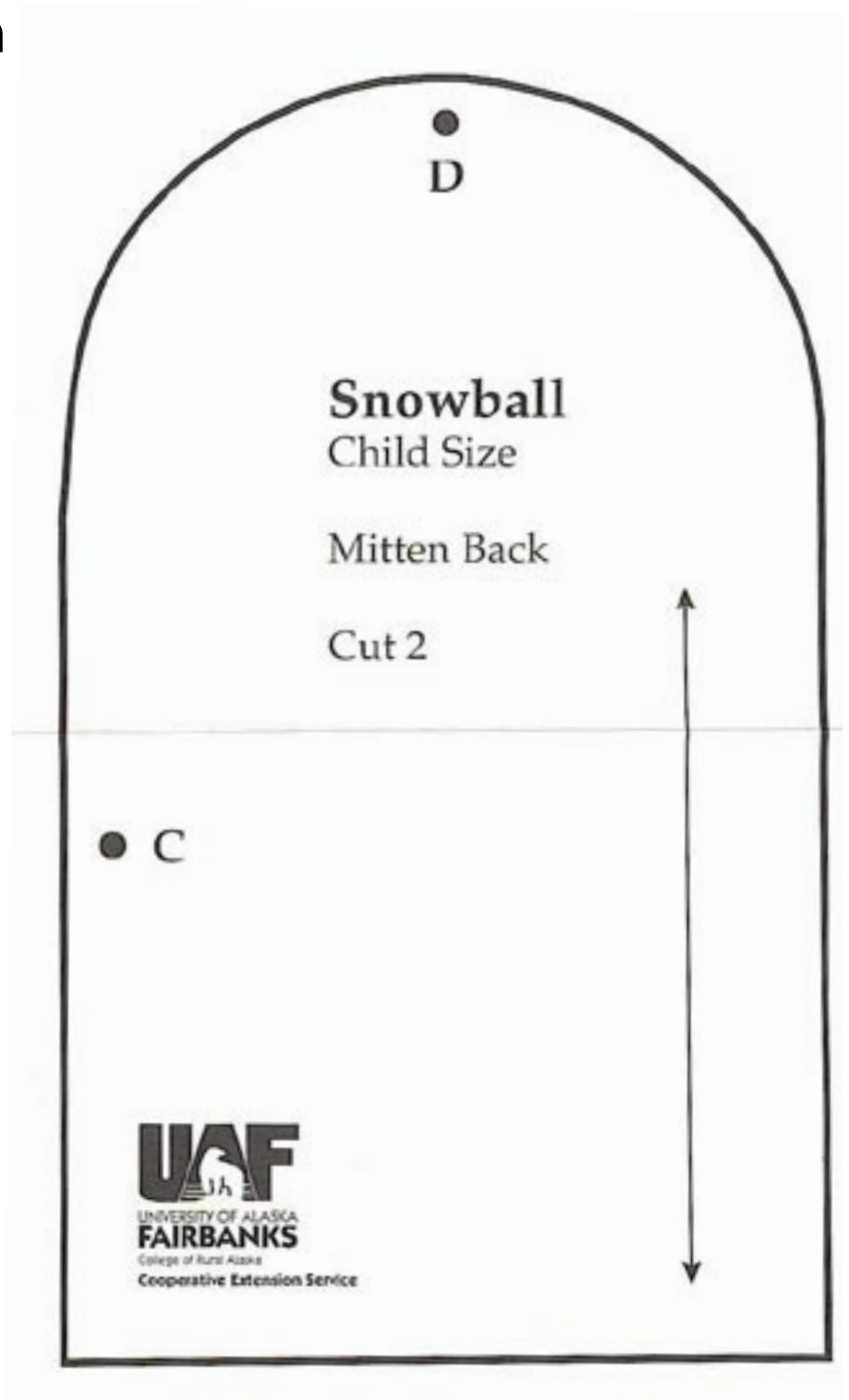
Outer material	Lining
Polar fleece	polar fleece
Corduroy	flannel
Lightweight wool	quilted fabric
Denim	double knit
Waterproof nylon	fur
Animal skin	

2. Cut out the paper pattern. Cut pattern to (•) at A along the solid line.
3. Place pattern on fabric. Pin in place and mark solid line separating thumb from palm. Cut out.
4. Using small stitches (20-22 stitches per inch), stitch to reinforce at (•) A. Cut along marked line to (•) at A.
5. To make thumb, fold thumb section of front pattern toward the fingertips along fold line.
6. Stitch a row of gathering stitches over top of each thumb piece.
7. Ease thumb piece to thumb on front pattern matching at B. Stitch the two pieces together starting at C. Stitch around thumb to A and continue to wrist edge using a 1/8-inch seam. Adjust stitch size as you near the sharp curve around A to 20 or more stitches per inch. The small stitches help reinforce this area. Repeat for the second mitten.
8. Fold each thumb to center of the mitten and pin to hold out of the way.
9. Place right sides of palm and back pieces together. Stitch 1/4-inch seam around entire mitten. Repeat for second mitten.
10. Construct linings using lining pattern and follow steps 1 - 9.
11. Turn mittens right side out but do not turn out linings. Slip a mitten over each lining; align seams and pin.
12. Finish wrist edges by hemming or add wristlets, if desired.

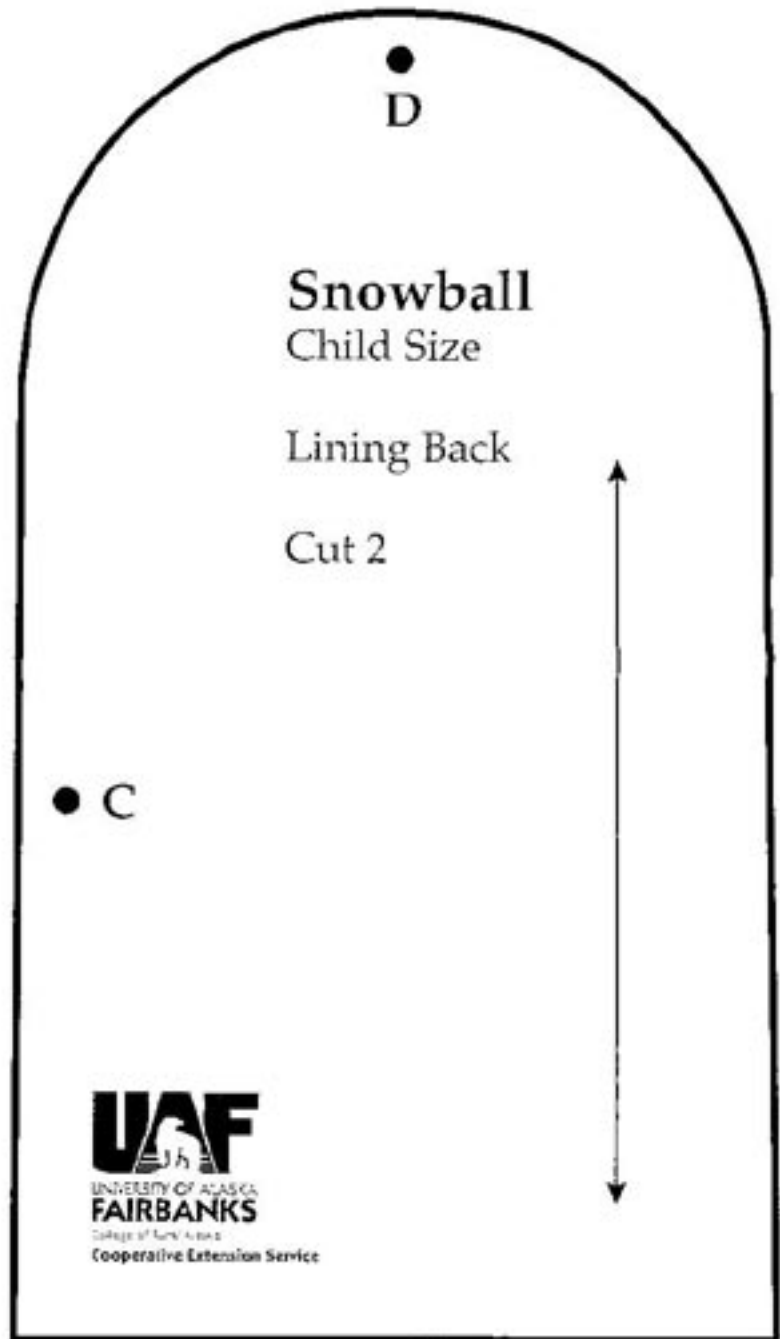
Mitten Pattern



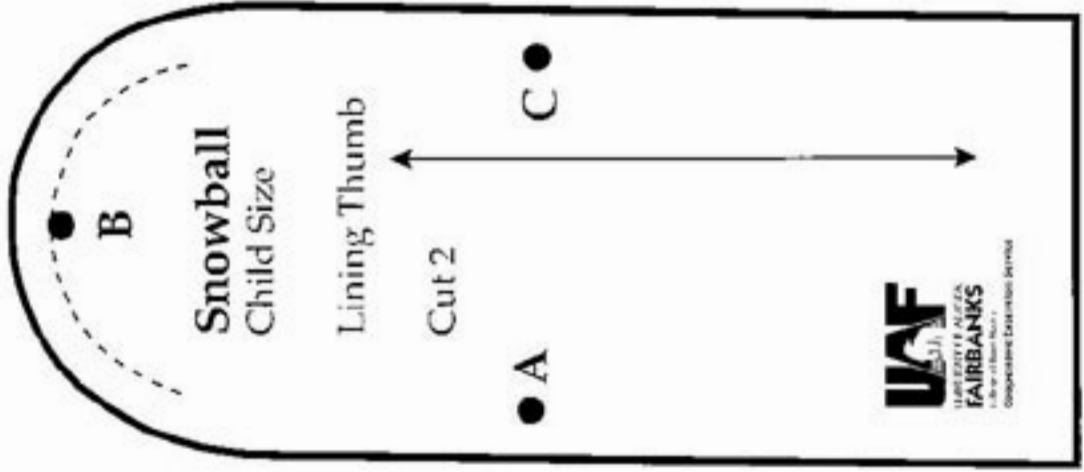
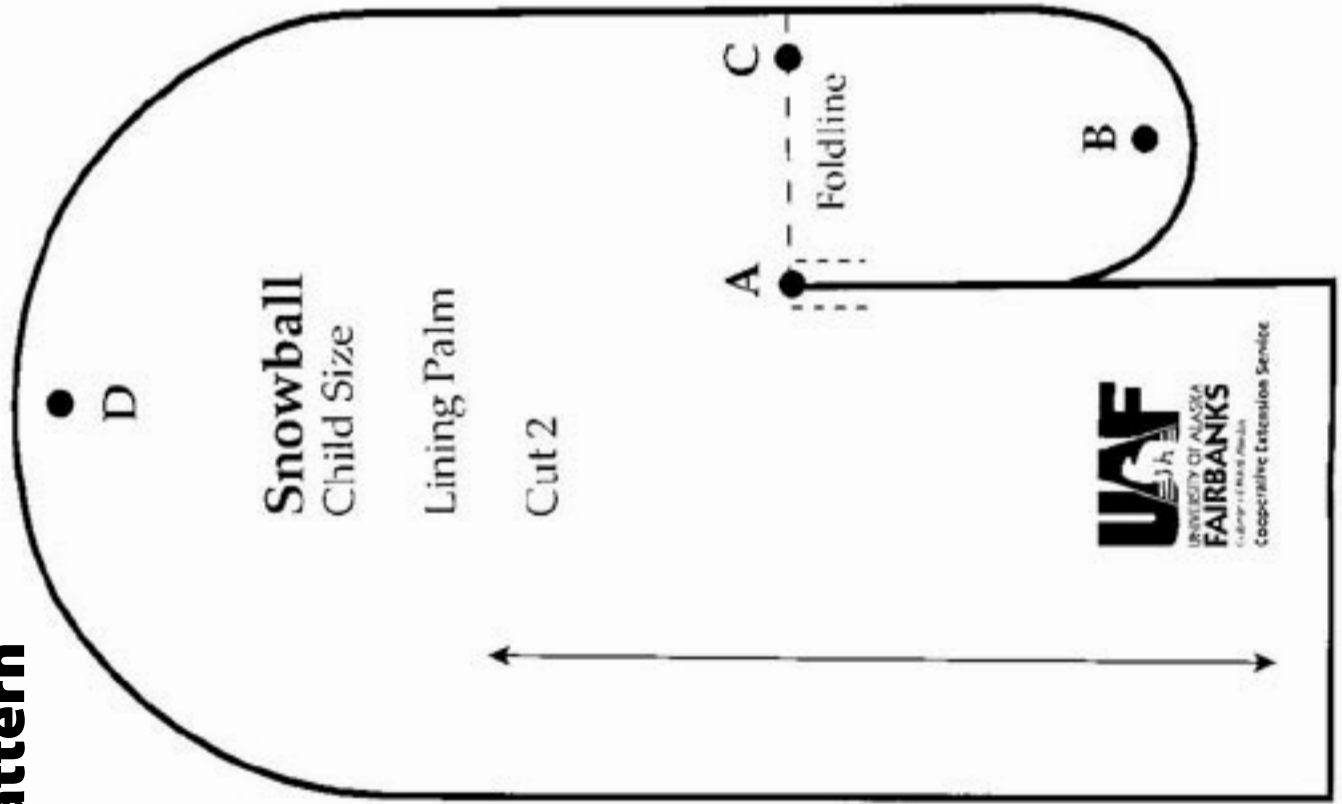
Mitten Pattern



Lining Pattern



Lining Pattern



7. Eskimo Ice Cream

Grade K - 4

Subject English, Reading

Duration 30 minutes

Alaska Content Standards E B.1, E A.3, G E.1, W B.2

Cultural Standards for Students B.2

Cultural Standards for Educators B.3, D.4

Instructional Goal

Students will comprehend written text and oral and visual information; they will demonstrate clear speaking skills. Students will understand how a local resource is used and they will learn some language and cuisine of the Inupiaq culture.

Performance Objective

Students will practice reading skills and follow a step-by-step process. Students will identify some Inupiaq words. Students will understand how a reindeer product is utilized through traditional knowledge.

Materials

PowerPoint slide show entitled *Eskimo Ice Cream*, located on the *Reindeer Visual Aids* CD-ROM.

Background

People have used reindeer and their products for over 5,000 years. Reindeer were first domesticated from their wild cousins thousands of years ago in Eurasia. Sheldon Jackson introduced reindeer to Alaska as a food source for Native Alaskans living along the western coast in the 1890s.

Reindeer are used for their meat, hide, antlers, fat, milk, and bone. Reindeer are also used for carrying loads or pulling sleds.

Akutaq or "the blended one, the mixture" is also known as Eskimo ice cream.

Eskimo ice cream is a favored delicacy that has been made by Native Alaskans for many generations, with differing recipes that vary by region. Dried tallow (fat) from reindeer, caribou, or moose is grated into small pieces and whipped with animal oil by hand into a light, creamy consistency. The animal oil is made from the blubber next to the skin of a seal, walrus, or whale. The blubber is cut into strips, stored in a large container and left to render into oil. Sugar, berries, or dried fish are added to this rich, high-calorie dish. In some regions, dried salmon eggs, greens, or fish liver is also



The Eaton Reindeer Station in 1900, near the village of Unalakleet.
—photo from *The Yukon Relief Expedition*, by V.R. Rausch and D.L. Baldwin, 2002, p. 153.

added. This food was traditionally made for funerals and potlatches. A traditional subsistence list of ingredients includes (taken from the *Eskimo Ice Cream* slide show):

- A pound of dried tallow from a reindeer (or caribou or moose)
- ½ cup of animal oil (from seal, walrus, or whale)
- ¾ cup of sugar
- ½ cup of water
- Blueberries, salmonberries, blackberries, cranberries

A more modern recipe uses the following ingredients for a single serving (from www.alaska.com):

- 1 cup berries
- ½ cup premixed raspberry yogurt
- Pinch of sugar
- 2-3 drops of lemon juice

Combine sugar, yogurt, and lemon juice. Whip with a wire whisk or in a blender. With a spatula or large spoon, carefully fold berries into the mixture. Serve immediately or chill in the bowl.

Procedure

1. Discuss the different ways people use reindeer and reindeer products.
2. Discuss what a step-by-step process is and how it applies to recipes.
3. Go through the *Eskimo Ice Cream* slide show as a class, either by reading the text aloud or having students take turns. If desired, use the recorded dialogue buttons on each slide to listen to a recording of the text.

Extensions

1. Make your own Eskimo ice cream as a class using the traditional or modern recipes listed in the **Background** section.



: Reindeer eat more during summer to put on fat and muscle mass for the winter.

2. Discuss other ways reindeer products are used.

3. Ask someone who speaks Inupiaq to visit the classroom to assist with the proper pronunciation of the Inupiaq words in the slide show, or have them teach you some new words.

Assessments

Ask students to name the ingredients in Eskimo ice cream. Ask students to define some uses of reindeer products. Ask students to name some of the ingredients in Inupiaq.

8. Velvet Antlers

Grade 5 - 10

Subject Science, Mathematics

Duration 45 minutes

Alaska State Standards S.A.12, S.A.14, S.B.1, G.E.2, M.A.4,

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Students will recognize a regional resource use and understand its ecology through the process of observing and interpreting data.

Performance Objectives

Students will understand the reindeer velvet antler industry and interpret data from a recent scientific study using tables, equations, and graphs.

Materials

Velvet Antler Worksheet for each student (photocopy master on page 81)

Background

Reindeer and caribou are unique in that both males and females grow antlers. Antlers are different from horns in that they fall off and regrow each year. Reindeer bulls usually lose their antlers sometime in December or January. Pregnant female reindeer lose their antlers about five days after they give birth and nonpregnant females lose their antlers in early spring. Even new calves grow a small set of antlers their first summer of life. As the new antlers are growing they are covered in a soft fuzzy tissue called velvet. Blood is pumped into the growing antler until it begins to ossify or harden into bone. Once the antler hardens, the velvet falls off. Each reindeer's set of antlers is unique in shape. Antler size usually increases each year.

Velvet antler from various deer species has been used for thousands of years by Asian cultures. Velvet antler is a desirable folk and tonic medicine in Korea, China, Hong Kong, Taiwan, Indonesia, and Mongolia. Velvet antler has many medical uses, but it is primarily used as an elixir or cure-all. Chinese medicine is based on the concept of Yin and Yang. The balance of these forces is fundamental in life's processes and they are mutually dependent. If an imbalance occurs, medication may be administered, often in the form of a velvet antler elixir. Velvet antler is not commonly used as an aphrodisiac, contrary to popular belief. Velvet antler is consumed for a variety of reasons, including kidney deficiencies, gastrointestinal disorders, cardiovascular disorders, sexual disorders in men,



: Antlers are different from horns in that they are shed and regrown each year.



In late summer, the velvet tissue that covers a growing antler falls off to reveal the full-grown bone antler.

and menstrual disorders in women. It has also been used to promote healing, to treat slow growth in children, weak bones, and cold hands and feet.

The production of velvet antler originates on commercial deer farms and reindeer herding operations throughout the world. Velvet antler from both males and females is harvested by reindeer herders on the Seward Peninsula during their summer roundups. The antler is then sold to the Asian markets. The antler is removed with manual shears and then it is stacked with the cut end up to avoid blood loss when it's placed in a cardboard box or container. After harvest, the antlers are transported to a freezer and frozen at -20°C . The frozen antler is sold and processed for consumption later. In 1996, velvet antler sales in western Alaska generated approximately \$564,000 for local economies.

Antler size is a factor in male reproductive success in many deer species, and antlers in female reindeer may be used to compete with other reindeer for food in winter. Researchers at the UAF Reindeer Research Program have determined factors that affect velvet antler weight, which is important economically and for the population dynamics of the herds. This research shows that velvet antler weight changes with age. Antler weights of lactating (nursing) females were lighter than nonlactating females, which could be due to the energy cost of pregnancy and lactation.



Harvested velvet antler from a summer roundup.

Procedure

1. Introduce the concept of antlers and the business of harvesting velvet antler on the Seward Peninsula. Show the sample of velvet antler included in the **Reindeer Roundup! Educational Kit**. Show pictures of reindeer in velvet (located on the *Reindeer Visual Aids* CD-ROM).
2. Review the purpose and use of line and bar graphs with appropriate scaling and labeling, and how they are used in scientific research.
3. Have each student complete the **Velvet Antler Worksheet**. Go over question 1 as a class for discussion and as an introduction to the topic.

Extensions

1. Have a researcher from the UAF Reindeer Research Program visit your class and give a talk about research that has been conducted on velvet antlers, showing graphs of additional data. Have them bring a reindeer to your classroom to discuss the ecology of antlers.
2. Graph the data on a computer using graphing software.
3. Show your class the slide show, *Adaptations of Reindeer to Life in the Arctic*, found on the *Reindeer Visual Aids* CD-ROM in the **Reindeer Roundup! Educational Kit**. This slide show contains a section on antlers. Use the slide index that corresponds with this slide show in **Appendix B** on page 170 for assistance.
4. Have a reindeer herder or farmer visit your classroom to discuss how the velvet antler industry has affected their herd management decisions and how it has changed over the years.



Assessment

Accurate completion of the worksheet. Students will write a summary statement comparing and contrasting the graphs they created.

Answers to the Velvet Antler Worksheet:

1. Antler growth in members of the deer family appears to be related to nutritional quality of the diet. Genetic factors and age also can affect antler growth. In reindeer on the Seward Peninsula, there is a significant positive relationship between antler weight and body weight. Antler size is usually the most practical way to measure genetic superiority. Selecting animals with lower antler weights for slaughter may increase the overall productivity of the herd, which is economically beneficial for the herder.
2. 2.21 kg for males, 0.62 kg for females
3. 0.68 kg for lactating females, 0.82 kg for nonlactating females.
4. Males have heavier antlers. In all members of the deer family, males grow large antlers mainly for reproductive success (to attract large numbers of females in a harem during the rut)
5. Male reindeer (or bulls) do not live as long in the wild as females. This is true for all deer family species. During the rut, bulls spend much of their time trying to gather females into a harem and chasing other bulls away, or fighting with them in competition for females. Males in rut spend little or no time eating, and therefore start the winter with low fat and energy reserves. Bulls can acquire more fat than females and generally are in prime condition in early fall, but they lose most of their fat during the rut. Once bulls pass the age of five or six, they are past their prime; the long winters and low energy reserves can take their toll, leaving the bulls weak, perhaps starving, and vulnerable to predators. Many bull reindeer do not survive past the age of eight.
6. Antler weights of lactating females are lower than nonlactating females because of the additional energy costs of pregnancy and lactation. Lactating females are not able to put as much energy or resources into antler growth.

Velvet Antler Worksheet

Use the following data tables of age and velvet antler weights to answer the questions and create the graphs.

Male Antlers		Female Antlers	
Age	Weight (kg)	Age	Weight (kg)
1	0.50	1	0.37
2	1.34	2	0.45
3	2.29	3	0.52
4	2.76	4	0.58
5	2.87	5	0.65
6	2.72	6	0.66
7	2.96	7	0.69
		8	0.71
		9	0.76
		10	0.76

Lactating Female Antlers		Nonlactating Female Antlers	
Age	Weight (kg)	Age	Weight (kg)
1	0.45	1	0.40
2	0.45	2	0.57
3	0.50	3	0.64
4	0.58	4	0.68
5	0.65	5	0.67
6	0.69	6	0.70
7	0.70	7	0.80
8	0.75	8	0.88
9	0.77	9	0.91
10	0.80	10	1.10
11	0.70	11	1.40
12	0.90	12	0.95
13	0.85	13	0.93
14	0.70		

1. The data on the page is real antler weight data from a research project conducted by the UAF Reindeer Research Program. Why is this information important for a reindeer herder? What can antler weights tell you about your herd?

2. Calculate the average antler weight of male and female reindeer on the Seward Peninsula.

3. Calculate the average antler weight of lactating and nonlactating female reindeer on the Seward Peninsula.

4. Create a line graph that illustrates male and female velvet antler weights at various ages. Which group has heavier antlers? Why?



5. Create a bar graph comparing male and female velvet antler weights at various ages. Why are there not as many data points for male reindeer as for female reindeer?

6. Create a graph, either a line graph or a bar graph, comparing lactating and nonlactating female antler weights. Which group has heavier antlers? Why?

9. What Do Farmed Reindeer Eat?

Grade 6 - 10

Subject Mathematics, Science

Duration 45 minutes

Alaska State Standards M.A.1, M.A.3, S.A.15

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Students will understand fractions, decimals, and percents, perform basic arithmetic functions, and understand reindeer nutrition.

Performance Objectives

Students will solve problems by converting between fractions, decimals, and percents on a topic of local significance.

Materials

Reindeer Feed Calculations Worksheet for each student (photocopy master on page 90)

Overhead copy of the feed recipe shown at the top of the **Reindeer Feed Calculations Worksheet** (photocopy master on page 90).

Background

Reindeer are ruminants, as are all members of the deer family. Ruminants have a four-chambered stomach, each with a special function in digesting food. Food enters the first chamber, the reticulum, then the rumen, the omasum, and finally the abomasum, before entering the small intestine. Each of the four chambers performs a different function in the digestion of plants and lichen that the reindeer ingests. Food first passes back and forth between the reticulum and the rumen. The reticulum has a honeycomb-shaped lining that is able to strain finer food particles from coarser ones. The rumen is unique to animals that eat grasses, plants, and lichen. These food items contain a material called cellulose that is indigestible to animals, including humans. Inside the rumen are live bacteria that can break down cellulose compounds into a form usable by the body. Reindeer could not survive on plants and lichen without this bacteria in the rumen.

Undigested coarse food in the rumen and reticulum is brought back to the mouth and rechewed. Enzymes in the reindeer's saliva help to further break down this tough cellulose material (sometimes called cud). Once it is swallowed again, it is further digested in the rumen and reticulum and then

passes into the omasum. The lining of the omasum has many folds that look like leaves. Food is ground further and the body absorbs water from the food. Food then passes to the abomasum or true stomach. This chamber is similar to our stomach, in which acidic juices digest the food and pass it on to the small intestine.

All *Rangifer* species (reindeer and caribou) exhibit an annual weight-loss, weight-gain cycle in which they gain weight during summer and lose weight during winter. They have a large appetite in summer and a small appetite in winter. This is an adaptation to living in the Arctic. In the summer, there is much green, protein-packed tundra vegetation that is available for reindeer to eat, and during this period they must acquire all of the protein they will need for the whole year. They are also putting on muscle mass for the upcoming winter months. During the long winter, the only thing available for reindeer to eat is lichen. Lichen contains no protein, fat, or minerals, just carbohydrates. Reindeer dig through the snow for lichen and live off of the fat reserves they built up during the summer. Reindeer are less active during winter, as they are trying to conserve heat and energy. Interestingly, the reindeer that live at the UAF reindeer research farm also exhibit this weight-gain, weight-loss cycle and have an increased appetite in summer and a decreased appetite in winter. This is amazing because the farm reindeer are fed a high-energy diet and are given as much to eat as they want!



These farmed reindeer eat a high-energy diet formulated to contain 18% protein during summer and 14% protein during winter.

Understanding how the reindeer's digestive system works is necessary for developing a diet for a farmed herd. Knowing the function and physiology of the rumen and the seasonal pattern of reindeer appetite also is critical to a successful reindeer farming operation. A farmed reindeer diet should reflect the nutritional value of the diet of a free ranging reindeer. The feed recipe should also be cost effective for the users. Currently, reindeer farmers in Alaska have to ship reindeer feed from the Lower 48 states, which is costly. If there was a locally produced reindeer diet that was nutritious, cost effective, and palatable to the reindeer, then maybe more people could afford to raise fenced reindeer in Alaska.

To meet this challenge, research conducted by the Reindeer Research Program developed a diet using Alaska-grown products to reduce cost. The resulting feed was successfully tested on the research herd for palatability, intake, reproductive performance, and weight gain. This reindeer diet contains barley as its primary energy component. Barley varieties that grow well in the north make up almost 80 percent of the diet. Feeding only barley to reindeer is not recommended because there is not enough fiber, which can cause digestive problems. Chopped hay that is grown at the university is added to the diet for fiber. For a protein source, whitefish meal from Kodiak is added. Fish meal is a byproduct of Alaska's lucrative fishing industry and is available year round at a lower cost than soybean meal, which has to be shipped in from the Lower 48 states. Soybean meal is commonly

fed to livestock species in the Lower 48 states. Corn oil is added for fat and liquid molasses is added for taste and palatability. Other ingredients in smaller amounts include limestone flour, urea, and dicalcium phosphate. A vitamin-mineral powder is also added. All of these ingredients are combined in a large mixer to make a 500-pound batch of feed. The UAF Reindeer Research Program mixes over 150,000 pounds of feed each year to feed their research herd.

Procedure

1. Introduce the concept of rumination and the nutritional needs of reindeer in summer and in winter, and the development of the UAF reindeer diet.
2. Put a copy of the feed recipe that appears on the **Reindeer Feed Calculations Worksheet** on an overhead.
3. Discuss each of the feed ingredients and why they are included in the diet.
4. Discuss the relationship between fractions, decimals, and percents.
5. Pass out the **Reindeer Feed Calculations Worksheet** to each student and have him or her complete the problems independently.

Extensions

1. Take a field trip to the reindeer research facility at the UAF campus and have a staff member of the Reindeer Research Program assist your class in mixing a batch of the recipe discussed in the lesson, using the large auger and mixer located in the feed mill at the UAF farm.
2. Have a researcher from the Reindeer Research Program visit your classroom and discuss reindeer nutrition, how this feed recipe was developed, and how its success was measured with the reindeer at the UAF research farm.

Assessment

Completion of the worksheet with students understanding the concepts presented.

Answers to the Reindeer Feed Calculations Worksheet:

1. 77.20
10.00
2.84
4.00
1.40
0.83
0.25
0.62
2.90
2. Step one: $77.2/100 = 100/x$, $x = 129.53$ (diet total)

Step two: $10/100 = x/129.53$, $x = 12.95$ pounds of hay

Other answers: 3.68, 5.18, 1.81, 1.08, 0.32, 0.80, 3.76

3. 129.53 total pounds, calculated from step one in answer 2 OR 129.58 pounds, calculated by adding up all of the answers from question 2. Answers may vary slightly due to rounding.

4. 366.60

49.20

33.85

20.15

6.05

5.10

2.65

1.95

14.45

Bonus question: Fish meal and soybean meal are two different types of protein and each has differing protein concentrations. But there is protein in the some of the other ingredients as well! Because this mix is formulated to contain 18% protein in total, the other ingredients need to be adjusted to keep the total protein amount constant.



Reindeer Feed Calculations Worksheet



Here is the feed recipe used at the reindeer farm at the University of Alaska Fairbanks, which is formulated to contain 18% protein. Use this information to answer the following questions. Use two decimal places for each answer.

Ingredient	Number of pounds
Barley	386.00
Hay	50.00
Fish meal	14.00
Molasses	20.00
Corn oil	7.00
Limestone flour	4.16
Dicalcium phosphate	1.24
Urea	3.10
Vitamin mix	14.50
Total	500.00

1. What is the percent of each ingredient in the feed mix?

Barley: _____%

Limestone flour: _____%

Hay: _____%

Dicalcium phosphate: _____%

Fish meal: _____%

Urea: _____%

Molasses: _____%

Vitamin mix: _____%

Corn oil: _____%

2. If you wanted to make up a batch of this reindeer diet but only had 100 pounds of barley, how much of each of the other ingredients do you need?

100 lbs. Barley
_____ lbs. Hay
_____ lbs. Fish meal
_____ lbs. Molasses
_____ lbs. Corn oil
_____ lbs. Limestone flour
_____ lbs. Dicalcium phosphate
_____ lbs. Urea
_____ lbs. Vitamin mix

3. How many total pounds of mix will you have when finished?

_____ lbs. of mix

4. You are a reindeer scientist and want to feed your research animals soybean meal instead of fish meal as a protein source to see if this change results in a change in weight gain during the summer months. Using a computer software program, you calculated the percentage of each ingredient that should go into the new diet containing soybean meal. Using the percentages given on the next page, calculate how many pounds of each ingredient you will need to make a 500-pound batch of the soybean meal feed for your research project.

Ingredient	Percentage in diet	Number of pounds
Barley	73.32 %	
Hay	9.84 %	
Soybean meal	6.77 %	
Molasses	4.03 %	
Corn oil	1.21 %	
Limestone flour	1.02 %	
Dicalcium phosphate	0.53 %	
Urea	0.39 %	
Vitamin mix	2.89 %	
Total	100 %	500

Bonus question: In question number 4, the only ingredient that was changed in the diet mix was the type of protein used (fish meal was changed to soybean meal). Why did the amounts of all of the other ingredients change too?

10. How Much Do Reindeer Eat?

Grade 4 - 8

Subject Mathematics

Duration 45 minutes

Alaska State Standards M.A.3, M.A.4, M.E.1

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Students will perform basic arithmetic functions, analyze mathematical patterns, and describe results using graphical representations.

Performance Objectives

Given basic information about intake rates, students will determine how much reindeer eat in the summer and winter by completing mathematical problems and creating a graph of their answers.

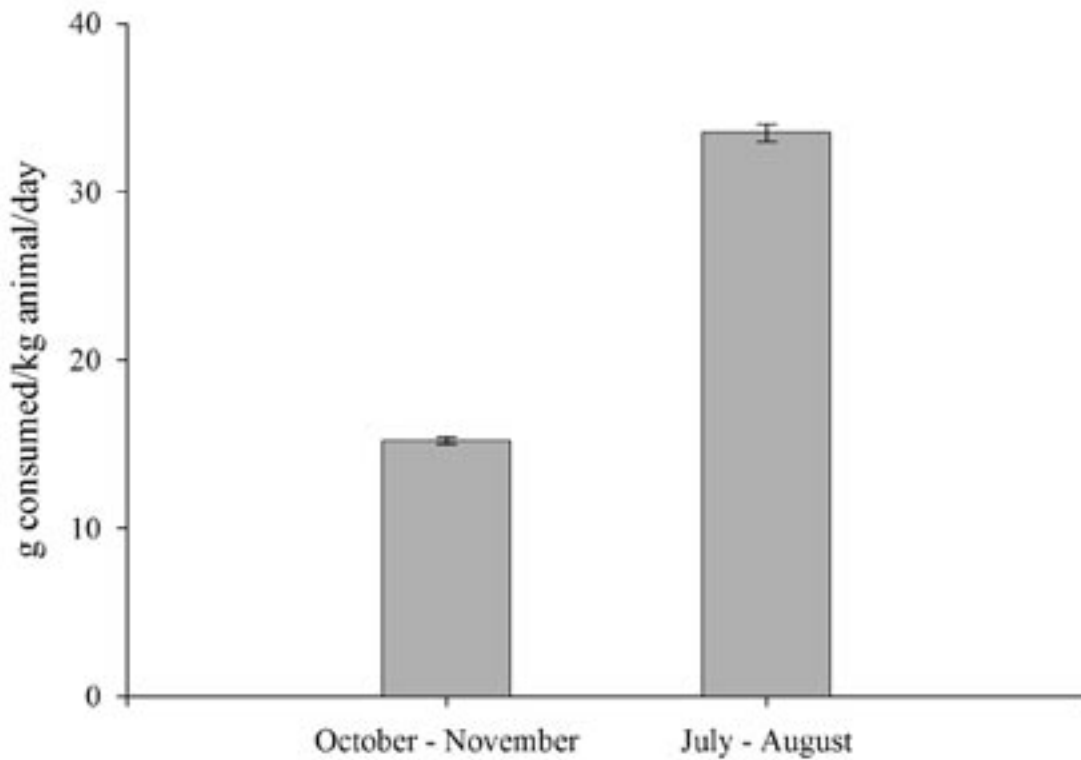
Materials

How Much Do Reindeer Eat? worksheet for each student (photocopy master on page 96)

Background

All *Rangifer* species (reindeer and caribou) exhibit an annual weight-loss, weight-gain cycle in which they gain weight during summer and lose weight during winter. They have a large appetite in summer and a small appetite in winter. This is an adaptation to living in the Arctic. In the summer, much green, protein-packed tundra vegetation is available for reindeer to eat. During summer they need to acquire all of the protein they will need for the whole year and put on fat and muscle mass for the upcoming winter months. During the long winter the only thing available for reindeer to eat is lichen. Lichen contains no protein, fat, or minerals, just carbohydrates. Reindeer dig through the snow for lichen and live off of fat reserves they built up during the summer. Reindeer are less active during winter to conserve heat and energy.

Interestingly, the reindeer at the Fairbanks Experiment Farm also exhibit the weight-gain, weight-loss cycle with increased summer appetite and decreased winter appetite. This is amazing because these captive reindeer are fed a high-energy diet and are given as much to eat as they want! Recent research on reindeer intake rates by the Reindeer Research Program shows that an average adult female reindeer eats about 15 grams of food per kilogram of body weight during winter and about 33 grams of food per kilogram of body weight during summer (see graph). The UAF RRP adult female



Intake rates for adult female reindeer during winter and summer.

reindeer, on average, weighs about 110 kilograms (kg); so one reindeer eats 3.63 kg per day in summer and 1.65 kg per day in winter. Here is an example of how we calculated this result:

$$\frac{15 \text{ g of food}}{1 \text{ kg of body weight}} \times \frac{?}{110 \text{ kg}} = 1650 \text{ g eaten/day} = 1.65 \text{ kg eaten/day}$$

By knowing how much an average female reindeer eats in one day, you can then calculate how much a group of 10 or 50 reindeer eats in the summer, in the winter, or year round. Reindeer typically eat more (3.63 kg/day) during the months of May, June, July, and August and eat lesser amounts (1.65 kg/day) during the remaining 8 months. A kilogram equals 2.2 pounds.

This information is valuable for people who own reindeer and keep them behind a fence. Knowing how much feed you will need for the upcoming year is important for financial and business management.

Procedure

1. Introduce the annual weight gain, weight loss cycle of reindeer and explain why calculating feed needs is important to a reindeer farmer with a fenced-in herd.
2. Distribute the **How Much Do Reindeer Eat?** worksheet to each student.

3. As a class, go over a problem together, then let each student complete the worksheet individually.
4. Upon completion, go over the answers as a class.
5. Have some students present their graphs to the class, if desired.

Extensions

1. How does the reindeer intake information apply to free-ranging populations on the Seward Peninsula? Introduce and discuss the concept of range management and how reindeer populations are managed for maximum range production.
2. Have a researcher from the UAF Reindeer Research Program visit your classroom to discuss range management on the Seward Peninsula for reindeer, how stocking densities for livestock species are calculated, and how vegetation and weather studies give insight into managing a reindeer herd.

Assessment

Correct completion of the worksheet.

Answers to the How Much Do Reindeer Eat? worksheet:

- 1a. 36.3 kg 1b. 181.5 kg
- 2a. 16.5 kg 2b. 82.5 kg
- 3a. 108.9 kg 3b. 49.5 kg
- 4a. $(108.9 \times 4) + (49.5 \times 8) = 831.6$ kg
- 4b. $[(36.3 \times 30) \times 4] + [(16.5 \times 30) + 8] = 8,316$ kg OR $831.6 \text{ kg} \times 10 = 8,316$ kg
- 5a. $831.6 \times 2.2 = 1,829.52$ lbs
- 5b. $8316 \times 2.2 = 18,295.2$ lbs



How Much Do Reindeer Eat?



1. If one adult female reindeer eats about 3.63 kg each day during the summer, then (a) how much would 10 adult female reindeer eat each day during the summer? (b) how much would a herd of 50 eat?

a. _____

b. _____

2. If one adult female eats about 1.65 kg each day during the winter, then (a) how much would 10 adult female reindeer eat each day during the winter? (b) how much would a herd of 50 eat?

a. _____

b. _____

3. How much would one adult female reindeer eat during (a) a 30-day month in the summer? (b) a 30-day month in the winter?

a. _____

b. _____

4. If the summer lasts for 4 months and the winter lasts for 8 months, then (a) how much would one adult female reindeer eat per year? (b) how much would 10 reindeer eat per year? Assume all months are thirty days for this calculation.

a. _____

b. _____

5. How many pounds of food would (a) an adult female reindeer eat per year? (b) 10 adult female reindeer eat per year? 1 kg = 2.2 lbs.

a. _____

b. _____

6. Make a bar graph comparing intake rates of reindeer in the summer versus the winter. Use any of the data from the above calculations.

11. Hair Identification

Grade 9 - 12

Subject Science

Duration 1 hour

Alaska State Standards S.A.10, S.A.12, S.B.2,

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Through scientific investigations using appropriate instruments, students will understand patterns of similarity and difference using traits common to all mammals.

Performance Objectives

Students will learn the parts of a mammal hair, then compare and measure different hair types under a microscope.

Materials

Parts of a Hair Fact Sheet and the **Hair Identification Data Table** for each student (photocopy master on page 102)

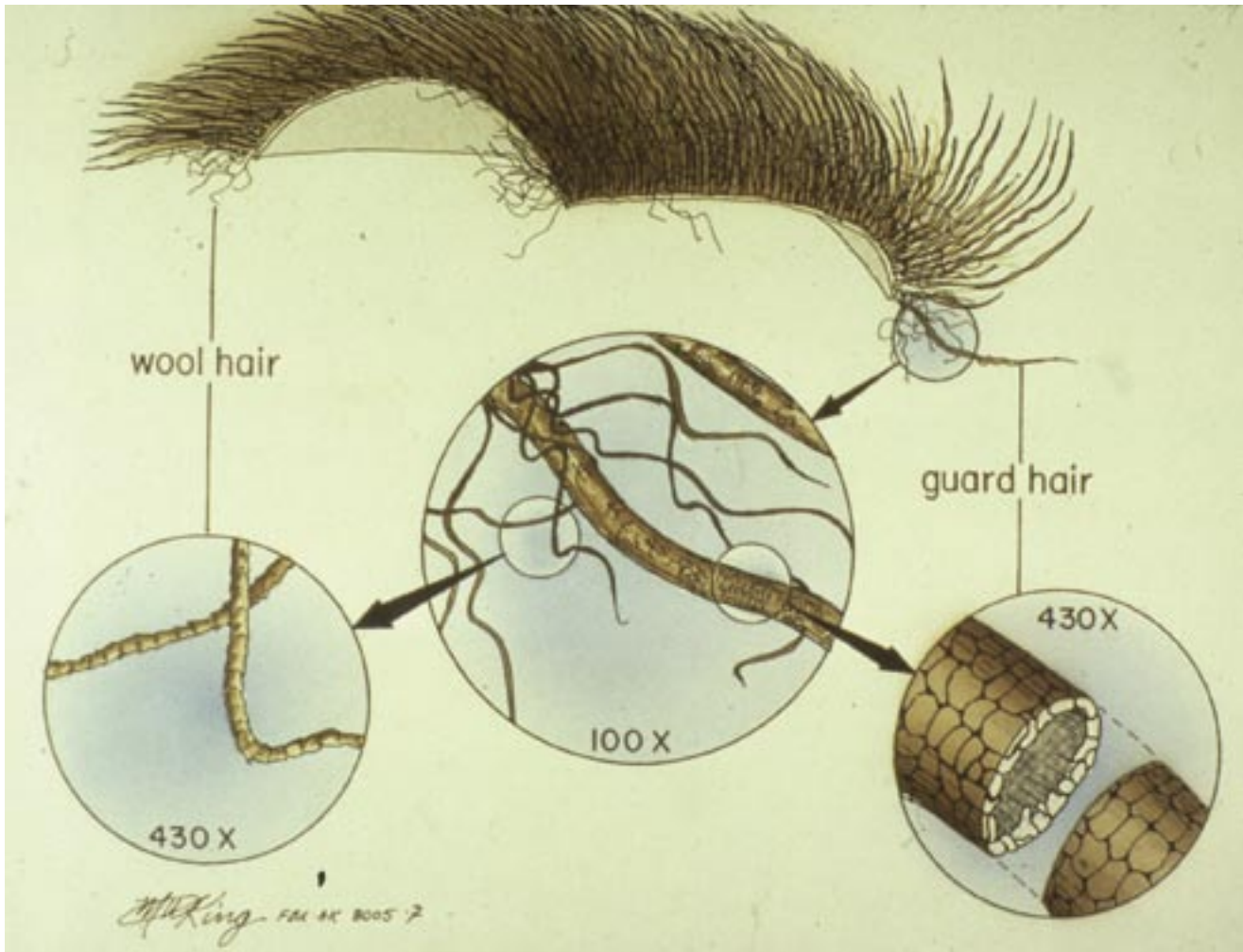
4 to 5 hair samples for identification: human, dog, cat, horse, sheep (wool), reindeer (contact a staff member of the UAF Reindeer Research Program a few days in advance for reindeer hair samples)

Compound light microscopes, slides, slipcovers, dropper, transparent ruler

Background

A common trait of all mammals is that they have hair, also called fur or pelage. Some species have more hair than others, depending on where they are adapted to living. For example, polar bears and arctic fox have thick coats to survive the cold winters in the Arctic, while desert mammals have short, thin hairs to help keep them cool and protect them from dust and sand. Some animals' hair helps to camouflage them from predators.

Hair is an appendage of the skin, growing out of an organ called a hair follicle. Hair is composed of keratin, a structural protein that also makes up your nails and your outer layer of skin. Hairs consist of three layers, the cuticle, the cortex, and the medulla. The cuticle is the outermost covering and consists of hard overlapping scales that point toward the tip end. The cortex contains the pigment granules that give the hair its color. The medulla is a hollow tube located in the center of a hair follicle. The shape and pattern of a hair's medulla can help scientists to determine its source. The medulla



A reindeer's winter coat consists of fine wool hairs and hollow guard hairs.

may be interrupted, fragmented, continuous, or absent. In many animals, the medulla makes up most of the cortex, but it is often completely absent in human hairs. In cats the medulla is arranged like a string of pearls. Dog hairs have a discontinuous medulla, while hairs of rabbits and mice have large, fragmented medullas. The medullary index may be expressed as a ratio by taking the diameter of the medulla over the diameter of the entire hair. Humans have a medullary index of less than $\frac{1}{3}$ (0.3), but in animals it is usually $\frac{1}{2}$ (0.5) or greater. Forensic science investigators often use hair analysis when investigating crime scenes. Scientists also can use a hair sample to detect drugs or poisons taken in by the body. Once a drug is ingested, it can stay in the hair for three to six months. Recently, doctors have found that analyzing a person's hair can tell them information about trace mineral levels in the body. This is important for tracking toxic levels of minerals in our environment.

The winter pelage of reindeer consists of two types of hairs; the long coarse guard hairs that have hollow cores and number about 5,000 per square inch, and the very fine wool hairs that are as dense as 13,000 per square inch. These hollow guard hairs and fine wool hairs combine to form a thick insulating mesh that traps air within and between the hairs. The insulating quality of reindeer hair prevents heat loss through the skin and is so great that reindeer can rest comfortably for long periods of time on cold snow. In fact, if you examine their beds carefully, you will see that the surface of the snow did not melt, nor did it ice over after the animal's rest period.

Procedure

1. Short lecture on the properties of animal hair, its function in different species, defining the parts of hair, and how it hair is measured. Use the reindeer hide found in the **Reindeer Roundup! Educational Kit** for demonstration.
2. Give each student a copy of the **Parts of a Hair Fact Sheet** and the **Hair Identification Data Table**. Review the **Parts of a Hair Fact Sheet** as a class.
3. Prepare wet-mount slides of each hair sample by placing hair on the slide, adding a drop of water, and covering with a cover slip. Have the hair samples in envelopes or bags labeled with a number, so students will have to identify each sample based on the information they collect.
4. Examine each sample at low, medium, and high power. Sketch the hair sample under high power.
5. Have each student complete the data table and try to identify 4 to 5 different hair samples.

Extensions

1. Show the slide show entitled *Adaptations of Reindeer to Life in the Arctic*, located on the *Reindeer Visual Aids* CD-ROM in the **Reindeer Roundup! Educational Kit** to demonstrate how well reindeer are adapted to living on the tundra. Use the slide show index that corresponds with this slide show in **Appendix B** on page 170 for assistance.
2. Have a researcher from the UAF Reindeer Research Program bring a live reindeer to your classroom to demonstrate the characteristics of the reindeer pelage.
3. Have a Native elder or reindeer herder from your community visit your classroom to discuss how reindeer hides were used for clothing and insulation (see the lesson **Traditional Uses of Reindeer** on page 64).

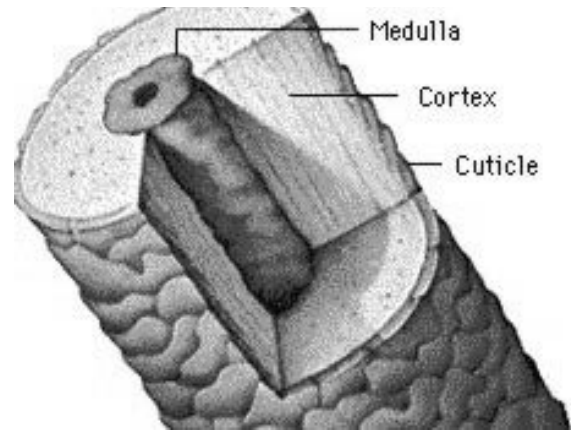
Assessment

Understanding of the parts of the hair. Accurate and neat completion of the data table. Have the students write a conclusion paragraph outlining what they observed.



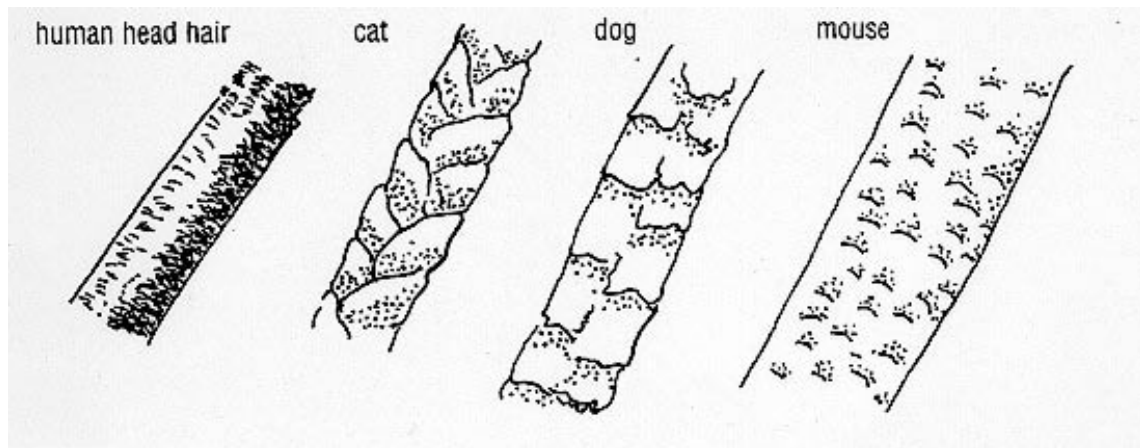
: Reindeer hairs are hollow to insulate them against the cold.

Parts of a Hair Fact Sheet²



Cuticle

- Outermost layer
- Thicker in animals than humans
- Regular scale patterns seen in animals

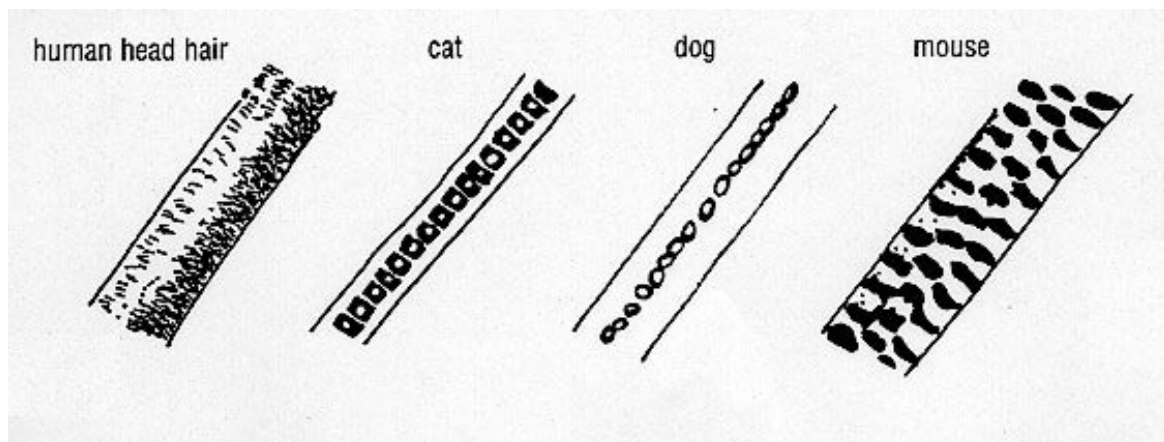


Cortex

- Spindle-shaped cells (cells that run along the length of the hair)
- Contains color granules

Medulla

- Shaft that runs through the middle of the hair
- Medullary Index is the ratio of the thickness of the medulla to the thickness of the hair
- Types of medulla: continuous, interrupted, fragmented, absent



2. Photos downloaded from http://www.nifs.com.au/FactFiles/fact_files.html, more hair photos shown under a microscope are available on this site.

Hair Identification Data Table

Sample	Sketch of hair	Root shape	Tip shape	Diameter of medulla	Diameter of hair	Medullary Index	What species is it?
1							
2							
3							
4							
5							

12. Reindeer Rumen

Grade 9 - 12

Subject Science

Duration 1 hour

Alaska State Standards S.A.12, S.A.14, S.A.15, S.B.1, S.B.2

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Students will distinguish patterns of similarity and difference to understand the diversity of life, interdependence between living things, and to describe the local environment through classifying and measuring using appropriate instruments.

Performance Objectives

Using a microscope, students will observe and compare organisms found in reindeer rumen and pond water, draw and label these organisms, and identify the ecological role of microbes in the environment.

Materials

Rumen fluid from a reindeer (contact the UAF Reindeer Research Program many weeks in advance for acquisition and proper transport)

Pond water or hay infusion water (1 ounce dry leaves to 1 gallon of water, let it sit for 1 or 2 weeks).

Compound microscopes, slides, cover slips

Background

Microbes are tiny creatures that are too small to be seen with the naked eye. Microbes can be divided into four different types: fungi, bacteria, protists (amoebas, paramecium, algae), and archaea, which are bacteria-like creatures that have some traits not found in any true bacteria.

Microbes thrive in almost all types of environments. They live at temperatures ranging from -20°C to temperatures greater than water's boiling point. They can live twenty miles below the Earth's surface to twenty miles overhead. Each gram of soil may contain up to one billion or more microbes! There are also many different species of microbes, up to 10,000 in that same gram of soil.

Microbes have been made to work for us. Many of the foods you eat, including tea, cheese, and chocolate are processed by microbes. Bread is made from grains fermented with yeast, which is a



Reindeer are able to extract nutrients from the plants they eat with the help of microbes that live in their rumen.

small fungus. Yogurt is made from milk that is fermented by bacteria called lactobacillus. Fungi and bacteria can produce antibiotics such as penicillin and tetracycline. One type of bacteria was used to help clean up oil from the *Exxon Valdez* oil spill. It ate the oil and turned it into carbon dioxide. Microbes are also used in manufacturing paper, chewing gum, the stonewashed look on blue jeans, and many other things that we use daily.

Many plants and animals (including humans) interact with microbes and depend on them for survival. Animals provide microbes with food and shelter, while microbes perform various functions to keep humans and animals healthy. For example, reindeer depend on microbes for their food. Reindeer are ruminants and have a special four-chambered stomach (see the background section of the lesson **What Do Farmed Reindeer Eat?** on page 86 for more information on reindeer digestion). One section of this stomach is called the rumen, which is host to billions of microbes. These microbes use proteins called enzymes to break down long molecules of cellulose into smaller bits to be absorbed by the body. Cellulose is found in plant cell walls of the food that reindeer eat, but they cannot digest it themselves. Without microbes present in their gut, reindeer would not be able to extract any nutrients from their food. The rumen is anaerobic, meaning no oxygen is present. Microbes that live in a reindeer rumen get their energy from anaerobic respiration or fermentation, rather than using oxygen. Fermentation in the rumen produces acids that give off a foul odor. Other ruminant animals include cows, moose, caribou, sheep, giraffes, goats, deer, and antelopes.

Protists, bacteria, and fungi of many different species may be found in the rumen of a reindeer, each performing different functions and interacting with each other to help the animal digest its food.



Bacterial strains of bacteroides, fibrobacter, streptococcus, and clostridium were found to dominate reindeer rumen fluid in a Norwegian study. In the rumen of reindeer, caribou, and musk oxen are microbes that produce unique enzymes that can break down lichens into sugars the animals can use. No other ruminants produce these lichen-digesting enzymes, which are part of these animals' adaptation to live on the tundra.

Procedure

1. Provide short lecture or background information on microbes, the microbes' role in the environment, and the function of microbes in the reindeer's rumen.
2. Have students work in pairs or individually.
3. Place several drops of rumen fluid on a slide and then add the cover slip.
4. Place rumen slide under the microscope and scan for microbes.
5. Have the students sketch and label the variety of microbes found (most biology texts have labeled pictures of protists, bacteria, and fungi).
6. Repeat steps 3 – 5 with the pond water or hay infusion water.
7. Compare the microbes found in each sample.

Extensions

1. Have a researcher from the UAF Reindeer Research Program visit your classroom and give a talk about the reindeer rumen, functions of the rumen and the microbes that live there. Have them discuss how the microbes in the rumen allow reindeer to survive on the tundra.
2. Have a microbiologist from your community visit your classroom to discuss microbes that you may encounter in everyday life and how an increase or decrease in the number of microbes in your environment may affect you.

Assessment

Have students neatly sketch and label microbes in a lab book or on a separate sheet of paper. Discuss as a class or assign the following questions:

1. Compare the two samples of microbes. Were there similar organisms? What differences did you find? What was the relative abundance of the microbes in each sample? Provide an explanation to account for the relative abundance you found.
2. What role do these microbes play in the two environments? What is different and the same about the two environments?
3. What is a ruminant? Name other ruminants and their habitat. Would you expect to see similar results when looking at rumen fluid from a different species? Why or why not?

13. Building a Radio and Transmitter

Grade 9 - 12

Subject Science

Duration 2 – 4 hours

Alaska State Standards S.A.8, S.D.1, T.E.6

Cultural Standards for Students B.4, E.2

Cultural Standards for Educators B.3

Instructional Goal

Students will understand physical reactions and the transformation of energy in a radio transmitter and receiver while using scientific knowledge to understand current issues and how this technology affects local culture.

Performance Objectives

Students will build a radio and transmitter using physics principles and theories to understand how this technology is used in wildlife management and how it is being used regionally to assist reindeer herders on the Seward Peninsula.

Materials

Building a Crystal Radio and/or **Building a Simple AM Voice Transmitter** instruction and parts sheets for each student or group of students (photocopy masters begin on page 111)

Parts for the radio and/or transmitter can be purchased at Radio Shack

Soldering gun

AM radio

Background

To understand telemetry you must have a basic understanding of the electromagnetic spectrum. The electromagnetic spectrum is the name given to the energy that is emitted in the form of waves (light) or particles (photons). This energy is called electromagnetic radiation. Electromagnetic radiation, such as the light from your lamp or the radio waves from your stereo, spreads out when it travels. Other examples of electromagnetic radiation are microwaves, infrared waves, ultraviolet light, X-rays, and gamma rays.





A biologist uses a receiver and antenna to locate a radio-collared reindeer on the Seward Peninsula.

The electromagnetic spectrum can be expressed in terms of frequency. Frequency is defined as the number of times a wave repeats each second. The unit of measurement for frequency is Hertz. It is commonly notated in mega-Hertz or millions of Hertz (MHz). For example, a wave with a frequency of 100 MHz oscillates 100 million times per second.

Conventional wildlife telemetry uses VHF (very high frequency) waves to transmit a unique signal for detection by a receiving system. Telemetry is a radio system in which there are two functional parts:

- a way to transmit a signal (usually by fitting a collar around an animal's neck), and
- a way to receive a signal (equipment carried by the researcher trying to locate the animal with the collar).

Transmitters can fit a broad range of animal species and each has three parts, the quartz crystal, a power source, and an antenna. The quartz crystal determines the unique frequency of the collar. These crystals are

extremely small, but are the most expensive part of the transmitting system. When the collar wears out, the crystal can be salvaged and reused in a new unit. The power source is typically a battery. The battery is generally the most limiting factor when creating a useful transmitter in terms of size and lifespan. You want a collar that will last a long time, which would require a big battery, but you don't want a system too big for the animal you are tracking. Tiny transmitters have been glued to the backs of bumblebees in Africa, but because they are so small they don't have a very long battery life. The collars used on reindeer weigh about two pounds and have a battery life of three to five years. All collars are designed so that they do not impede with an animal's normal activities. The transmitting antenna sometimes sticks out of the collar for better transmission. When fitting a collar on species such as foxes, wolves, or bears, the antenna should be fully contained within the collar to prevent them from chewing it off. The antenna can remain exposed for animals such as reindeer, caribou, and moose.

The receiving system must be designed to receive the specific frequencies of the collars you are trying to locate. An FM radio is a good example of a receiver designed to receive a signal within a specific range of frequencies. For wildlife applications, the receiver is often equipped with a scanner that allows the user to scan through a list of known frequencies and receive any of those signals. Many modern receivers include a personal computer interface for ease of uploading and downloading data. The receiver also has a receiving antenna attached to pick up frequencies within a certain range. There are many different types and styles of antennas for receiving signals.

Conventional VHF telemetry has some limitations. Weather is a big one, especially in coastal Alaska where the cloud ceiling is often too low for a plane to fly. The UAF Reindeer Research Program collects nearly all of its VHF data from fixed-wing aircraft surveys, making weather a big consideration. Antennas are mounted on the wings of a small plane and a biologist sits behind the pilot and listens for the signals.

Because there are a limited number of frequencies available for use in wildlife telemetry, and because all users in the geographical area must divide those frequencies among themselves (to prevent, for example, the reindeer biologist from inadvertently tracking a collared wolf that is being monitored by another researcher), wildlife programs are limited in the number of collars they can deploy. Each collar frequency must have a 5-10 KHz range between the collars. The inclusion of satellite transmitters in a wildlife telemetry program can help mediate some of these problems.

Satellite telemetry works the same way as VHF telemetry, but there are some major differences. First of all, satellite telemetry is much more costly than conventional radio telemetry. A typical radio collar costs about \$300, while a satellite collar can cost over \$2,000 and the user must also pay for the satellite time to acquire the collar locations. The cost of a radio collar is low, but you have to rely on a person to go out and track the animal, or have good weather and pay a tracking plane to find it.

Satellite telemetry operates in the Ultra High Frequency (UHF) range and each of the collars broadcasts at the same frequency. Each collar then has a separate identification number that the UHF receiver (mounted on satellites passing overhead) can differentiate. Batteries do not last as long, as the signal must travel much farther. You can determine how often you want the satellite to acquire a location from the animal (the Reindeer Research Program acquires reindeer locations every five to ten days). The location data goes to a processing center that takes the location data and converts it to a latitude and longitude. This information is then sent to the Reindeer Research Program's computer database. They have an automated mapping system that takes the reindeer location data, maps it, and posts it on the Internet for reindeer herders and researchers to access.

Procedure

1. Introduce the students to the topic of telemetry by showing the slide show, *Radio and Wildlife Telemetry*, on the *Reindeer Visual Aids* CD-ROM in the **Reindeer Roundup! Educational Kit**. Use the slide show index that corresponds with this slide show in **Appendix B** on page 170 for assistance.
2. Discuss the physics principles behind a radio and/or transmitter.
3. Hand out the **Building a Crystal Radio** and/or **Building a Simple AM Voice Transmitter** parts list and instructions to each student or group of students. Read over the parts list and instructions as a class.
4. Have each student or group of students gather the necessary parts provided by the teacher and work together to complete the assigned project.
5. Show the video, *High Tech on the Tundra*, in the **Reindeer Roundup! Educational Kit** to demonstrate how telemetry is used to locate reindeer and how technology has changed reindeer herding practices on the Seward Peninsula.



Extensions

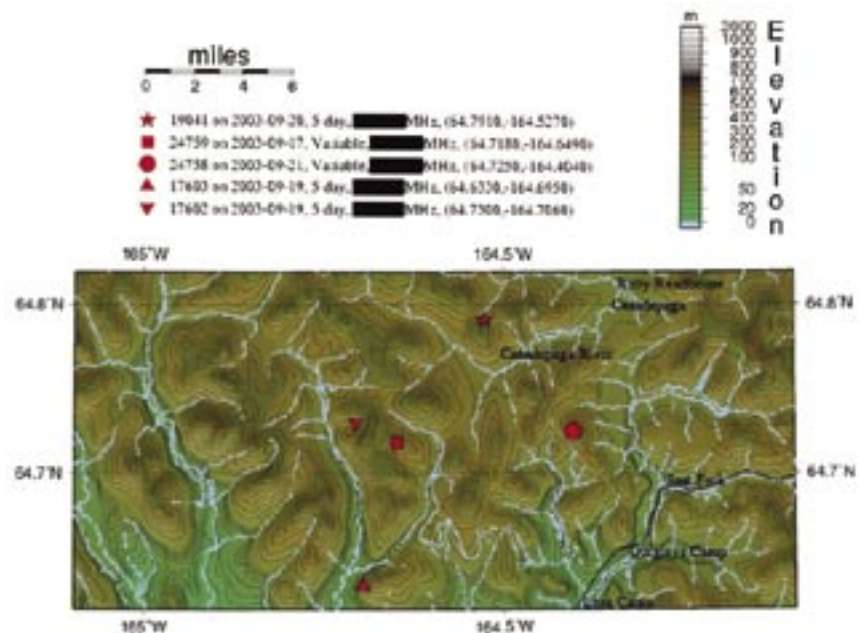
1. Have a researcher from the UAF Reindeer Research Program visit your classroom with a live reindeer and a telemetry system to demonstrate the components and its use.
2. Invite a reindeer herder into your classroom and have them discuss how radio and satellite telemetry have changed their herding practices.

Assessment

Have each student or group of students present and demonstrate their radio or transmitter to the class. Have them discuss their challenges, mistakes, or improvements they would make.

Note

The Telonics Company has been making radio and satellite collars for over twenty years and the UAF Reindeer Research Program uses their products. Telonics offers a one-month rental of an educational telemetry kit that consists of a basic transmitting and receiving subsystem. See www.telonics.com for more information. The UAF Reindeer Research Program owns one of these educational kits from Telonics and it may also be available for your use. Please call (907) 474-6055 to reserve the kit for instruction and demonstration purposes while teaching this lesson.



Reindeer herders can now track satellite-collared reindeer with location maps that are posted on the Internet every 5-10 days.

Building a Crystal Radio³

Parts list:

- √ A sturdy plastic bottle. Hydrogen peroxide bottles or bottles from contact lens cleaner work well, or anything that is about 3 inches in diameter and 5 to 7 inches long. Shampoo bottles also work well, but use one that has thick walls for wrapping the wire around.
- √ About 50 feet of enamel-coated magnet wire. Thicker gauges such as 22 or 18 gauge work well (Radio Shack part # 278-1345). You can also use vinyl-coated wire (Radio Shack part # 278-1217), which in some ways is easier to use than enamel-coated wire because it is easier to remove the insulation.
- √ A germanium diode. Most stores that sell electronic parts have these. They are called 1N34A diodes (Radio Shack part # 276-1123).
- √ A telephone handset with cord. You will listen to this radio just like you listen to the phone. If you have an old telephone sitting around, or can find one at a garage sale, you are set. Or you can buy the handset cord (Radio Shack part # 279-316) and borrow the handset from your home phone (using it for the radio will not harm it).
- √ A set of alligator jumpers (Radio Shack part # 278-1156), or you can find them anywhere electronics parts are sold.
- √ About 50 to 100 feet of stranded insulated wire for an antenna. This is actually optional, since you can use a TV antenna or FM radio antenna by connecting our radio to one of the lead-in wires. But it's fun to throw your own wire up over a tree or on top of a house, and it makes the radio a little more portable.

3. These instructions and parts list are reprinted with permission from Simon Field at <http://www.scitoys.com/scitoys/scitoys/radio/radio.html>. Color pictures of each step are available on this website.

Building a Crystal Radio

Instructions:

Visit the website <http://www.scitoys.com/scitoys/scitoys/radio/radio.html> for pictures to accompany these directions.

- √ Use a sharp object like a nail to poke four holes in the side of the bottle. Two holes will be about a half an inch apart near the top of the bottle and the other two holes will be half an inch apart at the bottom of the bottle. They should be matched. These holes will hold the wire in place.
- √ Thread the wire through the two holes at the top of the bottle and pull about 8 inches of wire through the holes. If the holes are large and the wire is loose, it is OK to loop the wire through the holes again, making a little loop of wire that holds snugly.
- √ Now take the long end of the wire and start winding it neatly around the bottle. When you have wound five windings on the bottle, stop and make a little loop of wire that stands out from the bottle. Wrapping the wire around a nail or a pencil makes this easy.
- √ Continue winding another five turns, and make another little loop with the nail or pencil. Keep doing this until the bottle is completely wrapped in wire, and you have reached the second set of holes at the bottom of the bottle.
- √ Cut the wire so that at least 8 inches remains, and thread this remaining wire through the two holes like you did at the top of the bottle.
- √ Now remove the insulation from the tips of the wire and from the small loops you made every 5 turns with the nail or pencil (these loops are called 'taps'). If you are using enameled wire, you can use sandpaper to remove the insulation. Don't remove the insulation from the bulk of the coil, just from the wire ends and the small loops. If you are using vinyl-coated wire, the insulation comes off easily with a sharp knife.
- √ Next we attach the germanium diode to the wire at the bottom of the bottle. It is best to solder this connection, although you can also just twist the wires together and tape them. You can also use alligator jumpers if you are in a hurry.
- √ Cut one end off of the telephone handset cord to remove one of the modular telephone connectors. There will be four wires inside. If you are lucky, they will be color coded, and we will use the yellow and black wires. If you are not lucky, the wires will be all one color, or one will be red and the others will be white. To find the right wires, first strip off the insulation from the last half-inch of each wire, then take a battery such as a C, D, or AA cell and touch the wires to the battery terminals (one wire to plus and another to minus) until you hear a clicking sound in the handset earphone. When you hear the click, the two wires touching the battery are the two that go to the earphone, and these are the ones we want.

- √ The 'wires' in the handset cord are usually fragile copper foil wrapped around some plastic threads. This foil breaks easily, sometimes invisibly, while the plastic threads hold the parts together, making it look like there is still a connection. I recommend carefully soldering the handset wires to some sturdier wire, then taping the connection so nothing pulls hard on the copper foil.
- √ Attach one handset wire to the free end of the germanium diode. Solder it if you can.
- √ Attach the other wire to the wire from the top of the bottle. Soldering this connection is a good idea, but it is not necessary.
- √ Now clip an alligator jumper to the antenna. Clip the other end to one of the taps on the coil.
- √ Clip another alligator lead to the wire coming from the top of the bottle. This is our 'ground' wire, and should be connected to a cold water pipe or some other metal object or wire that has a good connection to the earth.
- √ At this point, if all went well, you should be able to hear radio stations in the telephone handset. To select different stations, clip the alligator jumper to different taps on the coil. In some places, you will hear two or more stations at once. The longer the antenna is, the louder the signal will be. Also, the higher you can get the antenna the better.
- √ If your radio does not work, go to: http://www.scitoys.com/scitoys/scitoys/radio/trouble_shooting.html
- √ Now that your radio works, you can make it look better and it will be sturdier by mounting it on a board or in a wooden box. Machine screws can be stuck into holes drilled in the wood to act as places to attach the wires instead of soldering them.

Building a Simple AM Voice Transmitter⁴

Parts List:

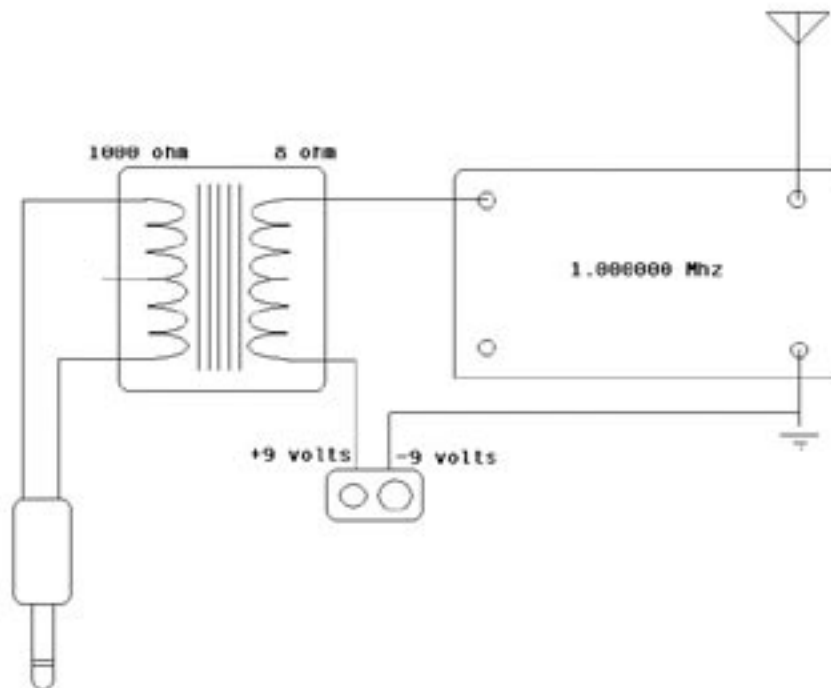
- √ A one megahertz crystal oscillator. This is a crystal clock oscillator such as those used in computers. There are many suppliers such as Jameco (part # 27861, www.Jameco.com) or JDR MicroDevices (part OSC1.0, www.jdr.com).
- √ An audio transformer; a 1000 ohm to 8 ohm transformer (Radio Shack part # 273-1380)
- √ A generic printed circuit board (Radio Shack # 276-159A)
- √ A phone plug. This should match the jack in your sound source. A 1/8-inch plug to match standard earphone jacks can be used (Radio Shack # 274-286A).
- √ A 9-volt battery clip (Radio Shack # 270-324).
- √ A 9-volt battery
- √ A set of alligator jumpers (Radio Shack # 278-1156)
- √ Some insulated wire for an antenna. You can use the same antenna you used for the crystal radio.

4. These instructions and parts list are reprinted with permission from Simon Field at <http://www.scitoys.com/scitoys/scitoys/radio/radio.html>. Color pictures of each step are available on this website.

Building a Simple AM Voice Transmitter

Instructions:

- √ This transmitter goes together in about 10 minutes and is small enough to fit in the palm of your hand. Depending on the antenna, the transmitter can send voice and music across the room, or across the street.
- √ Visit the website: http://www.scitoys.com/scitoys/scitoys/radio/am_transmitter.html for pictures to accompany these instructions.
- √ The crystal oscillator is the heart of the transmitter. It has four leads, but we only use three of them.
- √ The other main part is the audio transformer. In this circuit it is used as a *modulator*. The modulator changes the strength of the radio waves to match the loudness of the music or voice we want to transmit. The transformer has two leads on one side and three leads on the other side. The two leads are the *low impedance* side of the transformer (8 ohm side). The three leads are the *high impedance* side (1000 ohm side). The middle of the three leads is called the *center tap*, and we won't be using it in this circuit.
- √ A diagram of a transmitter looks like this:



- √ Attach the transformer to the circuit board. The transformer should be placed on the left side of the printed circuit board, leaving plenty of room on the right for the oscillator. The transformer has two metal tabs on the bottom. These can be bent out flat, so the transformer can be glued to the printed circuit board.
- √ Insert the leads of the oscillator into the printed circuit board, placing it far to the right. The copper side of the board should be down, with the oscillator on the side without copper.
- √ Gently bend the leads of the oscillator over, so it is held firmly onto the printed circuit board.
- √ Solder the pins of the oscillator to the copper foil of the printed circuit board. Be careful not to use too much solder or it may form bridges of solder between copper traces that are not supposed to be connected together.
- √ Insert the stripped end of the red wire into a convenient unused hole in the printed circuit board (such as the bottom left hole). Insert the red wire from the battery clip into a nearby hole that is connected by copper foil to the first hole, so the two red wires are electrically connected. Solder the two wires to the copper foil.
- √ Cut one of the clip leads in half, so you have two pieces of wire each with an alligator clip attached. In the photo on the website, two different colors are used for clarity (yellow and green). Strip the insulation from the last half-inch of each piece.
- √ Insert the black wire of the battery clip into a hole whose copper foil connects to the lower right pin of the oscillator. Insert the stripped end of one of the alligator clip leads into a hole that is also connected to the lower right pin of the oscillator. Solder the two wires to the copper foil. This alligator clip will be the *ground* connection, just like in the crystal radio.
- √ Open the phone plug, and insert the blue and green wires of the transformer into the plastic handle. The metal part of the plug has two pieces, each with a small hole. Put one of the transformer wires into one hole and solder it, then put the other wire into the other hole and solder it. When the metal has cooled, screw the plastic handle back onto the metal phone plug.
- √ Now you are ready to test the transmitter.
- √ Plug the phone plug into the earphone jack of a convenient sound source such as a transistor radio, tape player, or CD player.
- √ Plug the battery into the battery clip.
- √ Hold the transmitter near an AM radio, and tune the radio to 1000, so you can hear the your sound source in the AM radio. Adjust the volume controls on the sound source and on the AM radio to get the best sound.
- √ Without any connection to an antenna or a good ground connection, the transmitter will only transmit to a receiver a few inches away. To get better range, clip the ground wire to a good ground, such as a cold water pipe, and the antenna to a long wire, like the one used for the crystal radio. Many countries limit the length of the antenna you are allowed to use without a license, so check with your local laws before using a wire more than a yard or two long.

14. Creating a Reindeer Brochure

Grade 5 - 12

Subject English, History, Computer Science, Art

Duration 3 – 5 hours

Alaska State Standards E.A.1, E.A.5, E.A.7, T.A.2, T.D.1, H.B.1

Cultural Standards for Students E.2

Cultural Standards for Educators B.3, C.3

Instructional Goal

Students will gather information from a variety of sources, organize that information, apply the elements of effective writing using technological tools and illustration to edit and publish their information.

Performance Objectives

Students will design, organize, write, and illustrate a brochure about reindeer and the reindeer industry in Alaska using a variety of sources.

Materials

Informational materials (such as books, maps, photos, videos) made available to students for independent research. See the **For Further Study** section at the back of this book. Reindeer photos can be found on the *Reindeer Visual Aids* CD-ROM located in the **Reindeer Roundup! Educational Kit**.

Paper and art supplies for making brochure

Background

Brochures are pamphlets or leaflets that contain descriptive and advertising material. They are often used to convey a lot of information in a small amount of space using text, pictures, and graphics. This lesson requires students to research information on reindeer and the reindeer industry in Alaska to create their own brochure. The material to be researched is intended as a review and compellation of much of the material that is covered in this book. If desired, educators can use this lesson as an independent research project for students to discover other areas of reindeer history and biology.

Procedure

1. Students will collect data on Alaska reindeer, their habitat, history, and their relationship with humans.

Ear tags are given to reindeer fawns during summer handlings. The unique ear tag number can be used to track an individual animal throughout its lifetime.

—photo by
Roy Corral



2. Students will organize and develop this material into four sections: description of reindeer, habitat, history in Alaska, and human use. Other sections may be added or substituted, depending on the focus of each brochure.

3. Students will draft, edit, and produce a final copy of the text for their brochure, along with a bibliography. Older students may wish to use a computer for word processing or a software program for designing and publishing their brochure, if available.

4. Students will publish an illustrated brochure using their written text along with illustrations, photographs, maps, and tables or graphs that they have gathered in their research.

Extensions

1. Look for places around your community to distribute your brochures for public use.

2. Combine ideas, text, and photographs from various student-generated brochures to make one brochure as a class for bulk publication. Contact a staff member at the UAF Reindeer Research Program about making copies of this brochure available for visitors and tourists at the Fairbanks Research Farm's reindeer research facility on the UAF campus, or for distribution at the Nome Visitor's Center. Ask them for ideas on how to improve the brochure or what additional information is needed.

Assessment

Students will produce brochures meeting grade level standards for performance and quality.

15. Reindeer Alphabet Book

Grade K - 4

Subject English, Science

Duration 1 hour

Alaska State Standards E.A.1, E.A.2, E.A.6, S.A.12

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Students will communicate their knowledge of reindeer through writing and illustration.

Performance Objective

Students will write and illustrate a page to be compiled in a reindeer alphabet book.

Materials

Alphabet page for each student (photocopy master on page 122).

Background

This idea is patterned after the book, *Q Is for Duck* by Mary Elting and Michael Folsom. This lesson is designed as a review for younger students after completing many of the lessons in this book. Use the animal specimen props found in the **Reindeer Roundup! Educational Kit** to help students with brainstorming ideas.

Procedure

1. As an introduction, if necessary, show the class the slide show, *Adaptations of Reindeer to Life in the Arctic*, on the *Reindeer Visual Aids* CD-ROM in the **Reindeer Roundup! Educational Kit**. Use the slide index that corresponds with this slide show in **Appendix B** on page 170 for assistance. Use the reindeer specimen props to demonstrate topics on the slides.
2. List the alphabet on the board. Have students pick a different letter and complete their own alphabet page.



Reindeer use their large hooves to dig for roots in the spring.



: Reindeer noses are adapted to conserve water in the dry Arctic.

3. Brainstorm ideas as a class or have students work individually following this pattern (all letters are listed to give ideas or assist with troublesome topics).

Examples:

A is for reindeer.	Why?	Because reindeer have A ntlers.
B is for reindeer.	Why?	Because male reindeer are called B ulls.
C is for reindeer.	Why?	Because reindeer are related to C aribou.
D is for reindeer.	Why?	Because reindeer can D ig for roots.
E is for reindeer.	Why?	Because reindeer receive an E ar notch and an E ar tag
F is for reindeer.	Why?	Because reindeer have thick F ur.
G is for reindeer.	Why?	Because G rizzly bears can catch reindeer calves.
H is for reindeer.	Why?	Because reindeer have large H ooves.
I is for reindeer.	Why?	Because reindeer can walk across the I ce.
J is for reindeer.	Why?	Because reindeer can J ump over streams on the tundra.
K is for reindeer.	Why?	Because reindeer can K ick predators to defend themselves.
L is for reindeer.	Why?	Because reindeer like to eat L ichen.
M is for reindeer.	Why?	Because people raise reindeer for M eat.
N is for reindeer.	Why?	Because reindeer have a wide N ose.
O is for reindeer.	Why?	Because reindeer came to Alaska across the O cean.
P is for reindeer.	Why?	Because reindeer can be taught to P ull a sled.
Q is for reindeer.	Why?	Because reindeer can be Q uick.
R is for reindeer.	Why?	Because reindeer sometimes wear R adio collars.
S is for reindeer.	Why?	Because reindeer live on the S eward Peninsula.
T is for reindeer.	Why?	Because reindeer live in the T undra.
U is for reindeer.	Why?	Because reindeer are U ngulates.
V is for reindeer.	Why?	Because reindeer antlers have V elvet when they are growing.
W is for reindeer.	Why?	Because W olves try to catch reindeer for food.
X is for reindeer.	Why?	Because reindeer meat is e X cellent to eat.
Y is for reindeer.	Why?	Because reindeer lose their antlers each Y ear.
Z is for reindeer.	Why?	Because reindeer can Z ip across the tundra.

4. Have the student complete their alphabet page with a complete sentence and an illustration of their word or topic. For intermediate level: have students write an additional fact about their topic on the alphabet page.

5. Make copies of each page so each student has a complete reindeer alphabet book or hang the pages in the classroom or hallway to admire.

Extensions

1. Have each student present their letter and sentence to the class.
2. Have the class put on a reindeer presentation for another class using their alphabet pages and the reindeer props in the **Reindeer Roundup! Educational Kit**.

Assessment

Completed alphabet page with correct information, grammar, and spelling.



: Reindeer have large hooves for digging through the snow for food.

_____ **is for reindeer.**

Why?

Because...

16. Reindeer Bingo⁵

Grade 2 - 8

Subject Science

Duration 45 minutes

Alaska Content Standards S.A.14, S.C.7

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Students demonstrate their knowledge of reindeer biology and Alaska's reindeer industry by communicating observations using clear, complete, accurate, and objective descriptions.

Performance Objective

Students become familiar with reindeer-related terms and their meanings through a simple bingo game.

Materials

Bingo cards for primary, intermediate, or advanced levels (photocopy masters beginning on page 125)

Copies of word lists or an overhead copy of the word list for primary, intermediate, or advanced level (photocopy masters beginning on page 128)

Question and answer sheet for primary, intermediate, or advanced levels (photocopy masters beginning on page 131)

Tokens or squares of paper for marking the bingo squares

Bowl or bag to hold questions, if desired

Background

This is intended to be a review of much of the information provided in this kit. There are three levels of bingo included in this lesson: a shorter game for primary level, which uses a separate word list and clues, an intermediate level that does not contain categories for the questions and answers, and an advanced level that contains categories for the questions and answers.

5. Adapted from *Project Caribou*



Procedure

1. Pass out the bingo cards and have students fill in each box with one word from the list. For the advanced level, make sure students fill in words that match the appropriate category listed at the top of each word group.
2. Instruct students on the game rules: Questions will be read from a list. The answers will be found on the bingo cards. Put a token on the square if you have a correct answer. Call “bingo” when you have five (three for primary) tokens in a row (across or diagonal).
3. For primary level, read the **Primary Bingo Questions and Answers** out loud to the class. For the intermediate and advanced level, photocopy the **Intermediate and Advanced Bingo Questions and Answers** sheet and cut out the individual questions to place in a bag or bowl. You may want to have a student pick and read the questions. Otherwise, just read the questions and answers aloud.
4. The teacher decides if there is a winner by checking for correctly placed tokens.
5. This game may be played several times. Have the students exchange bingo cards after each game.

Extensions

1. Blackout Bingo—all squares must be covered to win.
2. Make up your own bingo game with questions and answers to adapt the game for different ages or subjects.

Assessment

This is a review of information covered in this book. Evaluate the student’s response time to the questions.

Primary Bingo Card

Word list:

antlers

warble flies

tundra

bull

reindeer

predator

calf

caribou

lichen

fur

hooves

velvet

Intermediate Bingo Card

Reindeer Bingo

Reindeer Bingo				

Advanced Bingo Card

Reindeer Bingo				
Adaptations	History	Dangers	Research & Management	Behavior

Intermediate Bingo Word List

Lichen	Gold	Squeeze chute
Shovel	The Lomens	Ear notch
Snowshoes	Reindeer Act of 1937	Internet
Guard hairs	Saami	Meat
Antlers	Caribou	Vitamins and minerals
Velvet	Mosquitoes	Pull a sled
Summer	Brucellosis	Panting
Winter	Warble flies	Grunting
Brow tine	Nose bot flies	Corral
Snow	Wolves	Circle
Sheldon Jackson	Broken antlers	Dominant
The <i>Bear</i>	Drowning	Rut
Captain Healy	Vaccine	Herd
Mission schools	Radio and Satellite collars	Craters
The Reindeer Queen	Pellets	Harem

Advanced Bingo Word List

Adaptations

Lichen
Shovel
Snowshoes
Guard hairs
Antlers
Velvet
Summer
Winter
Brow tine
Snow

History

Sheldon Jackson
The *Bear*
Captain Healy
Mission schools
The Reindeer Queen
Gold
The Lomens
Reindeer Act of 1937
Saami

Dangers

Caribou
Mosquitoes
Brucellosis
Warble flies
Nose bot flies
Wolves
Broken antlers
Drowning

Research and Management

Vaccine
Radio and Satellite collars
Pellets
Squeeze chute
Ear notch
Internet
Meat
Vitamins and minerals

Behavior

Pull a sled
Panting
Grunting
Corral
Circle
Dominant
Rut
Herd
Craters
Harem

Primary Bingo Questions and Answers

What member of the deer family is herded and sold for meat?

Reindeer

What is a wild member of the deer family that lives in the Arctic called?

Caribou

What is a male reindeer called?

Bull

What is a young reindeer, less than a year old, called?

Calf

These are like horns, but they fall off and grow back every year.

Antlers

This is a favorite food of reindeer in winter.

Lichen

These are part of the reindeer's feet that help them dig for food, walk on top of the snow, and swim.

Hooves

This is the land that the reindeer lives in. It has cold winters and short summers with low-growing plants.

Tundra

This soft tissue that covers a growing antler is called what?

Velvet

What covers the body of a reindeer to keep it warm?

Fur

What is an enemy of a reindeer called?

Predator

These are egg-laying flies that lay eggs under the reindeer's fur.

Warble flies

Intermediate and Advanced Bingo Questions and Answers

Adaptations

What do reindeer eat in the winter?

Lichen

.....

Adaptations

Reindeer hooves have this shape, allowing them to dig under the snow for food.

Shovel

.....

Adaptations

Reindeer hooves are just like _____, allowing them to walk on top of the snow.

Snowshoes

.....

Adaptations

What types of hair on the reindeer's coat are hollow, trapping air for insulation?

Guard hairs

.....

Adaptations

A unique feature of reindeer is that both males and females both grow a new set of these each year.

Antlers

.....

Adaptations

What is the soft, fuzzy tissue that covers a growing antler called?

Velvet

.....

Adaptations

Reindeer prefer to eat what in winter to get their water?

Snow

.....

Adaptations

Reindeer increase their food intake during this season.

Summer

.....

Adaptations

The long forward section of the antler that protects a reindeer’s eyes is called what?

Brow tine

.....

Adaptations

Reindeer decrease their food intake and utilize their fat reserves during this season.

Winter

.....

History

Who was largely responsible for bringing reindeer to Alaska from Russia?

Sheldon Jackson

.....

History

What was the name of the ship that the reindeer came over on?

The Bear

.....

History

Who was the captain of the *Bear*?

Captain Healy

.....

History

What was the name of the institutions that were commissioned by the Presbyterian Church in western Alaska that originally owned reindeer?

Mission schools

.....

History

Who was Mary Antisarlook?

The Reindeer Queen

.....

History

The demand for reindeer meat increased when this metal was discovered in Nome in 1900.

Gold

.....

History

These brothers had a successful reindeer business during the 1920s.

The Lomens

.....

History

This law allowed for an increase in Native reindeer ownership.

Reindeer Act of 1937

.....

History

What is the name of the Native people from Scandinavia who came to Alaska to teach Native Alaskans how to herd reindeer?

Saami

.....

Dangers

Sometimes these cousins to the reindeer lure them away from their home ranges.

Caribou

.....

Dangers

What buzzing insect can torment reindeer during the summer?

Mosquitoes

.....

Dangers

These predators live in packs and have followed the caribou onto the Seward Peninsula, where they have remained to prey on reindeer, which are easier to catch.

Wolves

.....

Dangers

This disease causes reindeer to abort their unborn calves.

Brucellosis

.....

Dangers

These flies lay their eggs in reindeer fur, which form cysts under their skin.

Warble flies

.....

Dangers

These flies lay eggs in the nose of reindeer. The larvae can make breathing difficult and irritate the reindeer.

Nose bot flies

.....

Dangers

Too many reindeer in a corral may cause this.

Broken antlers

.....

Dangers

What is a cause of mortality for reindeer calves trying to follow the herd across a raging river in the spring?

Drowning

.....

Behavior

Reindeer are easily domesticated and can be taught to do what?

Pull a sled

.....

Behavior

Since reindeer do not have sweat glands, how do they get rid of excess heat?

Panting

.....

Behavior

Mothers and calves can find each other in a large group by doing what?

Grunting

.....

Behavior

Reindeer herders round up their animals two times a year and put them into what?

Corral

.....

Behavior

When people, 4-wheelers, or a helicopter approach a reindeer herd, what shape do the reindeer form?

Circle

.....

Behavior

Reindeer that have their antlers are _____ over reindeer that have lost their antlers.

Dominant

.....

Behavior

What is another name for the reindeer breeding season?

Rut

.....

Behavior

Reindeer live in a group called what?

Herd

.....

Behavior

Reindeer create these holes in the snow while looking for lichens.

Craters

.....

Behavior

During the breeding season, reindeer bulls will gather cows in a group called what?

Harem

.....

Research and Management

Reindeer receive a shot of this to prevent the disease brucellosis.

Vaccine

.....

Research and Management

What kind of tool is placed on reindeer so herders and biologists can track their movements?

Radio or Satellite collars

.....

Research and Management

Biologist will collect these items left by the reindeer to study their food habits.

Pellets

.....

Research and Management

Reindeer are held in this so biologists can take body measurements or give them vaccinations.

Squeeze chute

.....

Research and Management

Each reindeer on the Seward Peninsula has this type of identification so it can be distinguished from members of other herds.

Ear notch

.....

Research and Management

Reindeer herders on the Seward Peninsula can now use this tool to observe maps of their collared reindeer.

Internet

.....

Research and Management

When feeding reindeer, you should always add these supplements.

Vitamins and minerals

.....

Research and Management

Biologists study this reindeer product for heavy metal contaminants to make sure that humans eating it don't consume unhealthy amounts of contaminants.

Meat

.....

17. Creating an Arctic Food Web

Images reprinted with permission: Alaska Department of Fish and Game. 2001. Alaska Ecology Cards. Anchorage, AK: Alaska Department of Fish and Game.

Grade 4 - 9

Subject Science, Geography

Duration 45 minutes

Alaska Content Standards S.A.14, S.A.15, G.C.1

Cultural Standards for Students E.2

Cultural Standards for Educators B.3

Instructional Goal

Students will understand the interdependence between living things and their environments and analyze the dynamic and interactive forces of a tundra ecosystem.

Performance Objective

Students will demonstrate their knowledge of energy flow between organisms by creating a food web.

Materials

Copies of the **Arctic Food Web Critters** worksheet for each student (photocopy master for primary level on page 141 and for intermediate level on page 143)

Large sheet of paper for each student

Crayons or colored pencils, glue, scissors

Background

Tundra comes from the Finnish word *tunturia*, meaning treeless plain. It is one of the coldest of all of the biomes with a short growing season, receiving low amounts of precipitation, and where temperatures range from -40°C to 18°C (-40°F to 64°F). There are two types of tundra, alpine tundra and arctic tundra. Alpine tundra is located on high-altitude mountains where trees cannot grow. Arctic tundra is found in the regions just below the ice caps of the Arctic, extending across North America, to Europe, and in Asia. Much of Alaska and the northern half of Canada are part of the tundra biome.

Precipitation in the arctic tundra only totals 150 to 250 mm a year (6 to 10 in), which is less than some of the world's deserts! Tundra winters are long, dark, and cold, with temperatures below freezing for 6 to 10 months of the year. The temperatures are so cold that there is a layer of permanently frozen



: Reindeer can smell lichen under three feet of snow.



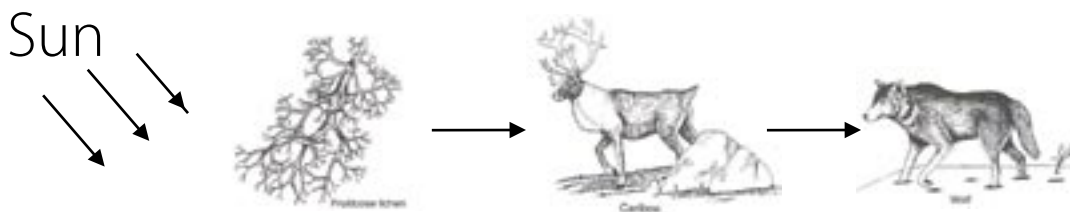
Grizzly bears play an important role in the food web on the Seward Peninsula.

ground below the surface called *permafrost*. Permafrost is a defining characteristic of the arctic tundra biome. Soils here form slowly, and there is very little drainage of water. In the summer, only the top layer of soil thaws just a few inches, providing a growing surface for the roots of vegetation. Tundra vegetation is adapted to the cold and the short growing season. These plants are adapted to carry out photosynthesis at low temperatures and low light intensities. Mosses, sedges, and lichens are common. There are few trees, and the ones that do manage to grow stay close to the ground so that they are insulated by snow during the long winters. Animals on the tundra are adapted to survive winter and to breed and raise young quickly during the short summer. Some species hibernate during winter; others may migrate south, like birds. Other animal and bird species remain on the tundra year round by relying on additional insulation from fat that they gain during the summer. An example of the 1,700 species of plants and animals that live in the arctic tundra can be found on the **Arctic Food Web Critters** page following this lesson (page 141).

The tundra can be characterized as having low biotic diversity compared to other biomes of the world, but the interactions between the plants and animals is diverse and complex. In this ecosystem the basic building blocks of life are present: air, water, sun, soil. Plants on the tundra are able to take these building blocks and make their own food to grow (photosynthesis). We call them producers. Other producers on the tundra include algae, lichen, and bacteria.

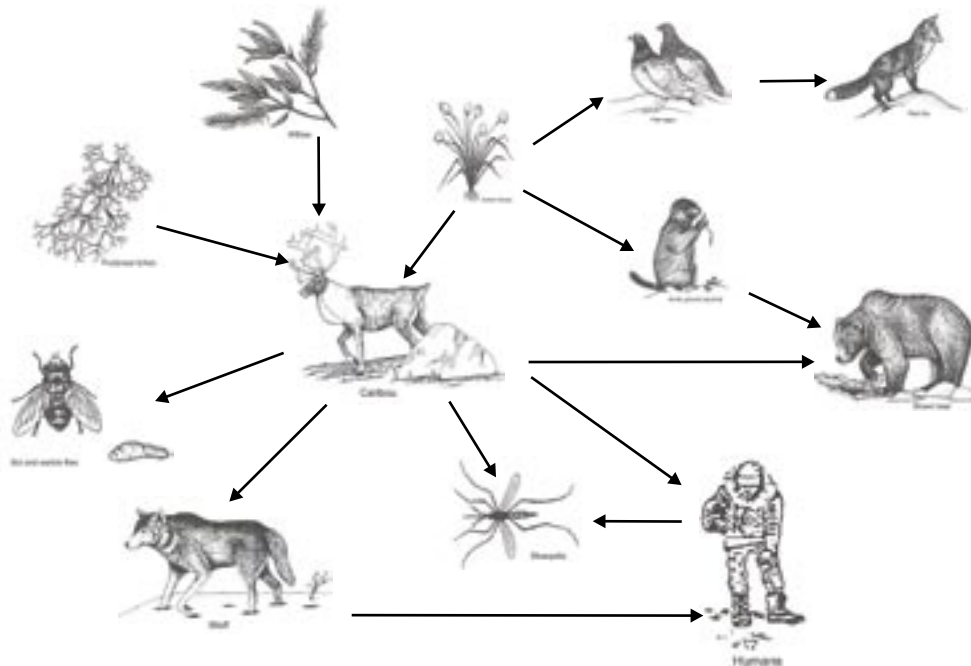
All other organisms on the tundra are called consumers because they eat or consume other living things. There are four major groups of consumers: herbivores, carnivores, omnivores, and detritivores. Herbivores eat plants. Caribou and musk ox are examples of herbivores living on the arctic tundra. Carnivores eat meat, like wolves and fox. Omnivores eat both plants and meat, like bears. Detritivores are organisms that feed on nonliving organic matter. When a plant or animal dies on the tundra, animals such as ravens, insects, mushrooms and bacteria will eat it. What is not eaten returns to the soil in the form of nutrients and minerals that help living plants grow, which in turn provides food for herbivores, which provides food for carnivores, and so on. All of these living things depend on each other to survive. They are all part of a food chain. A food chain describes the movement of energy in an ecosystem from the sun to the producer to the consumer. Food chains often form many interconnecting and overlapping chains called a food web.

Food Chain



Food chains may be affected by changes in plant and animal populations. A change in the size of one population in a food chain will affect other populations. This interdependence of populations within a food chain helps to maintain the balance of plant and animal populations within a community. A small change in one population can have effects on the entire food web. Learning about food webs is important for understanding how populations respond to environmental change, such as disease, weather, or human activities.

Food Web



Procedure

1. Provide a short lecture and give background information to the class on food web vocabulary and the tundra biome covered in the background information above.
2. Students will color their **Arctic Food Web Critters** page and then cut them out.
3. The objects are to be placed on the large sheet of paper. They should be moved around and checked for accuracy before they are glued down permanently. Students do not have to use every cutout on the page.
4. Students can draw food web lines between their cutouts.

Extensions

1. Have a researcher from the UAF Reindeer Research Program visit your classroom and give a seminar on the tundra biome and the interdependence of species on the Seward Peninsula, along with demonstrating the roles of reindeer and humans in the food web.

Assessment

Accurate creation of an arctic food web using the materials provided. Have students write a summary paragraph about their food web describing which organisms are herbivores, carnivores, omnivores, and detritivores. Have them describe what would happen to the other species in the food web if one population increases in number. What would happen to the other species in their food web if one population decreases in number?

Bibliography

The *Arctic Food Critters* images are adapted from the Alaska Ecology Cards and are reprinted with permission:

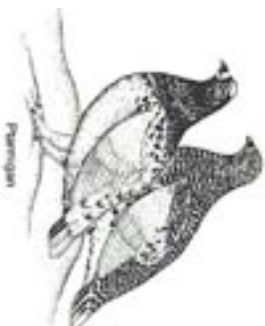
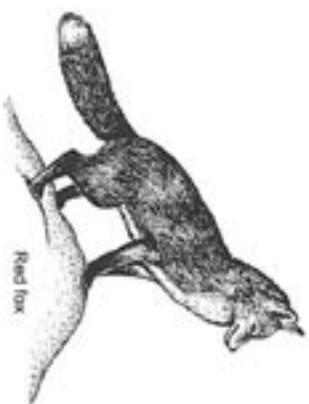
Alaska Wildlife Curriculum 2001
Alaska Department of Fish & Game
Wildlife Education Coordinator
Division of Wildlife Conservation
333 Raspberry Rd.
Anchorage, AK 99518-1599

907-267-2168
robin_dublin@fishgame.state.ak.us

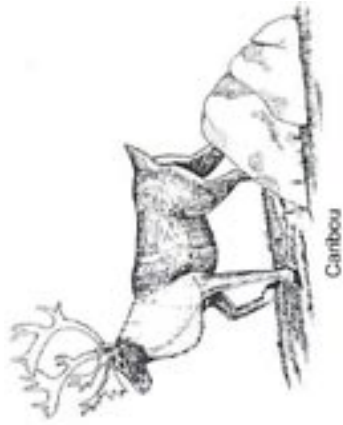
Alaska Wildlife Curriculum activity guides and the Alaska Ecology Cards can be ordered from:

Wizard Works
P.O. Box 1125
Homer, AK 99603
(907) 235-8757

Arctic Food Web Critters



Arctic Food Web Critters



Arctic Food Web Critters



Blueberry



Moose



Mosquito



Arctic ground squirrel



Salmon



Cotton Grass



Red fox



Bacteria



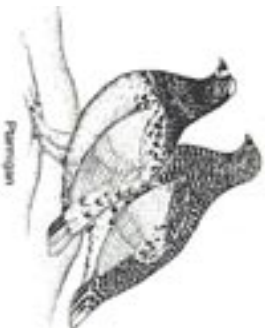
Caribou beetle



Raven



Brown bear

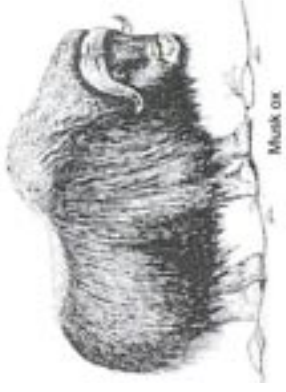


Ptarmigan

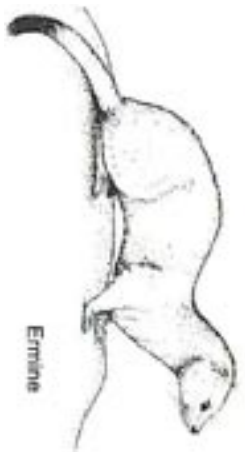


Humans

Arctic Food Web Critters



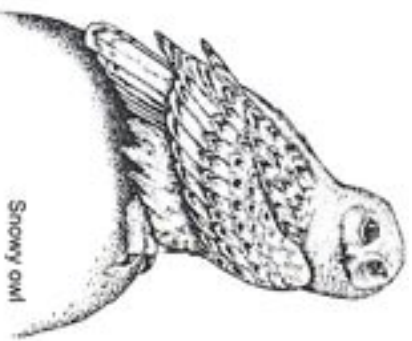
Arctic Food Web Critters



Ermine



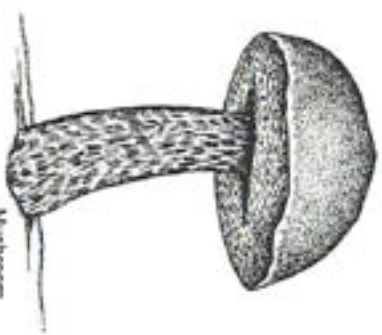
Butterfly



Snowy owl



Golden eagle



Mushroom



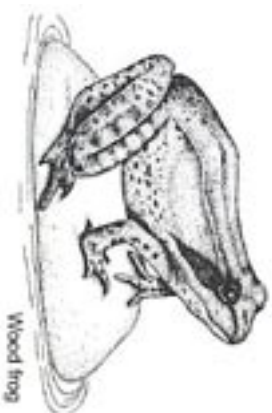
Sedges



Mayflies



Wolverine



Wood frog



Lemming



Horsetail



Herring

Extensions



A three-week-old reindeer calf.

18. Rangifer Tag

Grade 3 - 6

Subject Science

Duration 30 minutes

Materials

Outdoor area or gymnasium

Colored jersey or tags to discriminate between groups

Procedure

Explain that the class will be moving outdoors or to the gymnasium to play Rangifer Tag, which is a simulation of the different herd behaviors of reindeer and caribou. First

choose two or three students to be reindeer herders, and have them stand aside. Divide the remaining students into two groups, the reindeer and the caribou. Have one group wear a colored jersey or tag to distinguish them from the other group. Invite them to demonstrate appropriate herd behavior while feeding on the tundra. Reindeer feed in a close-knit group, while the caribou feed in a more scattered group and move around frequently.

Have the reindeer herders move toward the reindeer group and round them up into a corral for a handling. Have the reindeer group bunch up into a tight, revolving circle. The herders easily move the animals in the direction of the corral for a handling.

After the handling, the reindeer group resumes feeding on the tundra. Now tell the students that the caribou are moving onto the reindeer range on the Seward Peninsula during the winter. At this time, the caribou group moves toward the reindeer group and about half of the reindeer group joins the migrating caribou. Have about four to six caribou remain with the remaining reindeer group. Tell the students that it is now spring and the caribou (with half of the reindeer group) are leaving the Seward Peninsula to migrate to their calving grounds. The remaining reindeer group, with the four to six caribou, remains on the Seward Peninsula.

It is summer again and time for a roundup. Have the herders try to round up the remaining reindeer (with the four to six caribou included in this group). The caribou are not easily herded and try to scatter while being herded. The reindeer, which are usually docile and easily herded, behave much differently in the presence of caribou. They don't bunch up into a tight, revolving circle; instead they act more like caribou. The herders have a hard time trying to get them into the corral.

Have the herders, reindeer, and caribou groups trade roles and play again, if desired. Help students verbalize the outcome and discuss the implications of the caribou presence on reindeer range for herders and communities.



Female reindeer calf with mom.

19. Thermal Regulation and Insulation

Grade 8 - 12

Subject Science, Mathematics

Duration 1 hour

Materials

100 ml graduated cylinders (4 per student or group)

Thermometers

Rubber bands

Stirring rods

Fur swatches (a variety of animal furs, manmade fibers, or use layers of newspaper)

Procedure

1. Make a hypothesis that predicts the effect of the different insulation materials on the cooling rate of a warm body.
2. Make a hypothesis of which available fibers will have the best insulating properties.
3. Measure the air temperature of the room and outside.
4. Have students work in small groups or individually. Wrap two of the 100 ml graduated cylinders with the chosen fiber. Fasten with rubber bands. The cylinders will remain open at the top to insert a stirring rod and a thermometer. Leave the other two cylinders bare.
5. Add 100 ml of hot tap water to each of the four cylinders.
6. Measure the temperature of each cylinder.
7. Take one wrapped and one bare cylinder outside.
8. Leave the other wrapped and bare cylinder inside.
9. Measure the temperature of each cylinder every 5 minutes. Stir each slightly before each reading.
10. Continue for a minimum of 30 minutes.
11. Record all data in a notebook.



Reindeer calves are often born when there is still snow on the ground. Their dark-colored fur absorbs the sun's rays, which helps to keep them warm.



: Females give birth to one calf between mid-April and mid-May.

Analysis:

1. Graph the data with time on the horizontal axis and temperature on the vertical axis. Use a different color or pattern for each of the four cylinders.
2. For each cylinder, calculate the temperature difference between the starting and ending temperature.
3. For each cylinder, calculate the percent decrease in temperature.
4. Evaluate which cylinders lost heat the fastest and which cylinders lost heat the slowest. What effect did insulation have on heat loss? What effect did the air temperature have on heat loss?
5. Compare your data with the rest of the class.
6. Did your data support your hypotheses?

Other possibilities:

1. Put your samples in front of a fan. Does wind affect the rate of cooling? How does it differ for the insulated and bare cylinders?
2. Does evaporative cooling have an effect? Test a wet fur or fiber with a dry one and compare the results.
3. Does the size of the cylinder make a difference? Use a variety of different-sized cylinders to evaluate the surface to volume ratio. Larger containers will cool at a slower rate than small containers. The same principle applies to northern mammals; most arctic animals are larger, hence their bodies don't cool down as quickly as small mammals, making them better adapted to the cold.

20. Reindeer: Cattle of the Arctic?

Grade 7 - 12

Subject Science, English

Duration 1 – 3 hours

Procedure

Compare and contrast the cattle industry in the Lower 48 states with the reindeer industry in Alaska. Have the students do research on their own and have them write a report, give a presentation, or both, with references comparing and contrasting these two industries.

Ideas or topics for research and discussion:

- A. History of raising cattle in the Lower 48 states
- B. History of reindeer herding in Alaska
- C. Grazing/feeding
 - a. Reindeer, free ranging and fenced, vs. cattle, free ranging and fenced in pastures
 - 1. Advantages/disadvantages
 - 2. Amount of area needed for each species
- D. Animal identification and record keeping
 - a. Reindeer ear notching and tags vs. cattle brands and ear tags
- E. Reproduction
 - a. Natural selection and artificial selection
- F. Harvesting and slaughter
 - a. Reindeer roundup culture vs. cattle drive cultures
 - b. Slaughtering techniques
- G. Market for meat
 - a. Buyers
 - b. Price of meat
 - c. Amount harvested yearly for cattle and reindeer
 - d. Nutritional content of each type of meat
 - e. Recipes



: Reindeer can hear much better from behind than in front.



During winter, reindeer are often herded with a snowmachine.

H. Other uses of reindeer and cattle

- a. Hides and other products produced
- b. Dairy cattle
- c. Reindeer used for displays and in the media in the Lower 48

I. Future of reindeer herding and cattle ranching

- a. Problems facing each industry
- b. The projected future of each industry

Contact the UAF Reindeer Research Program for specific reindeer information and resources for researching many of these topics.

21. Reindeer Diorama

Grade 2 - 5

Subject Science, Geography

Duration 1 hour

Materials

Small box for each student

Colored construction paper, clay, pictures, scissors, glue, tape

Procedure

This will be a culminating activity after finishing many of the lessons in this book.

Students will complete a diorama depicting what they have learned about the culture of reindeer herding, and the physical characteristics and geographic location of reindeer in Alaska.



Reindeer bull during the rut.



: Reindeer have lived in Alaska since 1892.

22. Recording Herding Culture

Grade 7 - 12

Subject English, Geography, History

Duration variable

Materials

Video camera

Camera

Tape recorder

Notebook for recording or journal writing

Procedure

This is a culmination lesson after the students have completed many of the lessons in this book and have a solid understanding of the reindeer industry and herding culture.

Students will contact Native elders and reindeer herders in their community and request an interview to discuss their interests and involvement in the reindeer industry. Students need to request permission to film or record the event. Have interview questions prepared ahead of time. Discuss with elders and reindeer herders the importance of reindeer in their community, find out how reindeer herding has changed over the years, and discover how they use reindeer and reindeer products. Have students find out what they should be doing to keep the reindeer industry viable for future generations. Have students exchange ideas with elders and reindeer herders on how to insure the future of reindeer herding without diverging from the industry's original purpose while maintaining good stewardship of grazing lands. Use other community members involved with reindeer herding as a resource for more information. Students may also be able to arrange a visit to a family home for a demonstration on using reindeer products.

Students will share their experiences in the form of journal writing done throughout the project. Students will present to the class any audio or visual productions or other displays. Examples may be: visual displays such as charts, maps, etc., a PowerPoint presentation of the history of herding in the region, and interview results, video production of the interviews, video production of the use of reindeer products, artwork representing their discoveries, and many other possibilities.



Races were held at annual reindeer fairs on the Seward Peninsula during the 1920s and 1930s.
—photo from *Where Did Reindeer Come From?*, by Alice Postell, 1990, p. 73



: Saami herders from Scandinavia came to Alaska to teach Native Alaskans reindeer-herding skills.

Glossary

Abomasum. Fourth or “true” stomach of the reindeer, in which acids break down food prior to its entry into the small intestine.

Antler. Made of solid bone; two arise from the front of the skull each year in members of the deer family.

Brow tine. The long forward section on the antler that points down the nose and protects the reindeer’s eyes.

Brucellosis. Disease caused by the bacteria brucella; causes a female reindeer to abort its unborn calf; long-term infections can cause lameness in adults of both sexes.

Carnivore. A meat-eating animal.

Castrate. To remove the testicles of a male.

Cervidae. The deer family, includes reindeer, caribou, moose, deer, and elk.

Chronic wasting disease. A highly contagious, degenerative, neurological illness that affects both farmed and wild cervids in the US; not found in Alaska.

Circumpolar north. The area of the northern hemisphere that encircles the north pole extending south to the coniferous forests of the taiga.

Collar. Attached to a female reindeer neck to aid herders and researchers in locating reindeer herds; each collar contains a battery and a transmitter; the transmitter can transmit VHF(radio) or UHF (satellite) frequencies.

Consumer. Organism that eats other living things.

Corral. A large wooden pen that is used to confine reindeer during the biannual roundups.

Craters. A pit dug in snow by reindeer during the winter to get to lichens.

Detritivore. Organisms that feed on nonliving organic matter.

Dew claw. A vestigial digit on the foot of some mammals; reindeer have two dew claws that help distribute their body weight when they walk on top of the snow.

Ear notch. An ear notch is used to identify a reindeer’s owner, and each reindeer herder has a unique ear notching pattern. A new calf’s ear is notched during the summer roundup using a cutting tool. Ear notching is used instead of branding by herders to keep track of the animals they own.

Ear tag. Each reindeer is fitted with a plastic, colored tag in the ear. The tag is inscribed with a unique number that allows the herder and biologists to identify the animal throughout its lifetime.

Food chain. Describes the movement of energy from the sun to the producer to the consumer.

Food web. Interconnecting and overlapping food chains.

Gregarious. Describes those who tend to associate with others of their kind.

Guard hairs. One of the two types of hairs that grow on a reindeer's coat; long, hollow hairs that grow approximately 5,000 per square inch.

Handling. The act of gathering reindeer and processing them for vaccinations, antler harvest, ear tagging, etc.; also called a roundup.

Harem. A group of female reindeer associated with one male, usually found during the breeding season.

Herding. To keep animals together in a group; to own and raise reindeer.

Herbivore. A plant-eating animal.

Husbandry. The production and care of domestic animals.

Larva. Immature worm of a fly.

Lichen. An organism that is composed of an algae and a fungus living in a symbiotic relationship.

Nasal turbinate bones. Highly developed rolled bones in the nose of ungulates that assist in the conservation of heat and water.

Nose bot flies. Insects that deposit their larvae in the nasal opening of a reindeer. The larvae migrate up the nose and attach themselves to the internal wall where they develop throughout the winter, are blown out of the reindeer's nose the following spring, and develop into a mature fly.

Omasum. Third stomach of a reindeer, in which the folded leaf-like tissue grinds food and absorbs water from the food for the body.

Omnivore. An animal that eats both plant and animal material.

Parasite. Organisms that live either inside or outside an animal, the host, from whom they take their nourishment.

Pedicle. Base or stem of an antler.

Pelage. Fur or hair of a mammal.

Permafrost. A permanently frozen layer of soil found in the arctic regions of the world.

Pocket. Small wooden pens as part of the corral system that gradually reduce in size in order for a single reindeer to be funneled into the squeeze chute for handling.

Predation. The act of killing and consuming animals for food.

Producers. Organisms that produce their own food by utilizing Earth's building blocks such as the sun, soil, air, or water.

Range. An open region in which animals may roam and feed.

Range permits. Granted to each herder on the Seward Peninsula to raise their reindeer within a certain boundary; range sizes are approximately one million acres, each encompassing state, federal, and tribal lands.

Rangifer tarandus. Genus and species name for both reindeer and caribou.

Reindeer Herders Association (RHA). As part of the Kawerak, Inc. Natural Resources Division, this group provides assistance in the development of a viable reindeer industry to enhance the economic base for rural Alaska and to improve the management of the herds.

Reindeer Research Program. Established in 1981 to further develop and promote the production of reindeer in the state of Alaska through research and collaboration with producers and local communities.

Reticulum. First stomach of a reindeer, having a honeycomb-shaped lining that is able to strain finer food particles from coarser ones. Finer particles are sent to the rumen and coarser particles are sent back to the mouth to be rechewed.

Rumen. Second stomach of a reindeer, a large fermentation chamber that contains microbes that break down cellulose and other compounds in plant cell walls.

Ruminant. Even-toed hoofed animals that chew their cud and have a complex four-chambered stomach; members of the suborder Ruminantia.

Rut. The annual reindeer breeding season; time when bulls produce increased levels of testosterone and females enter into estrus.

Sedge. A grass-like plant that grows in wet areas; reindeer feed heavily on sedges in summer on the tundra.

Squeeze chute. An animal crush that safely restrains an animal with minimal stress to allow for veterinary care, health records, or antler harvest.

Steer. Castrated male.

Tallow. Solid, rendered fat.

Telemetry. A general term used to describe the use of a receiver and transmitting system (often a collar) to locate wildlife for research and management using either VHF or UHF frequencies.

Tundra. Treeless plain characterized by its frost-molded landscapes, extremely low temperatures, poor soil nutrients, and short growing season. There are two types: arctic tundra and alpine tundra.

Ungulate. A hoofed herbivorous mammal.

Vaccine. Prevents disease by causing the body to produce antibodies when exposed to killed germs so that the body can fight off the live disease if later exposed to it.

Velvet. The soft, fuzzy tissue that covers growing antlers.

Virus. Smaller than bacteria; must live within another living cell.

Warble flies. Small flies that lay their eggs in the reindeer's hair during summer. Larvae hatch and burrow beneath the reindeer's skin and form cysts. The following spring the larvae emerge and develop into adult flies.

West Nile virus. A mosquito-borne virus that causes encephalitis, or inflammation of the brain; migrating birds are believed to assist in its spread; not found in Alaska.

Wool hairs. One of the two types of hair on a reindeer's coat; the fine under hairs that grow very densely, about 13,000 per square inch.

For Further Study

Books

- Andrews, Clarence, L. *The Eskimo and His Reindeer in Alaska*. The Caxon Printers, Ltd., Caldwell, Idaho. 1939. 253 pp.
- Beach, Hugh. *A Year in Lapland: Guest of the Reindeer Herders*. University of Washington Press, Seattle, Washington. 2001. 256 pp.
- Conasty, Gerry. *Reindeer Herders of the Mackenzie Delta*. Firefly Books, Richmond Hill, Ontario, Canada. 2004. 96 pp.
- Ederer, Bernard, F. *Bingo, Gallant Reindeer Dog*. Exposition Press, Hicksville, New York. 1977. 126 pp.
- Hadwen, Seymour, I. and L.J. Palmer. *Reindeer in Alaska*. Shorey's Bookstore, Seattle, Washington. 1973 (reprint edition). Originally published 1922 by the Bureau of Biological Survey, United States Department of Agriculture Bulletin No. 1089, Washington, D.C. 74 pp.
- Lopp Smith, Kathleen and Verbeck Smith (eds.). *Ice Window: Letters from a Bering Strait Village, 1892–1902*. University of Alaska Press, Fairbanks, Alaska. 2001. 412 pp.
- Murray, Keith, A. *Reindeer and Gold*. Occasional paper no. 24. Center for Pacific Studies, Bellingham, Washington. 1988. 249 pp.
- North, Dick. *Arctic Exodus: The Last Great Trail Drive*. MacMillan of Canada, Toronto, Ontario, Canada. 1991. 284 pp.
- Poest, Gordon. *Raising Reindeer for Pleasure and Profit*. Gordon Poest, Hamilton, Michigan. 2001 (second edition). 106 pp.
- Postell, Alice. *Where Did the Reindeer Come From? Alaska Experience, the First Fifty Years*. Amaknak Press, Portland, Oregon. 1990. 116 pp.
- Rausch, V. R. and D. L. Baldwin (eds.). *The Yukon Relief Expedition and the Journal of Carl Johan Sakariassen*. University of Alaska Press, Fairbanks, Alaska. 2002. 280 pp.
- Rinaldo, Peter, M. *The Great Reindeer Caper: The Missionary and the Miners*. Dorpete Press, Briarcliff Manor, New York. 1997. 120 pp.

- Seveck, Chester, A. *Longest Reindeer Herder. A fascinating true life story of an Alaskan Eskimo covering the period 1890 to 1973.* Arctic Circle Enterprises, Anchorage, Alaska. 1973. 48 pp.
- Stern, Richard, O., Edward, L. Arobio, Larry L. Naylor, and Wayne C. Thomas. *Eskimos, Reindeer, and Land.* Agricultural Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks, Bulletin 59. 1980. 213 pp.
- Took, Richard. *Running with Reindeer: Encounters in Russian Lapland.* Westview Press, London, England. 2003. 365 pp.
- Tower, Elizabeth, A. *Reading, Religion, and Reindeer: Sheldon Jackson's Legacy to Alaska.* E.A. Tower, Anchorage, Alaska. 1988. 121 pp.
- Vorren, Rnolv and Ornolv Vorren. *Saami, Reindeer, and Gold in Alaska: the Emigration of Saami from Norway to Alaska.* Waveland Press, Prospect Heights, Illinois. 1994. 172 pp.
- Wilder, Edna. *Secrets of Eskimo Skin Sewing.* University of Alaska Press, Fairbanks, Alaska. 1998 (reprint edition). Originally published 1976 by Alaska Northwest Books. 141 pp.

Children's books

- Arnold, Caroline. *Reindeer.* Scholastic Books. 1993.
- Bernhard, Emery, and Durga Bernhard. *Reindeer.* Holiday House, New York. 1994.
- Brett, Jan. *The Wild Christmas Reindeer.* Putnam Publishing Group, New York. 1990.
- Denzel, Justin, F. *Snowfoot: White Reindeer of the Arctic.* Garrard Publishing Company, Champaign, Illinois. 1976.
- Kingman, Lee. *The Secret Journey of the Silver Reindeer.* Doubleday, New York. 1968. 93 pp.
- Kvale, Velma, R. *Tobuk, Reindeer Herder.* T.S. Denison Publishing Company, Minneapolis, Minnesota. 1968. 112 pp.
- Lepthien, Emilie, U. *Reindeer.* Children's Press. 1994.
- Lightener Hopf, Alice. *Biography of an American Reindeer.* Putnam Publishing Group, New York. 1976.

McCaughrean, Geraldine. *How the Reindeer got their Antlers*. Holiday House, New York. 2000. 32 pp.

McDonald, Mary Ann. *Reindeer*. Childs World, Plymouth, Minnesota. 1998. 32 pp.

Neelands, Barbara, S. *The Coming of the Reindeer*. Lantern Press, New York. 1966.

Palazzo, Tony. *Jan and the Reindeer*. Garrard Publishing Company, Champaign, Illinois. 1963.

Savage, Alma. *Smoozie: The Story of an Alaskan Reindeer Fawn*. Sheed and Ward, New York. 1941.

Audiovisual material

Canada's Reindeer. Inuk Films. 1981. 24 minutes.

This film is the story of the famous reindeer trek from Alaska to Canada in 1935. The Canadian government settled the reindeer in the Mackenzie Delta to improve the economic conditions of the Inuit people.

The Herd. National Film Board of Canada. 1999. 100 minutes.

This film traces the story of Andrew Bahr's drive of 3,000 reindeer over 3,000 miles from Alaska to Canada in 1935. What was supposed to take 18 months took 6 years.

High Tech on the Tundra. Science Times. 2002. 20 minutes.

A recent film describing the herders' plight on the Seward Peninsula as they struggle to keep their reindeer from following the caribou. Features UAF Reindeer Research Program researchers and Nome area residents.

The Odyssey of Captain Healy. Waterfront Sounding Productions. 60 minutes.

The story of Mike Healy, the law and order of the Alaska Territory. Captain Healy was instrumental in bringing reindeer to Alaska.

The Reindeer Queen. Waterfront Soundings Productions. 28 minutes.

The story of Mary Antisarlook, owner of the largest reindeer herd during the Nome gold rush.

Other reindeer- and education-related resources

Reindeer Research Program, University of Alaska Fairbanks

<http://reindeer.salrm.uaf.edu/>

School of Natural Resources and Agricultural Sciences, University of Alaska Fairbanks

<http://www.uaf.edu/snras/>

Reindeer Owners and Breeders Association

<http://www.reindeer.ws/>

Reindeer Herders Association, Kawerak, Inc.

http://www.kawerak.org/natural_resources/

Worldwide Rangifer research and resources

<http://www.taiga.net/rangifer>

Alaska Wildlife Curriculum, Alaska Department of Fish and Game

<http://www.state.ak.us/adfg/wildlife/geninfo/educate/awc.htm>

Project Wild, Alaska Department of Fish and Game

http://www.state.ak.us/adfg/wildlife/geninfo/educate/pw_home.htm

Cross-Reference Indexes

Grade Index

Grade	Title
K	Reindeer Herding in Alaska pg. 32; Eskimo Ice Cream pg. 74; Reindeer Alphabet Book pg. 119
1	Reindeer Herding in Alaska pg. 32; Eskimo Ice Cream pg. 74; Reindeer Alphabet Book pg. 119
2	Reindeer Herding in Alaska pg. 32; Eskimo Ice Cream pg. 74; Reindeer Alphabet Book pg. 119; Reindeer Bingo pg. 123; Reindeer Diorama pg. 153
3	Reindeer Herding in Alaska pg. 32; Eskimo Ice Cream pg. 74; Reindeer Alphabet Book pg. 119; Reindeer vs. Caribou pg. 53; Traditional Uses of Reindeer pg. 64; Reindeer Bingo pg. 123; Rangifer Tag pg. 148; Reindeer Diorama pg. 153
4	Reindeer Herding in Alaska pg. 32; Eskimo Ice Cream pg. 74; Reindeer Alphabet Book pg. 119; Reindeer vs. Caribou pg. 53; Traditional Uses of Reindeer pg. 64; How Much Do Reindeer Eat? pg. 93; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Rangifer Tag pg. 148; Reindeer Diorama pg. 153
5	Reindeer Herding in Alaska pg. 32; Reindeer vs. Caribou pg. 53; Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Velvet Antlers pg. 77; How Much Do Reindeer Eat? pg. 93; Creating a Reindeer Brochure pg. 117; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Rangifer Tag pg. 148; Reindeer Diorama pg. 153
6	Reindeer Herding in Alaska pg. 32; Reindeer vs. Caribou pg. 53; Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; How Much Do Reindeer Eat? pg. 93; Creating a Reindeer Brochure pg. 117; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Rangifer Tag pg. 148
7	Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; How Much Do Reindeer Eat? pg. 93; Creating a Reindeer Brochure pg. 117; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154

8	Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; How Much Do Reindeer Eat? pg. 93; Creating a Reindeer Brochure pg. 117; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Thermal Regulation pg. 149; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154
9	Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Traditional Uses of Reindeer pg. 64; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; Hair Identification pg. 99; Reindeer Rumen pg. 104; Building a Radio and Transmitter pg. 107; Creating a Reindeer Brochure pg. 117; Creating an Arctic Food Web pg. 137; Thermal Regulation pg. 149; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154
10	Traditional Uses of Reindeer pg. 64; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; Hair Identification pg. 99; Reindeer Rumen pg. 104; Building a Radio and Transmitter pg. 107; Creating a Reindeer Brochure pg. 117; Thermal Regulation pg. 149; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154
11	Traditional Uses of Reindeer pg. 64; Hair Identification pg. 99; Reindeer Rumen pg. 104; Building a Radio and Transmitter pg. 107; Creating a Reindeer Brochure pg. 117; Thermal Regulation pg. 149; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154
12	Traditional Uses of Reindeer pg. 64; Hair Identification pg. 99; Reindeer Rumen pg. 104; Building a Radio and Transmitter pg. 107; Creating a Reindeer Brochure pg. 117; Thermal Regulation pg. 149; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154

Subject Index

Subject	Title
Art	Traditional Uses of Reindeer pg. 64; Creating a Reindeer Brochure pg. 117
Computer Science	Website Scavenger Hunt pg. 49; Creating a Reindeer Brochure pg. 117
English	Reindeer vs. Caribou pg. 53; Traditional Uses of Reindeer pg. 64; Eskimo Ice Cream pg. 74; Creating a Reindeer Brochure pg. 117; Reindeer Alphabet Book pg. 119; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154
Geography	Reindeer Herding in Alaska pg. 32; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Reindeer Diorama pg. 153; Recording Herding Culture pg. 154
History	Reindeer Herding in Alaska pg. 32; History of Reindeer in Alaska pg. 58; Traditional Uses of Reindeer pg. 64; Creating a Reindeer Brochure pg. 117; Recording Herding Culture pg. 154
Mathematics	Reindeer Numbers pg. 61; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; How Much Do Reindeer Eat? pg. 93; Thermal Regulation pg. 149
Reading	Reindeer Herding in Alaska pg. 32; Eskimo Ice Cream pg. 74
Science	Reindeer Herding in Alaska pg. 32; Reindeer vs. Caribou pg. 53; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; Hair Identification pg. 99; Reindeer Rumen pg. 104; Building a Radio and Transmitter pg. 107; Reindeer Alphabet Book pg. 119; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Rangifer Tag pg. 148; Thermal Regulation pg. 149; Reindeer: Cattle of the Arctic? pg. 151; Reindeer Diorama pg. 153

Topic Index

Topic	Title
Adaptations	Reindeer Herding in Alaska pg. 32; Website Scavenger Hunt pg. 49; Reindeer vs. Caribou pg. 53; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; How Much Do Reindeer Eat? pg. 93; Hair Identification pg. 99; Reindeer Rumen pg. 104; Creating a Reindeer Brochure pg. 117; Reindeer Alphabet Book pg. 119; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Rangifer Tag pg. 148; Thermal Regulation pg. 149; Reindeer Diorama pg. 153
Alaska History	Reindeer Herding in Alaska pg. 32; Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Eskimo Ice Cream pg. 74; Creating a Reindeer Brochure pg. 117; Reindeer Bingo pg. 123; Reindeer: Cattle of the Arctic? pg. 151; Recording Herding Culture pg. 154
Behavior	Website Scavenger Hunt pg. 49; Reindeer vs. Caribou pg. 53; What Do Farmed Reindeer Eat? pg. 86; How Much Do Reindeer Eat? pg. 93; Reindeer Rumen pg. 104; Reindeer Alphabet Book pg. 119; Creating an Arctic Food Web pg. 137; Rangifer Tag pg. 148; Reindeer Diorama pg. 153
Culture	Reindeer Herding in Alaska pg. 32; Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Eskimo Ice Cream pg. 74; Velvet Antlers pg. 77; Creating a Reindeer Brochure pg. 117; Reindeer Alphabet Book pg. 119; Reindeer Bingo pg. 123; Reindeer: Cattle of the Arctic? pg. 151; Reindeer Diorama pg. 153; Recording Herding Culture pg. 154
Habitat	Reindeer vs. Caribou pg. 53; Reindeer Rumen pg. 104; Reindeer Bingo pg. 123; Creating an Arctic Food Web pg. 137; Rangifer Tag pg. 148; Thermal Regulation pg. 149; Reindeer Diorama pg. 153
Herding	Reindeer Herding in Alaska pg. 32; Website Scavenger Hunt pg. 49; History of Reindeer in Alaska pg. 58; Reindeer Numbers pg. 61; Traditional Uses of Reindeer pg. 64; Velvet Antlers pg. 77; Creating a Reindeer Brochure pg. 117; Reindeer Alphabet Book pg. 119; Reindeer Bingo pg. 123; Rangifer Tag pg. 148; Reindeer: Cattle of the Arctic? pg. 151; Reindeer Diorama pg. 153; Recording Herding Culture pg. 154
Nutrition	What Do Farmed Reindeer Eat? pg. 86; How Much Do Reindeer Eat? pg. 93; Reindeer Rumen pg. 104
Research	Website Scavenger Hunt pg. 49; Velvet Antlers pg. 77; What Do Farmed Reindeer Eat? pg. 86; Reindeer Rumen pg. 104; Creating a Reindeer Brochure pg. 117; Reindeer Bingo pg. 123; Recording Herding Culture pg. 154

Appendix A

Reindeer Roundup! Educational Kit Materials

Each kit includes this book and the following items:

Animal specimens

- Reindeer pelt
- Reindeer skull
- Velvet antler
- Bone antler
- 2 reindeer hooves (1 shovel shaped, 1 snowshoe shaped)
- 2 caribou hooves (1 shovel shaped, 1 snowshoe shaped)

Videos

High Tech on the Tundra, 20 minutes

Reindeer Queen, 28 minutes

CD-ROMs

Reindeer Herding in Alaska

UAF Jukebox series, an interactive oral history program

Reindeer Visual Aids

PowerPoint slide shows:

- Adaptations of Reindeer to Life in the Arctic
- History of Reindeer in Alaska
- Radio and Satellite Telemetry
- Eskimo Ice Cream (lesson on page 74)

Images (see samples on the following page):

- Cartoon drawings of reindeer biology and behavior
- Graphs and maps
- History photos
- Reindeer photos

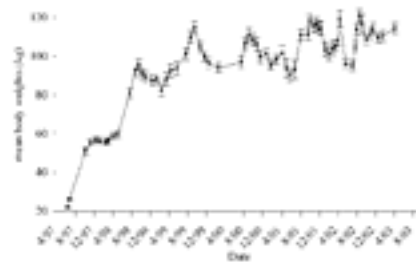
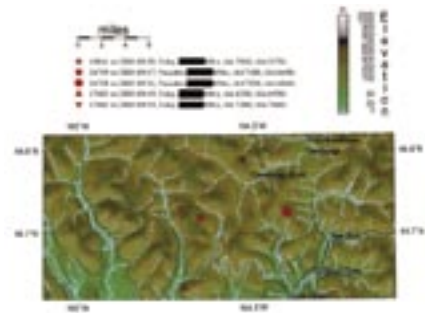
- Fairbanks farm reindeer
- Seward Peninsula reindeer and activities

Sample of Images on the *Reindeer Visual Aids* CD-ROM

Cartoon drawings:



Graphs and Maps:



History images:



Reindeer photos:



Appendix B

Slide indexes for PowerPoint slide shows on the Reindeer Visual Aids CD-ROM

Adaptations of Reindeer to Life in the Arctic

Slide 1: Title

Slide 2: Herds grazing in summer and winter photo

Herd foraging during the summer on the Seward Peninsula in western Alaska. Summer is a time for harvesting velvet antlers and tagging fawns.

Herd foraging for lichens during the winter on the Seward Peninsula in western Alaska. Winter is the time of year when the herders will slaughter some of their animals for meat and hides.

Slide 3: Warm in winter

Reindeer are adapted for survival during long periods of extremely cold weather in the Arctic. Perhaps most important is the reindeer's ability to conserve body heat and therefore, body tissues.

Consider what happens when a reindeer faces high temperatures. We have learned that the insulating quality of the coat is so great that heat cannot be eliminated from its body by radiation. Heat cannot be eliminated by sweating because reindeer have no sweat glands (except for a few around the nose). In fact, only panting can eliminate significant amounts of heat. When heat begins to accumulate in the body, body temperature rises. This is a deadly situation. Biologists call this heat stress.

Slide 4: Specialized hair coat

The furry pelage of reindeer consists of two types of hairs: the long coarse guard hairs, which have hollow cores and number about 5,000 per square inch, and the very fine wool hairs, which are as dense as 13,000 per square inch. These hollow guard hairs and fine wool hairs combine to form a thick insulating mesh, which traps air within and between the hairs. The insulating quality of reindeer hair prevents heat loss through the skin and is so great that reindeer can rest comfortably for long periods of time on cold snow. In fact, if you examine their beds carefully, you will see that the surface of the snow did not melt or ice over after the reindeer's rest period. Further, you may have noticed that the moisture in the reindeer's breath freezes on the surface of its shoulder when it runs in very cold weather. However, this ice is like a very dry frost on the coat surface. When the reindeer stops, it soon falls off or blows away.

Slide 5: Camouflage

In winter, the hair of the reindeer's hide is many-colored. The mane is white. The underbelly, rump, legs, and face are generally dark brown, and the shoulders and ribs are light tan. In summer when the long guard hairs fall out and the fine downy hairs are exposed, the reindeer appears dark colored, and often black (with white socks). Considering the colors of the vegetation, snow, and on the hills and mountains in the background, it is thought that the reindeer hair color serves to conceal them from predators. Unfortunately it also makes it more difficult for the herders to find and follow the herd. Therefore, experienced reindeer herders usually include a few white-colored or spotted reindeer in their herd to increase visibility of animals on the darker-colored tundra.

Slide 6: White reindeer photo

Owners of free-ranging herds like to have a handful of reindeer colored in this way. In the summertime, the dark-colored reindeer blend in with the tundra. Knowing how many white or spotted reindeer the herd has helps the herder determine if the entire herd is together. A wild caribou never has this coloring. The white color or spots are a result of domestication.

Slide 7: High Flotation

A swimming reindeer seems to ride high on the water. This results from the great buoyancy imparted by the air trapped within the hollow guard hairs. Reindeer are known to be great swimmers and will cross wide rivers and lakes when searching for prime feeding areas.

Slide 8: High-stepping gait

The reindeer's high-stepping gait enables it to plant its feet accurately. This specialized and exaggerated type of walking and running helps the reindeer travel across bogs and tussocks, deep snow, and ice.

Slide 9: Travel through snow

The relatively long legs of reindeer enable them to travel through deep snow in their almost constant search for food.

Slide 10: Photo of reindeer hoof

This photo is used to introduce the topic of reindeer hooves. Point out the two toes and the dewclaws.

Slide 11: Hooves as snowshoes

Broad hooves and dewclaws act as snowshoes, enabling the reindeer to travel more easily across deep snow. Other members of the deer family generally have small pointed hooves. Because other members of the deer family are not able to travel freely when snowfalls are heavy, they may become restricted to small grazing areas called yards, which in severe winters can cause many deer to starve.

Slide 12: Hooves as shovels

The broad, snowshoe-like hoof enables the reindeer to dig through snow in search of food. Researchers have found that reindeer can dig feeding craters when snow is as deep as three feet. Their shovel-like hooves also enable the reindeer to chip through hard and crusted snow. However, when icing conditions are severe, digging becomes impossible and the reindeer must move, often several miles, to more favorable feeding areas.

Slide 13: Hoof hair for quick stops

Look closely at the underside of a reindeer's hoof and you will see hairs that extend down and across the pad. These hairs are thought to enable the reindeer to better control the movement of its feet, for example, to prevent slipping on ice.

Slide 14: Nose warms air

The nostrils of reindeer are very highly developed for water and heat conservation. When seen in cross-section they appear as a rolled newspaper. Scientists call this a rolled scroll, or nasal turbinate bones. They have established that this specialized structure vastly increases the surface area within the nostrils. While the explanation of the biological function of this tissue is complex, we know that incoming air is warmed before it reaches the lungs and that heat in the expired air is retained and returned to the body before it is exhaled. Also water in the expired air condenses in the cooler portion of the nostrils, where it moistens incoming air or is absorbed back into the blood. This explains why you seldom, if ever, see the reindeer's breath as it grazes peacefully in deep winter.

Slide 15: No chapped lips

Hairs on the reindeer's face extend down to and almost completely cover the lips. This protects the muzzle from frostbite during winter when reindeer obtain their daily food as frozen vegetation from beneath the snow. The lips of a reindeer are very fleshy and mobile. You will also notice that reindeer have no upper front teeth or incisors. Both of these characteristics help them harvest northern food plants such as lichens, grasses, and willows.

Slide 16: Large organs

Some researchers have reported that reindeer have larger vital organs (heart, lungs, liver) than domestic animals of similar size, such as sheep and goats. These organs provide the nutrients and energy necessary for work and survival. Therefore, if reindeer must work harder, grow fatter, run more quickly, and generate more heat in winter, then their larger vital organs contribute to their survival.

Slide 17: Summer appetite

It is a curious fact that reindeer eat less food in winter than in summer. This holds true even when reindeer have access to an abundance of the most nutritious and preferred foods. It is also strange but true that during winter reindeer expend less energy and almost always lose body weight and body substance (mostly fat). We now know that reindeer have

evolved to survive the winter by using their body tissues for essential body functions and by living a sedentary rather than a highly active life during winter.

In summer when food is abundant, reindeer eat large quantities of highly nutritious green vegetation. It is during this time that reindeer put on muscle mass and deposit large pads of fat beneath the skin of the rump and back. These fat pads enable the reindeer to survive the long cold winter when food supplies are scarce.

Slide 18: Winter appetite

Reindeer eat less food in winter than in summer. This is true even when reindeer have access to an abundance of nutritious and preferred foods. Reindeer expend less energy during the winter and they almost always lose body weight and body substance (mostly fat). We now know that reindeer have evolved to survive the winter by lowering their metabolic rate and movements and by using their body tissues for essential functions.

Slide 19: Winter preference for snow

During winter, the only source of water available to reindeer is snow, which is little more than solidified, pure water, very cold and containing almost no dissolved minerals. Although the reindeer must use precious body heat to melt and warm snow when they eat it, given the opportunity to select different kinds of water while on winter diets, reindeer almost always choose snow. If fresh snow is available, they refuse to drink seawater, warm water, or cold water.

How does the reindeer's preference for snow contribute to survival? The explanation for these observations is quite complex. Researchers now think the answer is based on the fact that snow is a very pure form of water containing almost no minerals. If an animal takes in more minerals than required for normal functioning, the extra minerals must be eliminated in urine. This requires the intake of more water, which in turn has to be warmed to body temperature. Because snow contains almost no minerals, the daily water requirement for reindeer is minimized, and body heat that would have been needed to warm larger amounts of water is conserved.

Slide 20: Deer eating lichen

Perhaps the most important adaptation of reindeer for life in the north is the reindeer's fondness for lichens, which are sometimes called reindeer moss. In fact, of the many kinds of range plants, grasses, and livestock feeds tested to date, we have found that reindeer most often select lichens first. In contrast, other large arctic mammals (except caribou) almost never eat lichens. The importance of this unique physiological adaptation cannot be overestimated. The sustained use of tundra rangeland, as well as calculations for carrying capacity and maximum herd size, are based on the availability of lichens for winter grazing.

There are at least two reasons why the reindeer's preference for lichens has enabled them to survive in the north. First, lichens usually constitute a major part of the vegetative biomass (food supply) of winter tundra pastures. Because other grazing mammals do not eat

lichens, the reindeer is guaranteed a supply of food for winter survival, as long as they are allowed to graze freely and these pastures are not overgrazed.

The second reason for the importance of lichens in the reindeer's diet is more complex. From a nutritionist's viewpoint, lichens are extremely deficient in protein, fat, minerals, and vitamins. In fact, lichens, like candy, pancakes, and potatoes, contain mostly carbohydrate. How can a high-carbohydrate diet have any survival value for reindeer?

We know that lichens, like most carbohydrate diets, are highly digestible for reindeer. That means that almost all the nutrients in lichens become available to the reindeer (mostly as energy) for the maintenance of body functions. And secondly, because lichens contain only small amounts of protein and minerals, there are fewer metabolic wastes to be eliminated in urine. This is important because the elimination of body wastes in urine requires the excretion of body water. Replacing that water means eating more snow, which, as it is warmed to body temperature, will consume more body heat.

Does this mean that lichens are the best of all possible rations for winter survival of reindeer? Not at all. Reindeer do very well on highly nutritious livestock feeds, but such feeds are not usually available to reindeer in winter. The reindeer have adapted to an ecological niche, lichen pastures, in which there are no competitors for their preferred winter food resource (lichens). The survival value of lichens can be traced to their low content of minerals and proteins. This in turn enables the reindeer to conserve body water and therefore, body heat.

Slide 21: Lichen photo on tundra

Slide 22: Title slide to introduce the topic of antlers

Slide 23: Sparring deer

Male reindeer use their antlers to establish dominance before the breeding season. These tests of strength enable the largest and strongest male reindeer to gather and protect their harems and thereby to become the primary breeding sires of the herd.

Slide 24: Attract harem

Some romanticists claim that large antlers have considerable sex appeal to female reindeer as the breeding season approaches. While it would be difficult to disprove this claim, there does seem to be a close relationship between body size and antler size. As noted under the slide 23 (**Sparring deer**) description, the most successful breeding bulls are often the largest and strongest males in the herd.

Slide 25: Brow tines protect eyes

The long forward section on each antler is called the brow tine, although reindeer may not have brow tines on each antler. These brow tines help to protect the reindeer's eyes when they are sparring with another reindeer, scraping their antlers on a shrub, or feeding on tall willows leaves in the summer.

Slide 26: Antler scraping

At the end of the summer as the velvet antler hardens to bone, the velvet tissue that covers it will dry, harden, and begin to fall away from the antler. Reindeer will rub their antlers on trees, posts, fences, or anything sturdy they can find to help get that velvet tissue off.

Slide 27: Deer defend against wolf

Reindeer may use their antlers as a display mechanism to fend off predators, such as wolves (In other words, "Look how big my antlers are! You are going to have a hard time getting me!"). Free-ranging reindeer on western Alaska's Seward Peninsula are subject to the same array of natural forces as their wild caribou cousins (i.e. predators, weather, disease).

Slide 28: Female dominance

Females with antlers are dominant over all other reindeer that have lost their antlers. Females with antlers will be able to eat at food craters and easily ward off other, antlerless reindeer.

Slide 29: Protect food crater calf

In late winter, all male and nonpregnant females lose their antlers and begin to grow a new set in spring. Pregnant females will retain their antlers through late spring, which insures their dominance in feeding areas. This in turn provides more food for their calves both before and after birth.

Slide 30: Antlers = Dominance

Example of two female reindeer; one with antlers and one without.

Slide 31: Female defending food crater

Pregnant females retain their antlers until just shortly after they give birth (approximately five days later). Females with antlers are dominant over females without antlers and they are able to defend craters that were dug out to provide access to lichens.

Slide 32: High-nutrient milk

Reindeer milk is extremely high in fat and protein. Only sea mammals such as seals secrete more concentrated milk. Newborn reindeer calves start to nurse almost immediately after birth. The highly nutritious milk enables the calves to grow and develop very rapidly and provides the energy needed to follow their mothers, who are constantly moving to find food, seek shelter from wind and cold, or escape from predators.

Slide 33: Elsa and Denali photo

This is Elsa and her fawn, Denali, in spring 2001. Elsa lost her antlers a few days after giving birth. Notice the dark-colored coat of the fawns. Reindeer fawns are born between mid-April and mid-May, about a month earlier than caribou. There is often snow on the ground

at this time, and the dark-colored coat absorbs the sun's rays, keeping the fawn warm. Elsa is our ambassador reindeer, who travels with us to the local Fairbanks schools to help us teach about reindeer and the reindeer industry in Alaska.

Slide 34: Deer in velvet in pasture photo

This is a photo of a large group of males on the Seward Peninsula in June. Notice their large velvet antlers and dark brown summer coats.

Slides 35 – 50: Photo series of reindeer corralling on the Seward Peninsula

Native reindeer herders on the Seward Peninsula in western Alaska round up their herds at least twice a year. In the summer the reindeer are driven into large corrals either by foot, four-wheeler, or helicopter. The new fawns are ear tagged and ear notched, body weights are taken, adults are vaccinated for brucellosis, velvet antlers are harvested, some males are castrated, and sometimes radio collars are placed on adult females so herders and biologists can keep track of the herds' location.

History of Reindeer in Alaska

Slide 1: Title

Slide 2: Timeline

The five distinct periods that will be discussed during the slide show.

Slide 3: Whaling Affects Arctic People

Traders from the whaling ships wanted pelts, meat, and hides. To get them from the Natives, they traded guns, ammunition, traps, unnatural foods: flour, sugar, tobacco, alcohol (which was illegal at the time). Soon plastics and petroleum replaced whale products and the whalers left, leaving the Inuit people dependent upon imported food and goods they could not replace.

Slide 4: The *Bear*

The U.S. Revenue Cutter Service was a government agency that enforced laws, provided food for starving Natives, and gave medical attention to the sick and injured along the western coast of Alaska. By 1888, captains of these boats were becoming concerned for the wellbeing of Natives living along the Bering Sea coast. Whaling ships had so depleted the supply of marine mammals that the people were facing starvation.

Slide 5: Dr. Sheldon Jackson

These reports of starvation alarmed Jackson. He wrote a memo to the Commissioner of Education urging the establishment of schools to teach the Eskimos skills to enable them to compete in the white man's world.

Slide 6: Dr. Sheldon Jackson

Alaska was his main focus from 1877 until his death in 1909. By publicizing Alaska's needs, he spearheaded the passage of the Organic Act of 1884 and the beginning of the public school system. His successful introduction of reindeer into western Alaska may have saved the people there from starvation.

Slide 7: Jackson's Three Concerns

There were conflicting reports that the Eskimos were indeed desperate for food and were starving.

Slide 8: Schools and missions built

Jackson solved the first two concerns by establishing missions and building schools in the 1890s.

Lopp and Thorton were hired by Jackson to establish the school at Wales. The Bureau of Education could only pay for travel and school supplies, so Jackson appealed to the churches to come up with the salary money for the four missionaries.

Slide 9: Captain Healy

Jackson traveled with Healy to visit the teachers in Alaska and to visit a village in Siberia. Healy was born on a Georgia plantation to a white father and mulatto slave. Healy's father sent his children north to boarding schools at the age of ten so they would not be considered slaves. At the age of 16 he ran away from school and worked as a cabin boy, and at 24 became an officer on a merchant vessel. In 1868, he made his first cruise to Alaska with the U.S. Revenue Marine Service, and by 1883 was a full captain. In 1886, Healy received the *Bear*, the only ship monitoring Alaska waters at that time.

Slide 10: Map of Siberia

This visit gave Jackson the opportunity to observe the benefits that the Koriak people obtained from herding reindeer. He saw how the Eskimos used the hides for clothing and shelter and when hunting and fishing was poor, the reindeer provided a readily available source of food. Jackson was impressed and he felt that he and Healy had good evidence that reindeer would help Eskimos in Alaska. Healy added his voice of support to the idea of bringing reindeer to Alaska.

Slide 11: Jackson's plan

Jackson testified that the schools in western Alaska could teach young men in the skills to care and manage the reindeer. Jackson believed that it was no use to teach skills in the Alaska Arctic that were of no use to the people there, such as shoemaking, carpentry, or tinsmithing. The climatic conditions and tundra made reindeer herding practical for western Alaska. In a few years, reindeer could create a permanent and secure food supply.

Slide 12: First reindeer purchase

The first reindeer purchase was made using Healy's experience. Healy knew which bartered goods the Siberians would want and he knew where the reindeer were concentrated along the Siberian coast. Because Jackson had critics of this project back in Washington D.C., he decided to first perform a trial run in which sixteen reindeer were brought to Amaknak Island to see if they would survive the voyage and the winter. The reindeer did indeed survive the voyage and their first winter on the Alaska island.

Slide 13: 1892, 171 reindeer to Alaska

Captain Healy made five trips to Siberia for reindeer in the summer of 1892 and brought Siberian herders to western Alaska to help train Alaskan herders.

Slide 14: Port Clarence

More reindeer were brought in during 1893. Jackson wanted to distribute the reindeer and build herds as quickly as possible. After cultural clashes with Native Alaskans, the Chukchi herders left Alaska. At this time, Lopp took over as superintendent of the Teller Station.

Slide 15: Herders from Scandinavia

Jackson ran advertisements in Scandinavian newspapers looking for experienced folks in the Saami style of reindeer herding. They brought their families and their dogs. Once they arrived in Minnesota they then traveled the remaining distance with Reverend Brevig and arrived at Teller on July 31, 1894. In the meantime, Captain Healy imported more reindeer to Alaska.

Slide 16: Saami and Native Alaskan herders

Slide 17: Reindeer herds multiply

Jackson and Lopp were interested in increasing the reindeer industry, yet they were afraid that the white man (with their knowledge of private enterprise) would interfere with what was supposed to be the Eskimo's industry.

Slide 18: Reindeer Belonging to Missions, 1892–1902

The green dots represent missions that herded reindeer in the late 19th century. Herds owned by missions were also located in Bethel and Dillingham.

Slide 19: Charley Antisarlook's Herd

Charley was the first Eskimo herder in Alaska with his own herd.

Slide 20: Mary Antisarlook, The Reindeer Queen

Mary was born to an Eskimo mother and a Siberian trader. She served as an interpreter for Sheldon Jackson in the 1890s when he was purchasing reindeer in Siberia. She lived in Sinruk near Nome (she is sometimes referred to as Sinruk Mary). She and her husband received reindeer as payment for their work. The video entitled *The Reindeer Queen* is a 28-minute documentary that details the life of this renowned woman (included in this kit).

Slide 21: Rescue Mission

During the winter of 1897–1898, Charley Antisarlook and Tom Lopp took 435 deer to Point Barrow to feed several hundred stranded whalers. A herd was established there to prevent future emergencies.

Slide 22: Ice corral

Slide 23: Reindeer to Miners on the Yukon

Slide 24: Yukon Relief Expedition

In February 4, 1898, Jackson and 112 Scandinavians left the port of Alta in Norway with 900 loads of lichens (filling 71 railroad cars), which had been gathered to sustain the 539 reindeer they were transporting across the Atlantic to North America. Also included were

418 sledges and 511 harnesses. A detailed account of this story is captured in the book, *The Yukon Relief Expedition and the Journal of Carl Johan Sakariassen*.

Slide 25: Reindeer at Jersey City before the railroad journey to Seattle

Slide 26: Picture from *Seattle Post-Intelligencer*, circa 1898

Slide 27: Reindeer land in Haines

They landed in Haines with 521 animals on March 28, 1898.

Slide 28: From Haines to Dawson

In early May they arrived at the Klehini River with only 185 reindeer. Many had perished along the way or were lost. The men learned that the miners on the Yukon were no longer starving, but 15 crewmembers were ordered to take the remaining reindeer up the Yukon River to Circle City. The other crewmembers were to return to Haines. It took the Circle City crew ten months, and the herd was eventually stationed near Tanana.

Slide 29: Station at Unalakleet

Jackson sent the remaining Saami crewmembers on a ship from Haines to an area just south of Unalakleet near the future Eaton Reindeer Station.

The Eaton Station was built and served as management headquarters for reindeer herds for about ten years for the Norton Sound region.

Slide 30: Eaton Reindeer Station

The buildings were moved to the village of Unalakleet and then sold to a mission there. Today nothing remains of this station.

Slide 31: Carl Johan Sakariassen's route to Nome

From the book, *The Yukon Relief Expedition and the Journal of Carl Johan Sakariassen*. Carl overwintered there and then set out for Nome in April 1899 and arrived in May 1899.

Slide 32: Portrait of Carl

Carl was a lifelong friend with Leonhard Seppala (musher in the Serum Run from Nenana to Nome in 1925). It is not sure how long he spent in Nome. He was married in 1904 and lived in Oregon, where he worked as a postmaster, pastor, and farmer until his death in 1968.

Slide 33: Gold discovered in Nome

Gold was discovered in Nome in 1897 and the population boomed.

Slide 34: Beach scene in Nome, 1900

Slide 35: Miners using reindeer as pack animals

Miners entering the Seward Peninsula created a commercial market for reindeer products and draft animals.

Slide 36: Reindeer used as mail carriers

1898—more Scandinavians arrive to help care for the herds (~2,000 deer in Alaska). Several worked as mail carriers, using reindeer.

Slide 37: Early 1900s

Slide 38: Reindeer stations in Northwestern Alaska, 1892–1977

Map of locations of reindeer stations throughout northwestern Alaska from 1892–1977. The reindeer industry is beginning to expand throughout western Alaska.

Slide 39: Reindeer meat

Preparing reindeer carcasses for market.

Slide 40: Hauling meat to Nome

Slide 41: Chester Seveck

Two hundred reindeer were brought to Kivalina, and Chester and three other people were hired to be government apprentice herders.

After year one as a apprentice herder, you earned 6 live deer; after year two, 8 live deer; after year three, 10 live deer; after year four, 10 live deer. After five years, an apprentice officially became a herder and could start a personal herd with the reindeer earned during the apprenticeship.

Chester trained sled deer and sold meat from his herd to miners. He and his wife, Tillie, had eleven children between 1913–1933.

Slide 42: Reindeer Fairs

Chester and many other herders from all over western Alaska attended these fairs for three weeks at a time. They organized sled deer races and bull lassoing contests, with prizes for the winners. They showed off their reindeer skin items: parkas, mukluks, mittens, pants, sleeping bags, etc.

The herders had good cooks, good food, and a chance to gather and be together after spending time out alone with their animals.

Slide 43: Reindeer losses to caribou and wolves

In the late 1930s, Chester reported that caribou were coming onto the reindeer grazing lands. Many herders lost reindeer, as these herd animals followed the caribou.

Chester and his group followed one caribou group for three days and three nights to try and recover some reindeer, but they could not catch them because the caribou were too fast. Wolves also hung around the caribou herds, and reindeer were also lost to the wolves.

Slide 44: Chester Seveck

With his job at Wien Airlines he gave summer tourist tours that included a skin boat ride, a dog sled ride, a blanket toss, Eskimo dances, skin sewing, and ivory carving demonstrations.

Slide 45: Reindeer to Fairbanks

Chester sent reindeer to the University in Fairbanks in 1947. Some of these reindeer were used in tourist tours.

Slide 46: 1908–1914

Slide 47: The Lomen Brothers

To form Lomen and Company in 1914, the Lomen Brothers purchased 1,200 deer from Alfred Nilima, a Saami, living in the Kotzebue Sound area. The holdings of Lomen and Company eventually included a drug store, photography studio, freighting business, and reindeer operation.

Their father, Gudbrand Lomen, was the Federal District Court Judge for the Second Judicial District in Nome. The sons managed the company affairs with offices in Nome, Seattle, and New York.

Slide 48: Lomen reindeer business

Slide 49: Lomen's Elephant Point slaughter plant

Elephant Point provided easy access for shipping and was centrally located for driving the herds to slaughter. They had distributors for reindeer meat in Seattle, Portland, Minneapolis-St. Paul, Oklahoma City, Chicago, New York, and Boston.

Slide 50: 1920s

The Lomen Reindeer and Trading Corporation was organized in 1923 with holdings of 30,000–40,000 reindeer and capital stock worth \$1.5 million.

Slide 51: Continuing Problems

Questions continued to arise about how to deal with deer inheritance, sales, and marking animals.

Slide 52: Reindeer Abundance

Slide 53: Reindeer Act of 1937

This begins the period of increased Native reindeer ownership in western Alaska. The law restricted ownership of domestic reindeer in Alaska to Natives only.

Slide 54: Reindeer numbers decline

By the 1960s, the Reindeer Service started a campaign to do away with the Native corporations and associations and to reinstate private Native ownership of reindeer. At that time there were ten private herds with their own range boundaries (including one owned by current Nome resident and herder Larry Davis), a government herd on Nunivak, and a government model herd west of Nome.

In 1968, the Bureau of Indian Affairs (BIA) took over responsibility for range management, including issuing range permits and monitoring range condition. In the late 1960s, NANA Reindeer Corporation, in conjunction with USDA Soil Conservation Service and the Geophysical Institute at UAF, began applying modern range management techniques to reindeer herding.

Slide 55: Current Seward Peninsula Range Permits

Slide 56: Figure of total reindeer numbers in Alaska, 1900–2000

Slides 57–62: Arctic Exodus, 1929–1935

These slides depict the reindeer story of taking reindeer from western Alaska to the Mackenzie River Delta, in which Saami families remained to help Native people care for the animals. Refer to the book, *Arctic Exodus: The Last Great Trail Drive*, by Dick North for more information and a great adventure story.

Radio and Satellite Telemetry

Written by Suzanne Worker

Slide 1:

This slide show presents the basics of wildlife telemetry. It begins with VHF telemetry and how it works. Then it addresses satellite telemetry and how it differs from VHF telemetry. It is written in general terms but addresses reindeer-specific uses.

Slide 2:

To understand telemetry, one must have a basic understanding of the electromagnetic spectrum. Many signals common to us—AM/FM radio, television, ham radio, and others—are electromagnetic waves. These waves have properties that cause them to behave in certain ways.

The most notable property as it relates to this discussion is frequency. Frequency is defined as the number of times a wave repeats each second. The unit of measurement for frequency is Hertz. It is commonly notated in mega-Hertz or millions of Hertz (MHz). For example, a wave with a frequency of 100 MHz oscillates 100 million times per second. A wave with a long wavelength (as seen on the left side of the diagram) has a lower frequency than a wave with a shorter wavelength (as seen on the right side.)

The use of these frequencies is overseen by federal and international organizations.

Slide 3:

Conventional wildlife telemetry uses VHF (very high frequency) waves.

Slide 4:

As with all radio systems, there are two functional parts to a wildlife telemetry system: A way of transmitting a signal and a way of receiving a signal.

Slide 5:

First, the transmitting subsystem:

Slide 6:

Transmitters can be fitted to a broad range of animal species. It's not hard to imagine fitting a transmitter into a package small enough that an elephant or even a bear could carry around. But the transmitter would have to be much smaller for a fox kit to handle, and smaller yet for a bird.

Slide 7:

Transmitters come in all shapes and sizes. The photograph on the left shows a collar intended for an elephant. Notice the size of the man's foot near the bottom of the photo for

scale. The transmitters on the left are intended for much smaller animals. New technologies have allowed for the development of smaller and smaller transmitters, and nearly any animal can be tracked for at least brief periods.

Slide 8:

No matter the size of the transmitter, or the animal it's intended for, every transmitter has three components. The first is the quartz crystal, which determines the frequency of the collar. Each collar generally has a unique frequency so that an animal can be identified as an individual. Due to drift in frequency, it's necessary to leave at least 5-10 kilohertz (KHz) between each transmitter to ensure that identification of a specific animal is possible. The crystal is the most expensive part of the transmitter, and when the collar wears out, the crystal can be salvaged and reused in a new unit.

Slide 9:

The second essential component of a transmitter is a power source. Generally speaking, this is the most limiting factor in the creation of a useful transmitter for wildlife applications, both in terms of size and lifespan. The collars used for reindeer and caribou weigh approximately two pounds, nearly all of which is battery. They can be expected to last three to five years before the battery dies. Lithium batteries are common, but other options exist, including nickel-cadmium batteries and solar powered units. Generally, a pulsed signal is used to conserve battery life. (A transmitter broadcasting a short signal once per second will last much longer than one broadcasting a continuous signal.)

Slide 10:

The third necessary component of a transmitter is a transmitting antenna. These are omnidirectional antennas, meaning that they transmit the signal equally in all directions. It's ideal to have part of the antenna exposed. However, some animals—a bear or a fox, for instance—will chew off any external portion of the antenna, resulting in poor transmission. Collars manufactured for these species have the antenna fully contained within the collar.

Slide 11:

There are a few other things to consider with transmitters for animal tracking. Perhaps the most important is the method of attachment. The most familiar method is the collar. However, not all animals have necks, and a collar gets in the way of many animals' normal activities. For these cases, many alternatives exist. Transmitters can be fitted onto little backpacks for birds, they can be glued on to skin, feathers, and tusks, or they can be implanted within the body cavity or under the skin.

Transmitters can also be equipped with various sensors to detect an animal's activities. Temperature sensors are used to measure ambient temperature, mortality sensors are used to indicate when an animal has died, tip switches indicate what position an animal is in (upright or lying down) and pressure sensors are employed on diving birds and mammals in an effort to learn about diving behavior and depths.

Slide 12:

The second part of a wildlife telemetry system (and all radio systems) is the receiving sub-system.

Slide 13:

To receive a signal, one must have a frequency-specific receiver. An FM radio is a good example of a receiver designed to receive a signal within a specific bandwidth. For wildlife applications, the receiver is often equipped with a scanner that allows the user to scan through a list of known frequencies and receive any of those signals. The receiver may also be set up with a data logger to archive data as it is received. Many modern receivers include a personal computer interface for ease of uploading and downloading data.

Slide 14:

A receiving antenna is also necessary. These antennas are manufactured to receive a narrow frequency range. An “H” antenna is commonly used for wildlife applications. This type of antenna is directional, meaning that it is more sensitive to the signal on one end than on the other. This allows the user to determine from which direction the signal is coming. “H” antennas are also relatively small, making them convenient to use in the field.

One technique for using this type of antenna is known as the homing method. If traveling on the ground, this involves holding the antenna above the head while rotating in a slow circle. The signal will be the strongest (loudest) in the direction of the transmitter. By moving towards the transmitter, circling again, and adjusting course, and repeating the process, the user is able to home in on the receiver. A similar technique is used when tracking from fixed wing aircraft. Flying a survey is a very common way to obtain location data about a group of tagged animals.

Yagi antennas, which are also directional, are larger, have more elements and are used when a more cumbersome apparatus is not a problem. Omnidirectional antennas are used in applications where proximity data is more important than directionality. (For example, an omnidirectional antenna might be set up with a receiver and a data logger in a remote location to obtain data about how often animals approach a specific area, regardless of which direction they are coming from.)

Slide 15:

When placing a collar on reindeer, there are a few things to remember. First, there is the selection of the animal. Collars from the Reindeer Research Program are usually placed on strong adult females. Transmitters are not generally placed on young animals because they rapidly outgrow the collar. However, for studies requiring fawns to be collared, provisions can be made (a breakaway device, or soft padding that allows for expansion of the neck within the collar.) Bulls are not generally collared for the similar reasons—their necks swell significantly during rut, making fitting a collar difficult.

A properly applied collar will be snug around the animal’s neck. If it influences swallowing or breathing, it should be loosened. However, it’s more likely that a collar will be applied

too loose than too tight. The standard test at the Reindeer Research Program is the four-finger test. If you can slip four fingers between the collar and the neck of the animal, it's plenty loose. Keeping the collar snug minimizes movement of the collar on the animal's neck, reduces hair wear, and prevents feeding problems that are likely to occur when a loose collar slides up and bumps the lower jaw when the reindeer puts her head down to graze.

Slide 16:

The radio telemetry program at the Reindeer Research Program was established in the 1980s as a way of monitoring and managing the range resource. By watching seasonal patterns of reindeer movement, we learn about habitat selection and nutritional behaviors at specific times of year. We can also note heavily used areas and monitor them more closely for signs of overgrazing.

In recent years, the Western Arctic Caribou Herd has grown significantly and has expanded its winter range westward onto the Seward Peninsula. The presence of caribou is threatening the reindeer industry because in the absence of fences, many reindeer leave the ranges in the spring with the caribou as they migrate back to their calving grounds. Because members of the caribou herd are also fitted with transmitters, telemetry has provided researchers and herders a means of monitoring the proximity of the two groups.

Slide 17:

Conventional VHF telemetry has some limitations. Weather is a big one, especially in coastal Alaska where the cloud ceiling is often too low for a plane to fly. The Reindeer Program collects nearly all of its VHF data from fixed-wing aircraft surveys, making weather a big consideration.

Because there are a limited number of frequencies available for use in wildlife telemetry, and because all users in the geographical area must divide those frequencies amongst themselves (for example, to prevent the reindeer biologist from inadvertently tracking a collared wolf that is being monitored by another researcher), wildlife programs are limited in the number of collars they can deploy. (Remember that there must be at least 5–10 KHz between each collar.) The inclusion of satellite transmitters in a wildlife telemetry program can help mediate some of these problems.

Slide 18:

Satellite telemetry works the same way as VHF telemetry but with a few differences. First, instead of operating in the Very High Frequency range, it operates in the Ultra High Frequency (UHF) range.

Slide 19:

Another major difference is that all of the collars broadcast at the same frequency. Remember that with VHF transmitters, the frequency acts as the identifier for a specific animal. When UHF transmitters are manufactured for animal tracking, they are encoded with an

identification number. The result is that the number of collars deployed is not limited by the frequency band or by the occurrence of other wildlife telemetry programs in the same geographical area.

Slide 20:

The size of the battery is another notable difference between VHF collars and UHF collars. The signal must be much stronger to travel to a satellite-mounted receiver than it would need to be to travel to an aircraft-mounted receiver. The stronger signal draws more power, resulting in the need for a larger battery. Also, the encoded signal draws more power than the simple pulsed signal. A typical satellite collar is not only bigger and heavier than a VHF collar, but the battery will not last as long.

Slide 21:

The manner in which data is acquired is another major difference between VHF and satellite telemetry. Data acquisition for VHF telemetry data may involve a plane, a car, an all terrain vehicle, or just a good pair of boots, but the common denominator is generally a user who locates the signal and records the findings.

In contrast, satellite based programs rely on receivers mounted on National Oceanic and Atmospheric Administration (NOAA) satellites. Instead of using a directional antenna to establish the location of the transmitter, locations are calculated using the Doppler shift. The Doppler shift is the shift in frequency that occurs as an object approaches the receiver. (Imagine standing at the edge of a highway and listening to rapidly moving cars pass. The sound changes as the car approaches and then moves away again. This is an example of Doppler shift.)

Slide 22:

Once the signal is broadcast from the transmitter (1) and received by the satellite-mounted receiver (2), it is transmitted to one of three global receiving stations (3). The data then goes to a processing center (4) operated by a company called Service Argos, Inc. Argos owns the receiving hardware and provides download and data processing services. Once the data has been processed, it is forwarded to the user. In the case of the Reindeer Research Program, the data is received electronically, reformatted, and archived. Then a program called Generic Mapping Tools (GMT) is used to create maps (5). The maps are then posted to a password-protected website (6) where the herders can access them for use as a management tool. The data and maps are also used for research purposes.

Additional notes:

VHF telemetry and satellite telemetry each have their advantages and disadvantages. VHF programs are limited by weather and frequency band. Data acquisition is fairly labor intensive and can be expensive when aircraft are involved.

A satellite telemetry program can eliminate many of these difficulties but has its own constraints. Larger transmitters are more likely to influence the behavior of the animal being studied; shorter battery life means collars need to be replaced more frequently, requiring

both time and money; satellite collars are much more expensive to purchase and maintain than VHF collars; data downloading and processing can be quite expensive for large programs. There also is a variable degree of error in the location calculations for satellite collars that cannot always be accounted for.

Cost effectiveness of each system is variable and depends largely on the goals of the program and the number of transmitters deployed. The Reindeer Research Program uses a combination of the two to attain research and industry objectives.



Tundra Joe, one of the Reindeer Research Station's bulls.