Ecological Baseline and Management Plan for the Center for Alaskan Coastal Studies

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Client: Center for Alaskan Coastal Studies

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Abstract

Inspiration Ridge Preserve (IRP) is a 692-acre property in Homer, Alaska, home to a diverse array of wildlife and habitat. The IRP is currently owned and managed by Nina Faust and Ed Bailey, but management will be passed to the Center for Alaskan Coastal Studies (CACS), a nonprofit organization dedicated to fostering land stewardship, in the coming years. CACS plans to manage the preserve for environmental education and to protect native flora and fauna. Our goal was to establish a baseline ecological inventory of the preserve and create habitat maps to serve as references for future preserve management. We conducted field work at the IRP in May and August 2016 for a total of eight weeks. We collected vegetation data through field surveys and remote sensing techniques, conducted anadromous fish surveys on small tributaries, and employed camera traps to track and monitor wildlife presence on the property. GIS data and maps were compiled at U-M upon return. We created maps and accumulated baseline ecological data to support management recommendations for CACS. Our recommendations include a plan for long-term management and monitoring of the preserve using photo-monitoring points.

Acknowledgements

Our team would like to acknowledge the support and guidance of our clients Beth Trowbridge, The Center for Alaskan Coastal Studies, and Nina Faust, and our faculty advisor Dr. Bill Currie. We would also like to thank Joel Cooper, Chris Guo, Ginny Litchfield, Thomas McDonough, Coowe Walker, and Steve Baird for their assistance with fieldwork and information gathering. We thank Kachemak Bay National Estuarine Research Reserve and The Center for Alaskan Coastal Studies for providing housing during our visit.

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Introduction

Inspiration Ridge Preserve (hereafter "the IRP"), conceived by Ed Bailey and Nina Faust in the 1990s, sits near the tip of the Kenai Peninsula in Alaska (Figure 1). It has grown over the years to include major acquisitions of ecologically connected lands totaling 692 acres and encompasses significant wildlife corridors, varied wildlife habitat, nesting areas for cranes and staging areas for their migration, magnificent viewscapes, and tranquil landscapes. The IRP lands support a rich diversity of plant communities and wildlife that are undergoing constant ecological change. Additionally, the IRP contains several permanent buildings including a main house, greenhouse, aviary, ponds, a managed trail system, and three rental cabins. A total of 18 properties comprise the IRP, with seven protected under conservation easements through the Kachemak Heritage Land Trust (KHLT). The other 11 parcels will be under restricted use agreements through the Center for Alaskan Coastal Studies (CACS). CACS envisions not only achieving specific conservation goals within the IRP, but also hopes it will serve "as a model of land management and environmental education that balances human use with protection of coastal environments."[1]

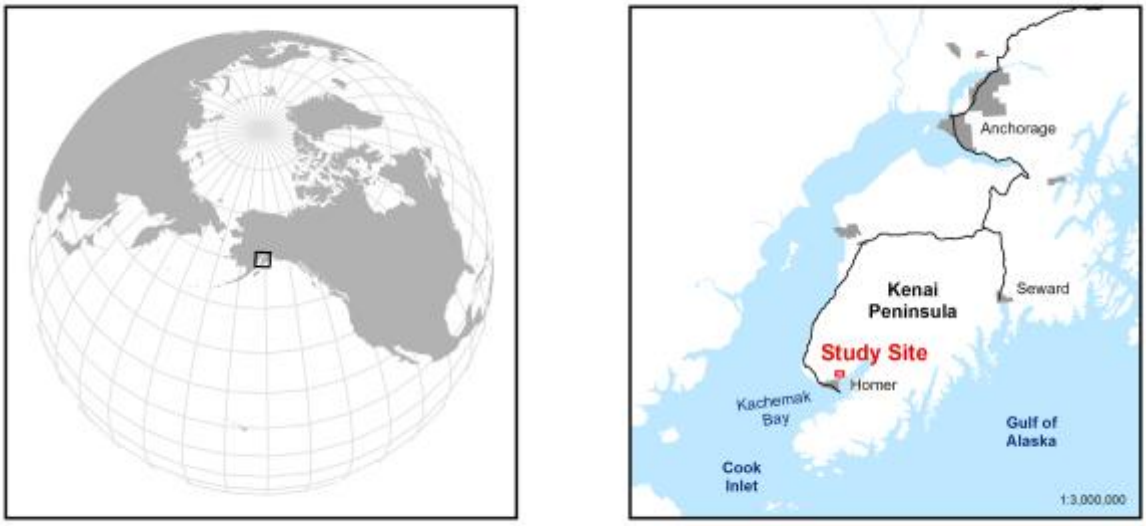

Figure 1. Location of study site near on the Kenai Peninsula near Homer, Alaska.

This document resulted from a Master's Project conducted in the School of Natural Resources and Environment at the University of Michigan in 2016-2017. It provides information on the current ecological conditions on the IRP including detailed descriptions of how our data was collected. It also lays out a proposed management plan that contains descriptions of the major threats faced by ecosystems on the IRP as well as specific recommendations related to preserve

[1] Nina Faust et al., 2016. IRP Master Plan 2016-2025

monitoring. An extensive appendix of maps and a photo monitoring book are also appended.

Property Overview

The IRP is composed of 18 properties currently owned by Edgar Bailey and Nina Faust (Figure 2). Seven of the properties are protected under conservation easements through the Kachemak Heritage Land Trust (KHLT), which conducts annual monitoring of the parcels. The IRP is currently managed primarily by Nina Faust and two caretakers, all of whom are permanent residents on the IRP. Additionally, a $250,000 endowment was established by Edgar Bailey and Nina Faust with the Alaska Conservation Foundation to offset operational costs of the IRP.

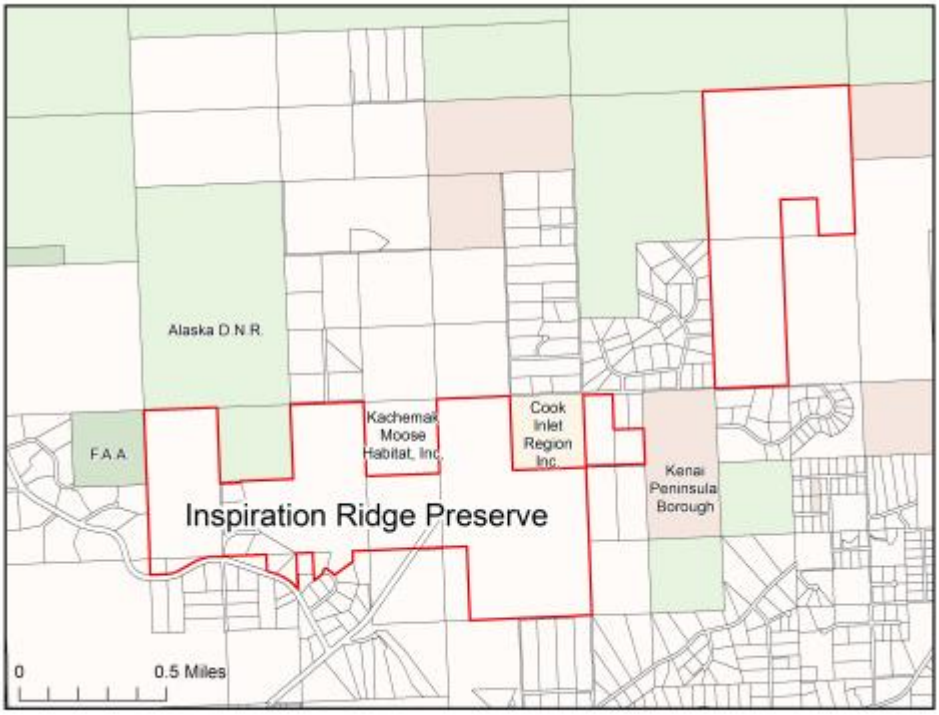

Figure 2. Boundaries of properties that comprise the IRP are shown in red. The IRP is located near the town of Homer, Alaska.

In the future, the IRP properties will be conveyed to CACS for management and will be used for educational groups to "inspire and educate visitors to a better understanding of land stewardship and appreciation of wildlife."[2] The 7 properties protected by the conservation easement with KHLT will continue to be protected under these legally binding agreements in perpetuity. The other 11 will be under restricted use agreements held by CACS. In addition, a life estate for Nina

[2] Zelenka, David. "About Us." *About Us - Center for Alaskan Coastal Studies | Homer, Alaska*. N.p., n.d. Web. 17 Apr. 2017.

Faust will also be established on the IRP.

The stated mission of the Center for Alaskan Coastal Studies is "to foster responsible interaction with our natural surroundings and to generate knowledge of the unique marine and coastal ecosystems of Kachemak Bay through science-based environmental education and stewardship."[3] In keeping with this mission and the IRP's founding principles, CACS will manage the IRP property to protect and preserve the land in its natural condition.

Current Conditions

Ecological Conditions

Vegetation/ecosystems

The IRP comprises a variety of natural communities that contain high plant diversity and provide habitat resources for a number of wildlife species. The dominant plant communities by area are spruce forest (~42% of land) and meadow (~30%) (Figure 3). Other communities include alder (~10%), willow (~8%), mixed forest (~4%), cottonwood (~2%), and bog (<1%). Buildings and structures occupy approximately 1% of the property and there is a large mowed area on parcel 17113258 (IRP Lot 1) that comprises almost 3% of the total land cover of the property that is currently maintained by the current land owner as Sandhill crane habitat.

[3] Zelenka, David. "About Us." *About Us - Center for Alaskan Coastal Studies | Homer, Alaska*. N.p., n.d. Web. 17 Apr. 2017.

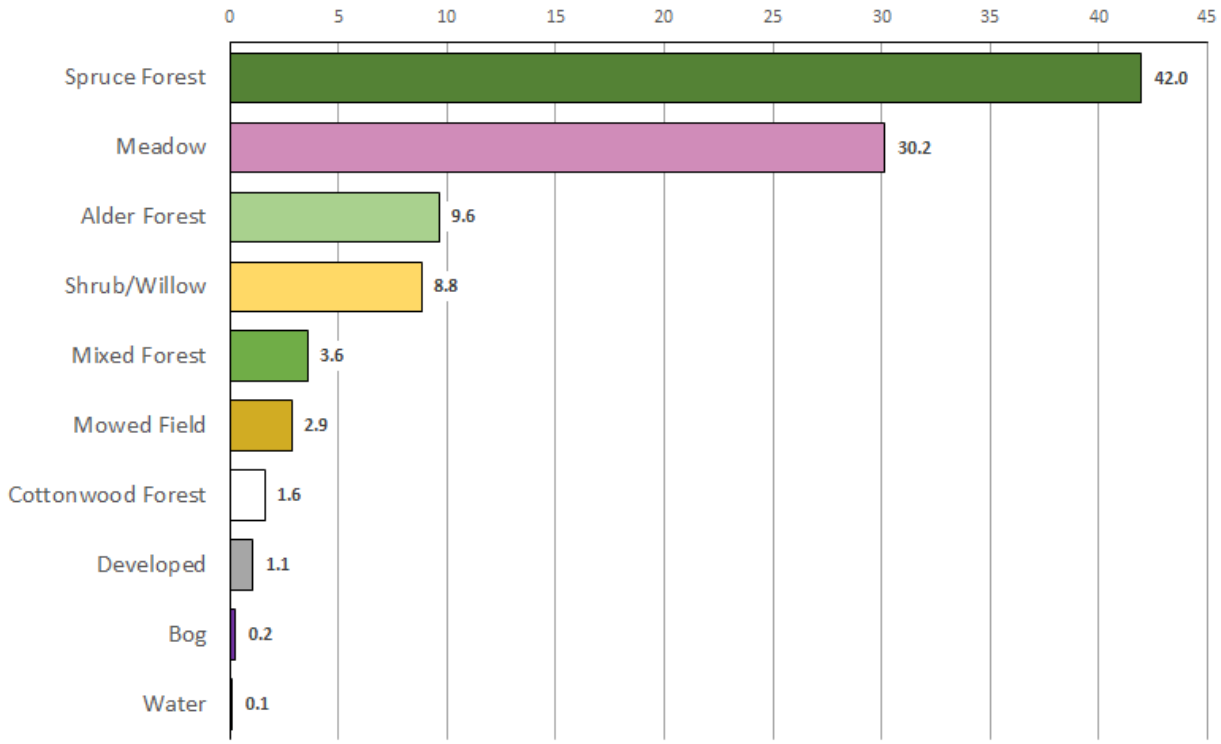

Figure 3. Land cover types in the IRP by percentage of land area.

Vegetation community maps in Appendix A illustrate the composition and dominance of the various plant communities present on the IRP and provide photographs and plant assemblages.

Wildlife

The mosaic of meadows, spruce forests, shrubs, and bog provide favorable habitats for a variety of fauna. Although a systematic survey of the species diversity in the IRP is yet to be carried out, data from anecdotal observations suggests a high biodiversity compared to typical biodiversity for coastal Alaska. Over the years, more than 17 mammal species, 1 frog species, 57 bird species (including 2 non-native species) have been observed on the property.[4] All the observed species are categorized as "least concern" by the IUCN Red List of Threatened Species[5], except the Olive-sided Flycatcher (*Contopus cooperi*) and Northern Bobwhite (*Colinus virginianus*), which are considered "near threatened".

In the camera trap survey conducted from May 30 to October 12, 2017, we recorded 4 common types of wildlife: moose, black bear, coyote, and an unidentifiable waterfowl. A comprehensive list of observed species based on camera trapping, animal sighting during field work, and

[4] Nina Faust et al., 2016. IRP Master Plan 2016-2025
[5] The IUCN Red List of Threatened Species. Version 2016-3. <www.iucnredlist.org>. Downloaded on 18 March 2017.

anecdotal evidence provided by the landowner, can be found in Appendix D. Other species that are known to occur in the lower Kenai Peninsula but not observed in the IRP include: northern bog lemming (*Synaptomys borealis*), tundra vole (*Microtus oeconomus*), and mink (*Neovision vison*).[6]

Moose are the most frequently recorded species in the preserve, accounting for 92.8% of animal occurrences in the camera trap photographs. Moose browse on the preserve in summer, fall, and early winter, but tend to migrate to lower elevations when the snow is deep. At least two black bears have been recorded in our camera traps, accounting for 5% of animal occurrences. Black and brown bears have been observed to use the steep slopes for denning areas, and the rest of the property for foraging.

Soils

The most common soil families found on the IRP according to the Natural Resource Conservation Service (NRCS) National Cooperative Soil Survey are listed in Table 1.

Table 1. Soil types present on the IRP property.

Soil Type	Acreage	Description (adapted from official series desc.[7])
Coal Creek Silt Loam	15.4	Deep, poorly drained soils commonly found on edges of drainages. Characterized by native vegetation including black spruce, paper birch, willow, alder, grasses, horsetail, low-growing shrubs, and mosses.
Kachemak Silt Loam	527.8	Well drained. Used for vegetables, hay production, rangeland, residential development, recreation, and wildlife habitat. The native vegetation is bluejoint grass, fireweed, alder, and associated plants.
Mutnala Silt Loam	86.4	The Mutnala soils are used for timber production, wildlife habitat, recreation, and residential development. The native vegetation is dominantly Sitka spruce and white spruce with an understory of Sitka alder, rusty menziesia, wood fern, and clubmoss.
Qutal Silt Loam	10.8	Somewhat poorly drained. Used for forestry and wildlife habitat. The native vegetation is Lutz spruce, bluejoint grass, willow, and alder.
Spenard Peat	0.5	Very poorly drained. The native vegetation is a forest of

[6] Thomas McDonough, Alaska Fish and Game, *personal communication*, 20 Mar. 2017.
[7] "Natural Resources Conservation Service." *Soil Classification | NRCS Soils*. N.p., n.d. Web. 17 Apr. 2017.

		spruce or alder.
Truuli Muck	21.1	Well drained. Used for forestry, wildlife habitat, and recreation. Native vegetation is mixed forest of Lutz spruce and birch, with an understory of water tolerant shrubs and forbs.
Typic Cryorthents	31.5	Steep slope (over 80%), well drained.

A complete guide to soils found on all the IRP properties (including a soils map) was acquired through the NRCS Web Soil Survey and can be found in Appendix G.

Hydrology

Streams and wetlands on the IRP flow north into the eastern end of the Beaver Creek Flats. Although the flats drain into either Beaver Creek or Fritz Creek (depending on hydrologic conditions), the IRP is considered part of the Fritz Creek watershed. Fritz Creek subsequently drains into Kachemak Bay, and is part of the Lower Kenai Peninsula Watershed (HUC-19020301)[8].

Current Land Management

Management Principles

The IRP was formed with the goals of habitat protection and stewardship at its core, and its master plan, developed by the landowner, describes it as having been "conceived as 1) a wildlife corridor and sanctuary and 2) as nesting habitat for Sandhill Cranes and other waterfowl and migration staging areas for cranes." [9] The IRP properties are currently managed with these overarching goals in mind. The IRP has generally been managed to promote the natural succession of habitats.[10]

Property Boundaries and Trails

The IRP consists of 18 parcels, with approximately 10 miles of external property boundary. In addition, the preserve has a relatively extensive network of trails - over 8.5 miles on 692 acres. The trails are currently used for a combination of recreation and on-foot monitoring and maintenance of the parcels - especially in the case of parcels monitored by KHLT. The parcels and trail networks are shown in the series of maps in Appendix A and a summary of trails on

[8] USGS, Alaska Watershed and Stream Hydrography Enhanced Dataset Project, 2006
[9] Nina Faust et al., 2016. IRP Master Plan 2016-2025
[10] Ibid

each parcel is summarized in Table 2 and displayed in Figure 4.

Table 2. Trail lengths by parcel in the IRP.

Parcel ID	Parcel Name	Trail Length (mi)
17113258	IRP Lot 1 CE	3.90
17113259	IRP Lot 2 CE	1.75
17113223	Mead 40 CE	0.82
17113221	Wong 80 CE	0.39
17203102	Hogback CE	0.29
17139002	Ohlson Mt. Sub Lot 2, Blk 2	0.12
17203140	Defibaugh No. 1 Lot 2A	0.10
17145003	Lookout Meadows U1, Lt 13, Blk 2	0.08
17139001	Ohlson Mt. Sub Lot 1, Blk 2	0.06
17145007	Lookout Meadows U1, Lt 9, Blk 2	0.04
17139117	Southview Meadows Lot 2	0.04
17145006	Lookout Meadows U1, Lt 10, Blk 2	0.04
17145005	Lookout Meadows U1, Lt 11, Blk 2	0.01

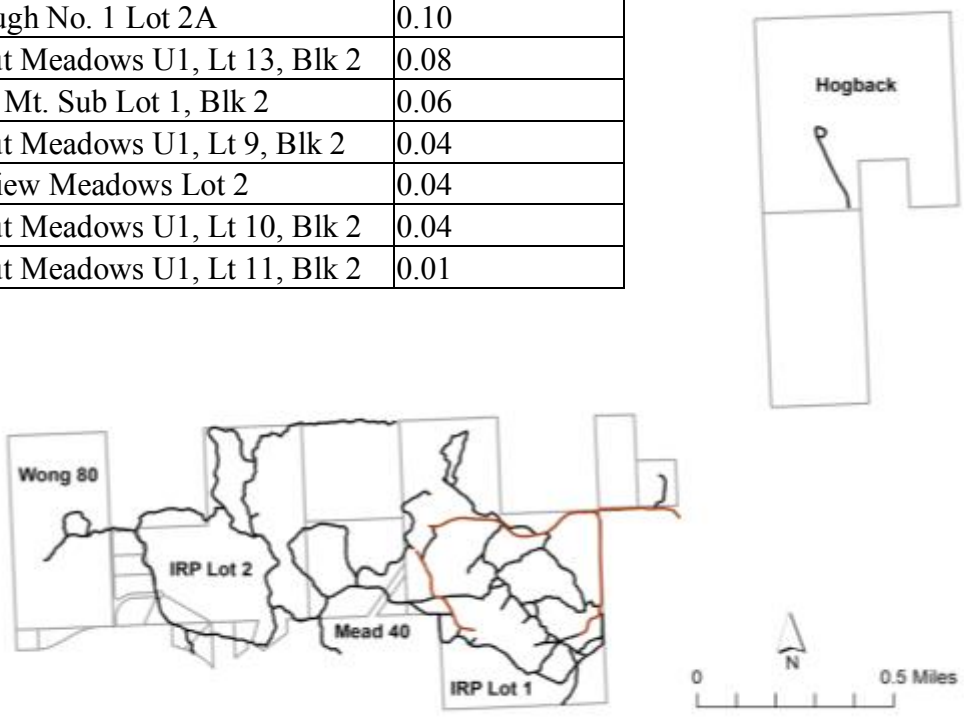

Figure 4. A map of the 8.5 miles of trail networks across the IRP property.

Several of the parcel boundaries and all trails are currently maintained by the landowner and property caretakers. Maintenance activities include annual mowing where feasible, weed whipping, trimming of canopy overgrowth where it obstructs passage, and removal of brush.

Crane Field

Mowing occurs extensively on the IRP around the Faust house. The mowing is intended to create an open yet secluded area for Sandhill cranes, who have used the area both as a nesting site and as a site for staging migration. Counts conducted by the Kachemak Crane Watch indicate that

cranes use the mowed field in varying numbers from year to year. The Watch's 2016 report indicates that the largest flock of cranes observed on the IRP during the 2016 season was 86 individuals (Figure 5).

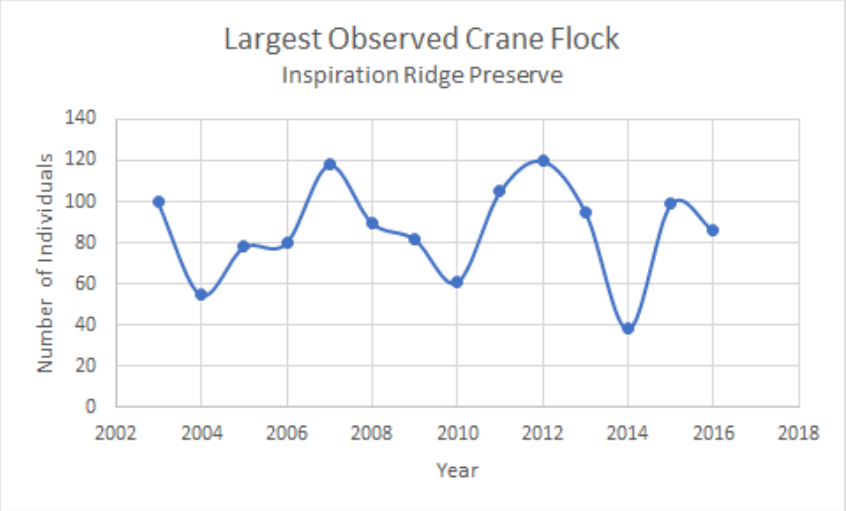

Figure 5. The largest observed flock of Sandhill cranes on the IRP each year over the last 15 years. Data from the Kachemak Crane Watch.

This area has evidently become an important habitat for Sandhill cranes in the Kachemak Bay area. However, the habitat is artificially created and, like the trail system, requires an investment of resources such as time, energy, and equipment for annual maintenance. Maintenance of crane habitat is under the management of the current landowner. Mowing is currently conducted once each summer by privately hired crew over the course of 1-2 days.

Developed Features

There are currently several developed features on the various properties of the preserve, with most occurring on parcel 17113258 (IRP Lot 1). These features include a greenhouse, aviary, alpaca pen, and several homes and cabins. The landowner of this parcel currently oversees maintenance of these facilities. Approximately 1% of the total preserve acreage is developed.

Threats

Climate Change

The impacts of global climate change pose potential threats to the health of the ecosystems and wildlife that make up the IRP. Regional impacts of global climate change are likely to alter the

dynamics of these ecosystems during both the near and long term. Alaska has already experienced warming at twice the rate of the rest of the United States with an average annual increase in temperature of 3°F during the last 60 years, and is projected to warm by another 4°-6°F by 2100.[11] Alaska is predicted to experience earlier spring snowmelt, widespread glacial retreat, melting permafrost, drier landscapes, and more extensive insect outbreaks and wildfires.

Annual precipitation is projected to increase during all four seasons, but this will be accompanied by warmer air temperatures and longer growing seasons that will ultimately result in a reduction in water availability, increasing the risk of insect outbreaks and wildfires.[12] Changes to the timing of snowmelt and freeze-up could impact seasonal migration patterns of birds and mammals,[13] resulting in potential mismatched phenologies between pollinators and plants or wildlife and food plants that could have major implications for individual species as well as communities and ecosystems.

Current climate models suggest that climate change will have significant impacts on vegetation composition on the Kenai Peninsula. Models run by biologists at the U.S. Fish and Wildlife Service suggest the following shifts are likely to occur:

- More frequent and hotter fires will cause a shift from softwoods to hardwoods
- Rising treeline associated with a loss of alpine tundra
- Increasing herbaceous cover
- Loss of old growth softwood forests[14]

Alaskan softwood species include Western red (*Thuja plicata*) and Alaska yellow cedar (*Cupressus nootkatensis*), Douglas fir (*Pseudotsuga menziesii*), Western hemlock (*Tsuga heterophylla*), Ponderosa pine (*Pinus ponderosa*), and Sitka spruce (*Picea sitchensis*).

Global Climate Change Model (GCM) projections for boreal forest climates suggest that burn areas will increase as fire regimes shift.[15,16] Increases in burn area may result in an increase in the invasion potential of these ecosystems, which in turn can contribute to more frequent and intense fires.[17]

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[11] Alaska Climate Assessment. *National Climate Assessment*. N.p., n.d. Web. 17 Mar. 2017.
[12] Ibid
[13] Ibid
[14] Fire Ecology and Regime Shift due to Climate Change - Kenai - U.S. Fish and Wildlife Service. *U.S. Fish & Wildlife Service*. N.p., 26 Sept. 2012. Web. 17 Mar. 2017.
[15] Podur, Justin, and Michael Wotton. "Will climate change overwhelm fire management capacity?." *Ecological Modelling* 221.9 (2010): 1301-1309.
[16] Amiro, B. D., et al. "The effect of post-fire stand age on the boreal forest energy balance." *Agricultural and Forest Meteorology* 140.1 (2006): 41-50.
[17] Fire Ecology and Regime Shift due to Climate Change - Kenai - U.S. Fish and Wildlife Service. *U.S. Fish & Wildlife Service*. N.p., 26 Sept. 2012. Web. 17 Mar. 2017.

Potential impacts to the IRP could include, but are not limited to:

- A reduction of the extent of the bog located in 17113258 IRP Lot 1 as a result of increased evaporation due to increases in air temperatures and radiative forcing from the atmosphere. The bog is home to many specialist plant species and provides resources to a number of wildlife species. Reduction in habitat size and quality could be detrimental to these populations.
- Reduction in streamflow across the IRP and reduction in the extent of ponds on the main IRP property reduce water availability to wildlife and waterfowl and could be detrimental to fish and amphibian populations.
- Shifts in the composition of plant communities. These shifts would in turn affect the availability of forage for certain wildlife species that could have impacts up and down the food chain. Over time, certain native species may start to be extirpated as temperature or moisture thresholds are surpassed.
- Increased risk of wildfires, drought, insect outbreaks, and invasion by non-native species resulting from warmer air temperatures, longer growing seasons, and overall drier conditions. Given the history of bark beetle outbreaks on the property (see 'Insect Infestation' section below) and the existence of dead standing and fallen wood that could serve as fuel sources make wildfire risk a major concern.

Although there is little that can be done to avoid some of these impacts, annual monitoring of vegetation, wildlife, and community composition could improve CACS' ability to respond to changes or threats as they arise. This will be especially important in the case of the increased risk of wildfire, insect outbreaks, and non-native invasions. CACS should act to reduce fuel loads and be prepared to proactively manage for insect outbreaks through early detection and treatment of infected trees.[18]

Insect Infestation

As noted above, changes in temperatures and the resulting land cover and precipitation shifts can allow for non-native insect species to thrive, some of which may be invasive and harmful to native vegetation.

Legacy of the Spruce Beetle

Spruce bark beetle (*Dendroctonus rufipennis*) outbreaks are responsible for killing large stands of mature spruce trees and are becoming more prevalent with warmer summers. Large outbreaks are serious threats to tree mortality. Historically, the Kenai Peninsula experienced severe spruce

[18] Ibid

beetle outbreaks during the 1850s, 1870-1880s, 1970s, and 1990s.[19] The last major spruce beetle outbreak hit Homer, Alaska in the mid-1990s. As of 2010, spruce beetle activity now covers over 6 million acres statewide.[20] The peninsula was the epicenter of the outbreak that dominated a large majority of the northwest U.S. and British Columbia in Canada. While spruce beetles are endemic to spruce forests, major attacks are triggered by the availability of host material and warm summers. The beetles most often attack Sitka spruce (*Picea sitchensis*), white spruce (*Picea glauca*), and Lutz spruce (*Picea × lutzii*), a white/Sitka hybrid, and inhabit the thin phloem layer between the bark and the wood. Spruce beetles feed and reproduce in fallen or injured trees, occasionally outgrowing the supply of downed trees and moving into mature spruce stands.[21] Because the beetles prefer downed spruce, human activities like fire suppression and improper disposal of logged trees serve to enhance conditions for outbreaks. Fire suppression increases the chance of injured and sick trees, habitats that beetles easily invade.

Figure 6. Spruce bark beetle. Source: Framepool.

The beetles produce pheromones that they use to communicate with other beetles. They use the chemicals for mating purposes and to locate susceptible host trees to then invade.[22] Two years after an attack, beetles will leave the tree, a life cycle common to south-central Alaska. Currently, existing stands of spruce have had a chance to regenerate since the outbreak in the 1990s, meaning that bark diameter has likely grown large enough to host another outbreak. Stands of downed spruce also pose a considerable fuel source on the property and could have implications for wildfire risk and management in the future.

[19] Barber, Valerie A., et al. "Reconstruction of summer temperatures in interior Alaska from tree-ring proxies: evidence for changing synoptic climate regimes." *Climatic Change* 63.1-2 (2004): 91-120.
[20] Division of Forestry. What's bugging Alaska's forests? Spruce bark beetle facts and figures. *Alaska Department of Natural Resources: Division of Forestry*. N.p., n.d. Web. 17 Mar. 2017.
[21] Ibid
[22] Division of Forestry. What's bugging Alaska's forests? Spruce bark beetle facts and figures. *Alaska Department of Natural Resources: Division of Forestry*. N.p., n.d. Web. 17 Mar. 2017.

Figure 7. Left, spruce beetle larvae gallery. Source: Salida Regional Library.
Figure 8. Right, standing dead spruce trees. Source: Salida Regional Library.

Aphid Outbreak

Alongside spruce beetle outbreaks, spruce aphids (*Elatobium abietinum*) also pose a risk to mature spruce trees. European spruce aphids had their first outbreak on the Kenai Peninsula in early 2015. While the aphids have existed in southwest Alaska since the 1960s, 2015 was the first time the aphids were seen in the Homer area, most likely originating from Prince William Sound.[23] Due to their light weight, the aphids can be carried by the wind, allowing populations to invade new territory. However, KNWR staff also noted that aphid outbreaks need warm winters to expand in population size, which the Kenai Peninsula has experienced over the past couple years. Usually, the aphids die during cold periods, but unusually warm weather has allowed the aphids to reproduce throughout the entire winter, contributing to high population numbers.

[23] Chandler, Quinton. "Peninsula spruce threatened by aphid." *Alaska Public Media*. N.p., 06 Apr. 2016. Web. 17 Apr. 2017.

Figure 9. Left, Spruce aphid. Source: Alaska Public Media.
Figure 10. Right, Aphid damage - note healthy needles alongside bare branches. Source: Homer News.

While aphid outbreaks do not generally kill off trees like the spruce beetle, they can contribute to tree disfiguration. Aphids suck spruce needles dry, wounding the tree.[24] On a positive note, most trees survive aphid attacks. Insecticides are available, but most untreated trees will survive on their own, although their damage might lead them to be more susceptible to other disturbances. Aphids were noted on the bluff below the IRP property during fieldwork in May 2016 and August 2016, but there is hope that the cold winter this year will slow their advance.[25]

Invasive Species

In general, the continental U.S. is experiencing a northward migration of tree distributions due to climate change. The Kenai Peninsula and its flora and fauna are particularly sensitive to climate effects: according to Alaska Fish and Wildlife (AF&W), Homer has 'jumped' two United States Department of Agriculture (USDA) plant zones, a standard by which gardeners and growers can determine at what locations a specific plant is likely to thrive in. The plant zone map is based on average annual minimum winter temperatures.[26] AF&W anticipate that the biggest threat to the Kenai Peninsula in the upcoming years is the uncertainty in precipitation levels. Extreme weather events, such as rising temperatures or unseasonal rainfall, can allow for non-native species of trees to thrive and compete against native species. In 2016, the National Oceanic and Atmospheric Administration (NOAA) determined that Alaska was 10.6 degrees warmer than its long-term historical average, using records that date back to 1895. AF&W predict that by 2099, 37% of the Kenai Peninsula landcover types are expected to change. Currently, there are 108

[24] Boettger, Ben. "Invasive aphids found around Kachemak Bay." *Peninsula Clarion*. N.p., 17 Apr. 2016. Web. 17 Mar. 2017.
[25] Nina Faust, *personal communication*, December 6, 2016.
[26] United States Department of Agriculture. *USDA Plant Hardiness Zone Map*. N.p., n.d. Web. 17 Mar. 2017.

species of plants and 30 species of animals that are non-native that occur on the Kenai Peninsula. As climate and landscapes change, these species are poised to fill novel assemblages in the ecosystem, often thriving at the expense of native species.[27]

Listed below are some invasive species of note found on the IRP.

Orange Hawkweed

The largest invasive plant threat on the IRP is orange hawkweed (*Pilosella aurantiaca*). Orange hawkweed is a perennial plant and member of the sunflower family. It was originally planted as an ornamental, but quickly became an invasive species due to the viability of its seeds[28]. Seeds can remain viable in the soil for up to seven years, and infested areas often form continuous seed banks. One plant can spread and infest an area 2-3 feet in diameter in its first year of growth alone. Hawkweed most easily invades disturbed sites such as roadside patches and residential areas, so it is important to minimize disturbance to control spread. Hawkweed is allelopathic, meaning that it can influence the germination, growth, and survival of other plants nearby. It can effectively poison other root systems in proximity and aggressively competes for space, light, and nutrients, leading it to become extremely dense in patches where it is found. Additionally, the plant can reproduce in the absence of a mate or pollinators,[29] making it extremely adaptable to a wide variety of ecological conditions.

Figure 11. Orange hawkweed. Source: The Student Conservation Association.

[27] Morton, John. PDF PowerPoint: "What's an exotic plant in a rapidly changing climate?" *Kenai National Wildlife Refuge.* 17 Mar. 2017.

[28] Snyder, Cynthia and Shephard, Michael. "Invasive Plant: Orange Hawkweed" *USDA Forest Service, Alaska Region*. 17 Mar. 2017.

[29] Loomis, Eli S., and Lila Fishman. "A continent-wide clone: population genetic variation of the invasive plant Hieracium aurantiacum (Orange Hawkweed; Asteraceae) in North America." *International journal of plant sciences* 170.6 (2009): 759-765.

Orange hawkweed is characterized by a single leafless stem approximately 12 inches long, and its orange-red petals are easily distinguishable from other flowers because of their square edges and notched tips.

Hawkweed Management

Methods of management are difficult. Small patches of the weed can be managed through manual removal, but mowing and plowing are not recommended because of the risk of spreading the plant due to the way hawkweed reproduces. To prevent spread, it is important to carefully check clothes and boots for seeds when working near hawkweed infestations. Avoiding unnecessary site disturbances can also help prevent spread of the species. Herbicides have been proven to be effective, but must be applied at specific stages in the life cycle, making application tricky for larger patches.[30] There are four native species of hawkweed in Alaska,[31] but orange hawkweed is not native to the area and has been introduced.

Dandelion

While dandelion (*Taraxacum*) is found widespread on the IRP property, it is of lesser note than orange hawkweed and other invasives. While dandelions are not as invasive as orange hawkweed and do not choke out other root systems quite so easily, minimizing disturbance, such as mowing, will help prevent spread. Dandelions are perennial plants that often displace native grasses. They are easily transported from one system to another, most often through hay and grass cuttings. They are very common in disturbed mowed systems, which explains the prevalence of dandelions on IRP Lot 1 (parcel 17113258) below the main building.

Figure 12. Dandelion. Source: Edible Wild Food.

[30] Seefeldt, Steven. PDF PowerPoint: "Alaska hawkweeds and control of the orange one," *University of Alaska Fairbanks.* 20 Feb. 2017.
[31] Ibid

It should be noted that there are nine native species of dandelion to Alaska, but we were unable to confirm whether dandelions on the IRP property were native or non-native.[32]

Other Invasive Species of Interest

Other invasive species in the Kenai Peninsula are: purple loosestrife (*Lythrum salicaria*), white sweetclover (*Melilotus albus*), reed canary grass (*Phalaris arundinacea*), smooth cordgrass (*Spartina alterniflora*), Japanese knotweed (*Fallopia japonica*), and ornamental jewelweed (*Impatiens glandulifera*). All species are of high invasive potential in the Homer area, though none were noted on any IRP property. Smooth cordgrass is not anticipated to be a threat to IRP property as it grows only in tidal areas. Reed canary grass, which looks like bluejoint grass that is abundant on IRP property, thrives in wet spots alongside rivers, roads, and coastal areas. However, IRP property is far removed from the coast and lacks a river on the property, so potential for invasion is low.

Other Invasive Species Management

While purple loosestrife was not noted on IRP property, it is sometime mistaken for fireweed and should be carefully monitored for presence, especially when fireweed is in full bloom. The species grows well in marshy wetlands and bogs, so CACS should take care to monitor the bog on IRP Lot 1 (parcel 17113258) for presence of purple loosestrife. White sweetclover and Japanese knotweed grow alongside streams and rivers, and should not be as high a risk as other species due to the absence of rivers on the IRP property. However, streams should be carefully monitored for these species regardless. Last, ornamental jewelweed is not a threat to the IRP habitat due to its preference for rivers and beach meadows.

Preventative activities are the best way to reduce potential for introduction of non-native species in an area. Generally, minimizing disturbance activities such as mining, logging, fire suppression, and farm management, is the best course of action in preventing the spread of invasive species.[33] While the IRP property generally does not experience these sorts of disturbances, there is extensive mowing and care should be taken to minimize the spread of invasive species. Specifically, a tractor should not be driven in areas where invasives are prevalent. CACS should also prevent the transportation of invasive species from visitors by implementing shoe and clothing cleaning practices. Early detection and rapid response are the next best course of action after prevention, and educational tools should also be utilized. CACS should aim to educate volunteers or other staff members who will monitor the IRP property about invasive hotspots on the property (at present time, invasive are limited to occasional

[32] "Managing Invasive Plants in Denali (U.S. National Park Service)." *National Parks Service*. U.S. Department of the Interior, n.d. Web. 20 Mar. 2017.
[33] Homer Soil and Water Conservation District. "Integrated Weed Management Strategy Focusing on Early Detection/Rapid Response for the Kenai Peninsula - Cooperative Weed Management Area" December 2007. *Homer Soil and Water Conservation District.* 13 Feb. 2017.

patches) and the best methods for control.

Figure 13. Left, purple loosestrife. Source: Alaska Department of Natural Resources**.**
Figure 14. Center, white sweetclover. Source: Nanna Borcherdt, Sitka Conservation Society.
Figure 15. Right, reed canary grass. Source: Kenai Watershed Forum.

Figure 16. Left, smooth cordgrass. Source: United States Department of Agriculture.
Figure 17. Center, Japanese knotweed. Source: Vital Plan.
Figure 18. Right, Ornamental jewelweed. Source: Sagebud.

Development and Noise Pollution

As development in the surrounding area increases, CACS can expect further disturbances in the land surrounding the IRP. Specifically, there has been an increase in tourism to Homer, and there has been interest in starting helicopter tours over the area, which would contribute significant noise. Construction of new buildings will increase noise pollution on the IRP property, which has potential to disrupt bird calls and other wildlife communication. Utilizing sound monitoring will be helpful in determining how much noise pollution has increased before and after construction events in the area. Additionally, while there have been calls to allow jet skis in Kachemak Bay surrounding the spit, Homer residents are adamantly opposed due to noise pollution. This sound has potential to carry up the bluff to the IRP property if allowed in the future.

Logging, Hunting, and Trespassing

Logging and hunting will continue to remain threats to the IRP property and wildlife, but with proper monitoring, the disturbances can be mitigated. Most often, logging occurs on the boundaries of the IRP parcels due to uncertainty over property lines[34] and perpetrators are often taken to court to settle these disputes. Recently, a five-year permit was allocated to Axtel Enterprises, LLC to partake in community fuel reduction activities and timber harvest in the proximity of Hogback. All activities are in accordance with the Kenai Peninsula Borough's Land Management Division, but CACS should anticipate increased activity in the area and actively monitor any activity that crosses property lines.

CACS should be diligent with maintaining 'No Trespassing' signs to ensure that the public knows the boundaries between the IRP property and public land. Currently, there is a short list of individuals who are allowed to walk in and use the IRP property with Nina Faust's consent. CACS should plan to review this list in the future and determine if these rights should be extended or not. If so, all individuals should be briefed on new management and monitoring protocols, and should additionally be educated about invasive species. All volunteers and others on the IRP property should learn to recognize signs of illegal logging or hunting on the property and report disturbances as soon as possible to the proper authorities. Providing volunteers with GPS devices can be helpful in marking down both signs of illegal disturbances, as well as locations of invasive species.

Changes in Land Management

Expanding Mission and Considerations for New Use

When the property transitions into the management control of CACS, there are several considerations that need to be taken for the continued monitoring and management of the property. CACS' mission is in line with the management principles that have governed the management of the IRP to date, but adds an additional element of experiential environmental education that will bring more visitors to the property. For detailed discussion of plans to manage visiting groups' impact on the property, see the *Inspiration Preserve Master Plan: 2016-2025.*

To date, there have been three people that devote considerable time year-round to management of the property. KHLT will continue to monitor the 7 parcels that are under its purview, but additional monitoring will be needed on the other 11 parcels. With new management, there will

[34] Personal communication, Nina Faust

likely be a mix of volunteer and staff labor used to carry out the considerable management duties including trail maintenance and monitoring of the property. Towards this end, CACS should consider the role that tour groups can play in monitoring the property. As noted in the threats section, all volunteers and others on the IRP property should be educated about signs of illegal activity and invasives to help in identifying potential problems quickly. Additional important questions for CACS consideration include whether there will be a full-time caretaker; the role that full and part time staff will play in monitoring and managing the property; and coordination with KHLT.

Management Recommendations

Moving forward and building on current management and monitoring practices, we suggest that CACS carry out yearly baseline activities to maintain the property and continue monitoring for the threats outlined above. Every three years, it is suggested that more extensive studies be done to examine and thoroughly understand any changes to the flora and fauna communities of the IRP. An outline of a recommended monitoring and maintenance schedule is listed in Figure 19. These recommendations have been broken into essential activities and those that should be done as resources permit. Additional details of monitoring protocols are outlined in the sections that follow.

	Spring	Summer	Fall	Winter
Annual	**Maintain trails**			
	Maintain property lines			
	Maintain signage and buildings			
	Photo monitoring of primary points			
	Periodic invasive species monitoring			
	Drone monitoring of property lines and remote photopoints*			
	Phenology study*			
	Camera traps at points of interest			
	Sound monitoring*			
Every 2 Years	**Photo monitoring of all points**			
Every 3 Years	Vegetation surveys at established plots			
		Mammal trapping		
	Fish trapping			
Evey 5 Years	Update vegetation classifications with new areal imagery			

Legend	
*Additional recommendations beyond methods established by SNRE students	
	Vegetation monitoring
	Maintenance
	Fauna monitoring
Bold	Crucial activities that should be conducted annually
Not bold	Less crucial ctivities to be added as resources allow

Figure 19. Summary of stewardship and monitoring recommendations.

Property Maintenance

Trails on the property should be kept free of obstacles and downed trees. This will facilitate the educational programing conducted by CACS and allow staff and volunteers to adequately monitor the property and better reference disturbance events, like invasive species or illegal logging events. No new trails should be developed without a specific need in mind to minimize disturbance events that can act as catalysts for the spread of invasive species.

We recommend that CACS does not continue extensive mowing on the main IRP property.

While mowing has allowed cranes to nest in the field, it also has negative ecological implications and allows the spread of invasive species like dandelions and orange hawkweed. If CACS continues to mow, mowing events should be limited to IRP Lot 1 (parcel 17113258). Depending on whether the main building will be inhabited or not, a small amount of mowing may be necessary to create areas for visitors and volunteers.

Activities like mowing to create artificial habitat and feeding corn to Sandhill cranes have mixed ecological impacts on the cranes. The Sandhill cranes prefer wetland habitat with standing grass, which provides foraging areas and protection from predators. They avoid upland and forested area, presumably because such locations attract predators.[35] An example of a natural habitat for Sandhill cranes in Homer is the Beluga Slough. Mowing creates an artificial crane habitat in an upland area close to forests, which may cause higher predation of adult cranes and colts by bald eagles, coyotes, lynx, and other predators. Feeding wildlife is commonly viewed as negative to the long-term conservation of species.[36] It is shown to alter natural behavior patterns and population levels; it also increases wildlife dependence on human for food provision.[37] However, Sandhill cranes are omnivorous and opportunistic foragers that will exploit waste corn fields when possible.[38] A study in Nebraska shows that waste corn from farmland can consist of up to 97% of Sandhill cranes' diet, while the other 3% consists of invertebrates.[39] Analysis showed that cranes had substantial energy gain but no significant change in protein levels. Therefore, it could be argued that feeding corn to cranes will not significantly change the behavior or reliance on humans of some cranes that already graze on corn due to the expansion of industrialized agriculture. Nevertheless, if the goal of the CACS is to manage land and wildlife in a natural state, then this goal would seem to be contrary to maintaining an artificial crane habitat and human feeding.

[35] Baker, Bruce W., et al. "Spatial analysis of sandhill crane nesting habitat." *The Journal of wildlife management* (1995): 752-758.
[36] Orams, Mark B. "Feeding wildlife as a tourism attraction: a review of issues and impacts." *Tourism management* 23.3 (2002): 281-293.
[37] Ibid
[38] Reinecke, Kenneth J., and Gary L. Krapu. "Feeding ecology of sandhill cranes during spring migration in Nebraska." *The Journal of wildlife management* (1986): 71-79.
[39] Ibid

Monitoring

Photo Monitoring

In Person

It is recommended that CACS institute a photo monitoring regimen modeled after the KHLT photo monitoring protocols on the additional points selected (see the map in Appendix A and photo point handbook in Appendix C).

Once a year (in the spring or summer), two volunteers should visit the primary photo monitoring points (Appendix A) and every other year volunteers should take photos of all the points.

Volunteers should ensure that each point is the same as the original by using a GPS unit with the photo points programmed into it. The photo book (Appendix C) should be taken with the volunteers and the photo points also visually confirmed against the original pictures and directional information. Pictures should be taken again in each of the original directions of the originals, including areas of interest or special features (see 'Photo Monitoring Methods' in Appendix E).

These photos should be compiled in the same way as the initial photos to ensure that a log of landscape changes is captured and that annual comparisons can be made and changes across time can be observed.

Drones

CACS recently purchased a DJI Phantom 3 drone capable of taking high quality photographs which would increase the ability of CACS volunteers and staff to monitor hard to reach places with much less effort and time spent in transit. The current model is not able to navigate to specific GPS points, but it can navigate to 'waypoints.'[40] The drone could be taken to specific photo points and flown so that the drone can capture and remember the point and subsequently be directed to the point from a more convenient location to capture pictures of areas of interest. Drones would also be useful for periodic flyovers of hard to reach areas to monitor for illegal activity such as logging and to monitor property lines.

In the future, additional drones may be necessary if they are used to conduct full property

[40] "Phantom 3 4K - Specs, FAQ, Tutorials, Downloads and DJI GO - DJI." *DJI Official*. N.p., n.d. Web. 17 Mar. 2017.

monitoring. Additionally, a model that can be navigated accurately to specific GPS points would be desirable.

Other Drone Considerations

According to Koh et al (2012), open source software can be used by non-technical operators to fly pre-programmed autonomous missions to produce real-time geo-referenced land cover maps, conduct large animal population censuses, and monitor significant property changes/illegal activities. Drones can produce high-spatial resolution images on demand, for a low price, when conditions are ideal (i.e. no cloud cover). Monitoring can be done in real-time which lends itself to adaptive management.

The disadvantages of drones include low spectral resolution of imagery, poor geometric and radiometric performance, sensitivity to atmospheric conditions, short flight endurance, and the possibility of collisions/collateral damage (or other safety issues).[41] Additionally, social impacts such as safety, privacy, psychological wellbeing, and data security should be considered when using drones for conservation.[42]

For the purposes of monitoring habitat, results of data collected should be compared with the results of other data collection techniques (e.g. on the ground photo points) to compare accuracy. Further review of regulations and feasibility should be conducted for the purposes of potentially monitoring Sandhill Crane populations and nest sites.

The use of drones in general is undergoing changes in terms of regulatory frameworks under the Federal Aviation Administration.[43] Regulations which would apply to recreational use of drones in the context of this project include:

1. Register the drone if it weighs more than 0.55 pounds (https://registermyuas.faa.gov/)
2. Fly drones under 400 feet
3. Fly within eyesight, using an observer to assist if needed
4. Remain at least 25 feet away from individuals and vulnerable property
5. Remain well clear of manned aircraft operations
6. If flying within five miles of an airport or helipad, contact the airport first. This regulation should be of note to CACS since the IRP property lies within proximity to the Homer airport and tourist helicopter operations.

[41] Paneque-Gálvez, Jaime, et al. "Small drones for community-based forest monitoring: An assessment of their feasibility and potential in tropical areas." *Forests* 5.6 (2014): 1481-1507.
[42] Sandbrook, Chris. "The social implications of using drones for biodiversity conservation." *Ambio* 44.4 (2015): 636-647.
[43] Federal Aviation Administration (FAA) Emerging Technologies Team. Notice: Unmanned Aircraft Operations in the National Airspace System (NAS) – Number JO 7210.891. (2015).

GIS Monitoring

As a result of this project, CACS will have improved access to a number of publicly available and produced geospatial datasets. We organized a variety of datasets for CACS as spatial maps, as requested, shown in Appendix A. Although the maps provided can serve as a basis for management planning in and of themselves, CACS can more fully take advantage of the datasets for management and monitoring purposes at a variety of levels by including GIS-capable personnel on their staff (temporary or permanent).

At a minimum level of investment, hiring a summer intern with GIS experience and installing QGIS (free, open-source GIS software) would allow CACS to:

1. **Record and track drone monitoring efforts on the IRP**. Each drone flight can be imported and shown over pre-existing layers to show which areas have been monitored and especially which areas show any significant changes.
2. **Record and track trail usage**. Numbers of visitors can be joined to existing trail data and corresponding maps can be modified to show which trails receive the highest impact. This can guide usage of environmentally sensitive areas like the bog and wetlands.
3. **Update the provided dataset** over time with additional camera trap, fish trap, and/or vegetation monitoring sites as needed. Other monitoring of interest to CACS (for example, crane nest sites) can also be incorporated into the existing dataset.
4. **Expand on the provided dataset** to include other CACS properties and activities, including the Wynn Nature Center and Peterson Bay Field Station.
5. **Build maps specific to the needs of the center.** Maps provided in this document are intended as aids in management and planning. These maps could be modified to be used by different target audiences (for example, hiking groups).

At a higher level of investment, CACS could utilize the provided data as a basis for additional research related activities:

1. **Update vegetation classification.** The completed vegetation classification serves as a baseline of vegetation communities present on all the IRP properties at the time of property transfer. To monitor changes over time, vegetation classification would ideally be repeated over time, when new aerial imagery becomes available. At a minimum, changes are typically monitored over time scales of 5 to 10 years.
2. **Integrate with CACS Research Action Plan**. The CACS Research Action Plan[44] lists several staff and citizen science driven research projects. These projects can incorporate geospatial components for additional research value.

[44] IRP Master Plan 2016-2025.

3. **Expanding vegetation monitoring plots.** The vegetation monitoring already conducted was limited to three locations (for sake of time). A more robust baseline might include a dozen different sites.

Vegetation Survey

The team set up three permanent vegetation transects in the following habitat types:

1. Bog (on the IRP property)
2. Transitional meadow (in the Mead 40)
3. Tree line along spruce forest (on the 103)

Each transect is 100 meters long and marked by two wood stakes with flag tape indicating orientation.

Recommended Survey Protocols:

It is recommended that this vegetation survey be carried out in August at least every three to five years to allow monitoring of changes in the vegetation community. The survey requires at least two volunteers who have some level of familiarity with the vegetation in the Homer area. In addition, the wooden stakes should be replaced every five years to maintain good condition. General locations of the stakes could also be marked with a GPS in case the stakes become inadvertently removed or lost.

Materials needed

1. A 1x1m nested quadrat. One such quadrat has been made using PVC pipes and strings, and was stored at the CACS main office. New quadrats can be made based on the design shown in Figure 20.
2. A transect tape over 100 meters in length
3. Waterproof notebook and pencil
4. Vegetation identification sheets
5. Gloves

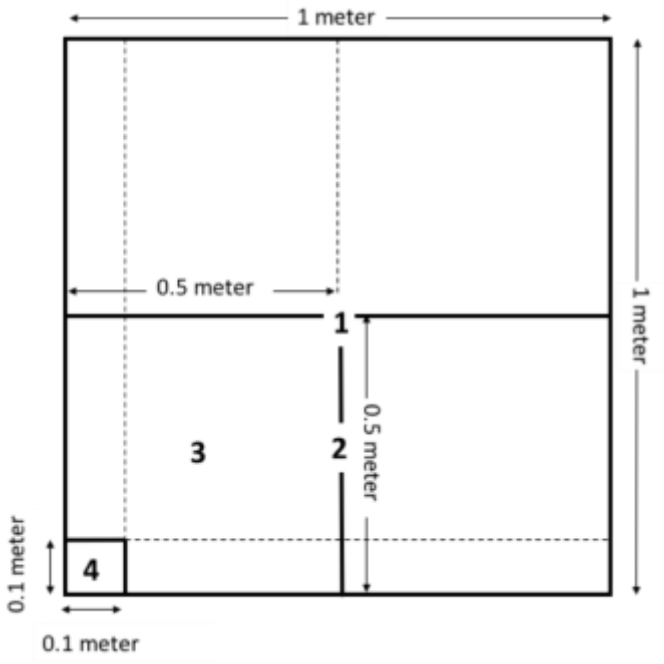

Figure 20. A 1m x 1m nested frequency quadrat with four nested sizes.

Procedure

1. Find the two wood stakes using map (Appendix A) and GPS; use the transect tape to connect the two points and form a straight line, with 0m on one end and 100m on the other.
2. Use a random number generator application from a smartphone, generate 5 random numbers between 0-100 representing the location along the transect line where a 1*1 quadrat will be placed. With the help of a plant identification guide, thoroughly survey and record all the plant species found in each of the nested quadrats. Plants that fall within the smallest quadrat should be recorded as score "4." Species found outside the smallest quadrat but within the second smallest quadrat should be given a score "3", and so forth.
3. Take pictures of unidentified plant species, note the picture number and the location found.
4. Survey the woody plants within 2 meters on either side of the transect. Record the DBH and species for wood plants that have a DBH of 2.5cm and over. Count the total number of spruce seedlings/saplings within the 2-meter range.

It takes approximately 2-3.5 hours for two volunteers to complete the field survey at each transect.

Data Entry and Analysis

After all plant species are identified, a list of species should be developed for each transect. For each species in the list, calculate the mean nested frequency score by averaging the scores received from all 5 plots. The average score can indicate whether the species is dominant or not. The species list and scores can be compared with survey results from previous years to understand the changes in vegetation community. See 'Vegetation Survey Methodology' in Appendix E for sample data sheets.

Camera Trapping

Camera trapping has a wide range of applications in ecology and conservation, including species inventory, occupancy estimation, density estimation, and monitoring of population trends. [45] [46] The advantages of using camera traps in wildlife surveys include: low invasiveness to animals, reduced human interference, extended sampling time, and a comprehensive record of information including date, time, location, and species. Camera trapping is especially useful for surveying medium to large sized terrestrial and semi-terrestrial mammals, as well as large ground birds.[47]

It was suggested that for the purpose of creating ecological inventories, there is no strict requirements on location and number of camera traps or distances between two sites, except that the sites should represent key habitats. To maximize captures, camera traps can be placed upon intensively used wildlife trails, drinking sites, or nests. Studies suggested that after 1,000 camera trap days, the number of species detected by camera traps can often reach over 50% of the total fauna.[48] [49]

In the context of the IRP, camera traps have the potential to also monitor human use of the property. Illegal activities such as trespassing, hunting, and logging can be detected by the cameras.

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[45] Rovero, Francesco, et al. "" Which camera trap type and how many do I need?" A review of camera features and study designs for a range of wildlife research applications." *Hystrix, the Italian Journal of Mammalogy* 24.2 (2013): 148-156.

[46] Rowcliffe, J. Marcus, and Chris Carbone. "Surveys using camera traps: are we looking to a brighter future?." *Animal Conservation* 11.3 (2008): 185-186.

[47] O'Connell, Allan F., James D. Nichols, and K. Ullas Karanth, eds. Camera traps in animal ecology: methods and analyses. *Springer Science & Business Media*, 2010.

[48] Rovero, Francesco, et al. "" Which camera trap type and how many do I need?" A review of camera features and study designs for a range of wildlife research applications." *Hystrix, the Italian Journal of Mammalogy* 24.2 (2013): 148-156.

[49] O'Connell, Allan F., James D. Nichols, and K. Ullas Karanth, eds. Camera traps in animal ecology: methods and analyses. *Springer Science & Business Media*, 2010.

Recommendation

Continuing Baseline Survey

In the summer of 2016, the team conducted a camera trapping survey using 2 cameras from CACS and 1 from the landowner. The survey lasted 331 camera trap days (the combined number of days of each camera placement), documenting four species – black bear, moose, coyote, and an unidentified waterfowl. We recommend this effort be continued until the total camera trap days reach 1,000. Additional species recorded should be added to the species list.

Long-term Monitoring

We recommend that camera traps be placed in points of interest throughout the year to monitor animal activities. The ongoing camera trapping generates several benefits: (1) Increase knowledge of the diversity and population dynamics of medium to large-bodied animals in the IRP, (2) Improve understanding of the time and location of animal activities, which can guide future wildlife viewing programming, (3) Provide pictures and videos that can be used for educational purposes, and (4) Monitor human use of the property, and detect illegal activities.

Fish Trapping

The coastal water bodies in Alaska are important habitats for anadromous fish. The Alaska Department of Fish and Game (ADFG) created the Anadromous Waters Catalog and Atlas to specify "rivers, lakes, and streams, or parts of them, that are important for spawning, rearing, or migration of anadromous fishes."[50] Streams that have been shown to be important habitat for anadromous fish are afforded additional protections under Alaska Statute.[51] However, fewer than 50% of the streams, rivers and lakes used by anadromous species have been specified in the Catalog.

As noted in the 'Hydrology' section of this document, the IRP is considered part of the Fritz Creek Watershed. However, depending on hydrologic conditions, headwaters on the IRP may connect to Beaver Creek, portions of which have been known to have anadromous fish.[52] Fish trapping was carried out in streams in several locations on the IRP property to test for the presence of fish with a particular interest in anadromous species (Appendix A).

During the fish survey conducted by the team in summer 2016, 5 minnow traps were placed at

[50] Johnson, J., and P. Blanche. "Catalog of waters important for spawning, rearing, or migration of anadromous fishes–Southeastern Region, Effective June 1, 2012." *Alaska Department of Fish and Game, Special Publication* 11-07 (2011).
[51] Johnson, J., "Anadromous Waters Atlas and Catalog: Where The Salmon Are." *Alaska Department of Fish and Game,* (2011).
[52] Steve Baird, Kachemak Bay National Estuarine Research Reserve, *personal communication*, August 2016.

several locations throughout the IRP over the course of two separate 24-hour periods. Ten juvenile dolly varden trout (*Salvelinus malma*) were found in four locations on two parcels of the IRP (Appendix F). Dolly varden exhibit a variety of life history forms and can be anadromous or stream residents.[53] Thus presence in the IRP streams is not conclusive to afford anadromous protection, but is clear evidence that the streams are healthy enough to support aquatic life.

Recommendation

We recommend that CACS conduct additional fish surveys every three years to monitor the health of the streams and test for additional, potentially anadromous, species. For a more complete picture of how fish use the streams, trapping should be conducted during different times of the year between spring and fall, when the streams are running.

Recommended Procedures

A catch permit must be secured from the ADFG to trap fish at the study site. Any fish found during the trapping must be reported to ADFG within 30 days in a data sheet format provided by the agency with supporting photographs. Fish trapping occurs over a 24-hour period following these steps:

1. Minnow traps should be placed in streams on the IRP in areas deep enough to submerge traps. Traps should be baited with uncured salmon eggs placed in small, perforated plastic bags to release the smell of the eggs. Traps should be anchored to the bank, locations flagged so they can be found again, and a GPS point of the location taken.
2. Traps should be checked about one hour after being placed to ensure that they remained in place. Traps should then be left to soak overnight (approximately 24 hours) before retrieval.
3. Traps should be checked approximately 24 hours after they were placed. Traps should be pulled, opened, and any fish caught placed into a bucket filled with water. The total length of fish present should be measured using a photarium and identified with the help of Alaska Fish and Game species guides. A photo should also be taken.
4. Any fish caught should be released back into the stream.

Small Mammal Survey

To establish an ecological baseline of the small mammal species in the preserve, we recommend that a more comprehensive small mammal survey be conducted within the next three years.

Once baseline data is established, repeated surveys of small mammal can be conducted annually

[53] Alaska Department of Fish and Game. "Dolly Varden". (2008). Retrieved from https://www.adfg.alaska.gov/static/education/wns/dolly_varden.pdf on April 17, 2017

if CACS is interested in documenting the population trend of small mammal species. Small mammals function as important primary consumers as well as the primary food source for predatory birds and mammals. The fluctuations in small mammal population can reflect changes in climate, resources, and enemies.[54]

Materials and Procedure

To achieve a higher trap success, at least 50 Sherman traps should be used, or the survey needs to be repeated for 2-3 consecutive days if using fewer traps. The survey should take place in sunny, warm weather during the summer months, and in locations that represent the most common habitat types – forest and meadow.

1. In the afternoon of the first day of the survey, place 50 Sherman traps ten steps apart from one another in a forest-meadow transitional transect.
2. Use sunflower seeds, bird seed, corn, or oats, as bait. Place bait both inside and at the entrance of the traps. Moss should also be placed inside the trap to protect the trapped animal from hypothermia.
3. Mark the location of each trap using flagging tape placed at eye level.
4. Early the following morning, retrieve all traps. Remove any animals from the occupied traps to a Ziploc bag for observation. Record species, weight, sex, age, and presence of any observable parasites for all the animals.
5. As soon as each animal is processed, it should be released into a nearby forest patch.

Sound Monitoring

Sounds play significant roles in ecosystems in determining how plants and animals interact with each other and their landscape.[55] Sounds can be both indicative of organism health or stress. The field of soundscape ecology examines the broader ecological significance of sounds in landscapes.

Three components of soundscapes are characterized in the literature: biophony, geophony, and anthrophony. Biophony consists of sounds made by animals, such as birds, insects, reptiles, and mammals. Biophony allows animals to interact with their environments in several ways. Animals can find mates, give alarm calls, detect predators, and find food through environmental biophony. Geophony are sounds made by geophysical phenomena. This includes rain, snow, hail, wind, and water. Anthrophony are all human-made sounds, such as speaking, music, and vehicle noises. The combination of all three components of soundscapes have the potential to

[54] Batzli, George O. "Dynamics of small mammal populations: a review." *Wildlife 2001: populations*. Springer Netherlands, 1992. 831-850.
[55] Mullet, Timothy C., et al. "Temporal and spatial variation of a winter soundscape in south-central Alaska." *Landscape Ecology* 31.5 (2016): 1117-1137.

affect organism functioning. For example, the presence or absence of wind can decrease or increase bird calls in the environment, while increased anthrophony might drown out the mating calls of some other organisms. This is termed *masking*, when a sound interferes with the detection of another sound.[56]

Because soundscapes vary both temporally and spatially, the configuration of the environment is important in determining sound configurations. Soundscapes differ between seasons as well. Researchers have found that wildlife vocalizations decrease in winter soundscapes because of wind increase and winter vehicle noise.[57] This finding has direct implications upon ecological monitoring of wildlife populations, as several external variables must be considered when performing sound monitoring. The expansions of human settlements through urbanization has the potential to vary the soundscape as well, and conservation efforts are needed to preserve their functioning.

Sound monitoring is usually performed with audio recording equipment, often called an "EAR" (Environmental Acoustic Remote Sensor). The EAR is preferred in many sound monitoring programs because it allows real-time monitoring of acoustic feedback. The recorder is used in tandem with other equipment like digital cameras, acoustics analysis systems, weather stations, and satellites. Collection of environmental data beforehand is especially necessary, as baseline ideas of wind speeds, direction, air and soil temperature, and solar radiation are needed. The EAR can capture the frequencies of sounds that vary over time, which are then visualized in a spectrogram, with the intensity of the color representing that sound.[58] Louder sounds are displayed with the brightest colors, and frequency is represented on the Y-axis, while time is displayed on the X-axis.[59]

Recommendations

Sound monitoring was not conducted by the students as part of this project. Outside help from Scott McEwen is necessary if CACS plans to pursue sound monitoring. Expertise with complex software and setup is necessary to adequately carry out this part of the monitoring plan. Scott was awarded a grant to purchase a Wildlife Acoustics Song Meter SM4 Acoustic Recorder, which was placed beside Mallard Pond. Monitoring sound on the IRP will be useful to CACS in determining novel sound threats to the property in the following ways: (1) sound monitoring could be used to educate visitors about natural soundscapes and how they can be affected by

[56] Mullet, Timothy C., et al. "Temporal and spatial variation of a winter soundscape in south-central Alaska." *Landscape Ecology* 31.5 (2016): 1117-1137.
[57] Ibid
[58] Ibid
[59] Sanchez, G; Maher R.C; and Gage S. "Ecological and environmental acoustic remote sensor (EcoEARS) application for long-term monitoring and assessment of wildlife," in Proc. U.S. Department of Defense Threatened, Endangered and at-Risk Species Research Symposium and Workshop, Baltimore, MD, USA, 2005.

human activities, and (2) monitoring could be useful to the people of Homer as evidence for keeping out jet skis, helicopters, and other anthropogenic disturbances through legal action.

If CACS chooses to conduct sound monitoring on the IRP, the land should first be divided up into spatially explicit regions, with a permanent sampling site within each region. Access to permanent sampling sites will most likely be constricted by accessibility of roads, trails, and rivers. At each site, GPS coordinates should be recorded. The EAR, or whichever type of sound recording equipment CACS is in possession of, should be set to record sounds for 1 minute at 30-minute intervals throughout the day. Data can then be stored in computers for further analysis. See Appendix E for more detail on sound data extraction.

Plant Phenology Study

Phenology is defined as "the study of periodic events in the life cycles of animals or plants, as influenced by the environment (especially seasonal variations in temperature and precipitation)."[60] Changes in phenology affects species population, distribution and diversity, which in turn influences biogeochemical cycles and ecosystem services. Phenology is also an important indicator of species response to climate change.[61] A plant phenology study involves long-term, frequent observation of selected individual plants using standardized protocols. Such data is often collected by volunteers through regional or national phenology networks. The USA National Phenology Network provides monitoring protocol, training materials, and other technical assistance to partners who are carrying out local phenology monitoring.

Considering the time and manpower required, external support is necessary if CACS plans to implement a phenology study in the IRP. CACS should partner with the National Phenology Network to obtain technical support. The plant species need to be carefully selected to provide the best indicator of environmental change for the area. Monitoring protocols need to be set up detailing monitoring frequency and phenology observed. Daily observation can provide the most accurate reflection of phenology changes, and is thus recommended for the study in the IRP.[62] Volunteers or full-time staff member who can commit to daily monitoring of selected plants is required.

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[60] Cleland, Elsa E., et al. "Shifting plant phenology in response to global change." *Trends in ecology & evolution* 22.7 (2007): 357-365.

[61] USA National Phenology Network. "Phenology, a national indicator". (2015). Retrieved from https://www.usanpn.org/about/national-indicator on April 15, 2017

[62] Miller-Rushing, Abraham J., David W. Inouye, and Richard B. Primack. "How well do first flowering dates measure plant responses to climate change? The effects of population size and sampling frequency." *Journal of Ecology* 96.6 (2008): 1289-1296.

Conclusion

The IRP is an important protected area providing habitat for flora and fauna native to Homer, Alaska. The transition of property ownership to CACS expands the potential of the IRP to play a key role in environmental education in addition to conservation. To ensure the health of the property, extensive management and monitoring will need to be continued at current levels and expanded as property use and local disturbances increase. The data collected over the course of this project establishes a documented baseline for the managers of the IRP to use as the property continues to undergo ecological change, especially in the face of climate change and other anthropogenic factors impacting the Kenai Peninsula. For instance, the compiled list of species and their distributions contribute to a better understanding of community composition in various habitat types and will help CACS monitor for potential disturbances. The management plan and recommendations contained in the document aim to support CACS' goal of balancing human use with protection of coastal ecosystems. The recommendations indicate priority activities to be conducted annually, most of which build upon or are continuations of current management practices, and a subset of ecological monitoring activities that should be conducted on time scales from 2-5 years. The document also identifies additional monitoring methods that should be conducted as resources allow to develop a more comprehensive picture of the ecological health of the IRP. This suite of recommended monitoring activities build on the baseline studies conducted in 2016 and will help to establish ecological trends that can be used to inform future management decisions.

Photo References

Figure 6: Salida Regional Library. “Spruce beetle.” Salida Regional Library: http://www.salidalibrary.org/spruce-beetles-vs-trees/

Figure 7: Salida Regional Library. “Spruce beetle damage.” Salida Regional Library: http://www.salidalibrary.org/spruce-beetles-vs-trees/

Figure 8: Salida Regional Library. “Spruce beetle damage.” Salida Regional Library: http://www.salidalibrary.org/spruce-beetles-vs-trees/

Figure 9: US Forest Service. “Spruce aphid.” Alaska Public Media: http://www.alaskapublic.org/2016/04/06/peninsula-spruce-threatened-by-aphid/

Figure 10: Winters, John (Alaska Division of Forestry). “Spruce aphid damage.” Homer News: http://homernews.com/local-news/2017-03-02/cold-may-curtail-spruce-aphids

Figure 11: Hauser, Kevin. “Orange hawkweed.” The Student Conservation Association: https://www.thesca.org/connect/blog/%E2%80%9Caha%E2%80%9D-moment-blooms

Figure 12: Edible Wild Food. “Dandelion.” Edible Wild Food: http://www.ediblewildfood.com/dandelion.aspx

Figure 13: Byrd, John (Mississippi State University). “Purple loosestrife.” Alaska Department of Natural Resources - Division of Agriculture: http://plants.alaska.gov/invasives/noxious-weeds.htm

Figure 14: Borcherdt, Nanna (Sitka Conservation Society). “White sweetclover.” US Forest Service: https://www.fs.fed.us/database/feis/plants/forb/melspp/all.html

Figure 15: Kenai Watershed Forum. “Reed canary grass.” Kenai Watershed Forum: http://kenaiwatershed.org/science-in-action/fish-barriers/reed-canary-grass/

Figure 16: USDA-NRCS PLANTS Database. “Smooth cordgrass.” US Department of Agriculture - Natural Resource Conservation Service: https://plants.usda.gov/core/profile?symbol=spal

Figure 17: Vital Plan. “Japanese Knotweed.” Vital Plan: https://vitalplan.com/ingredients/resveratrol

Figure 18: Tubifex. “Ornamental Jewelweed.” Sagebud: http://sagebud.com/ornamental-jewelweed-impatiens-glandulifera

Appendix A. Maps

Inspiration Ridge Preserve

Parcels Map

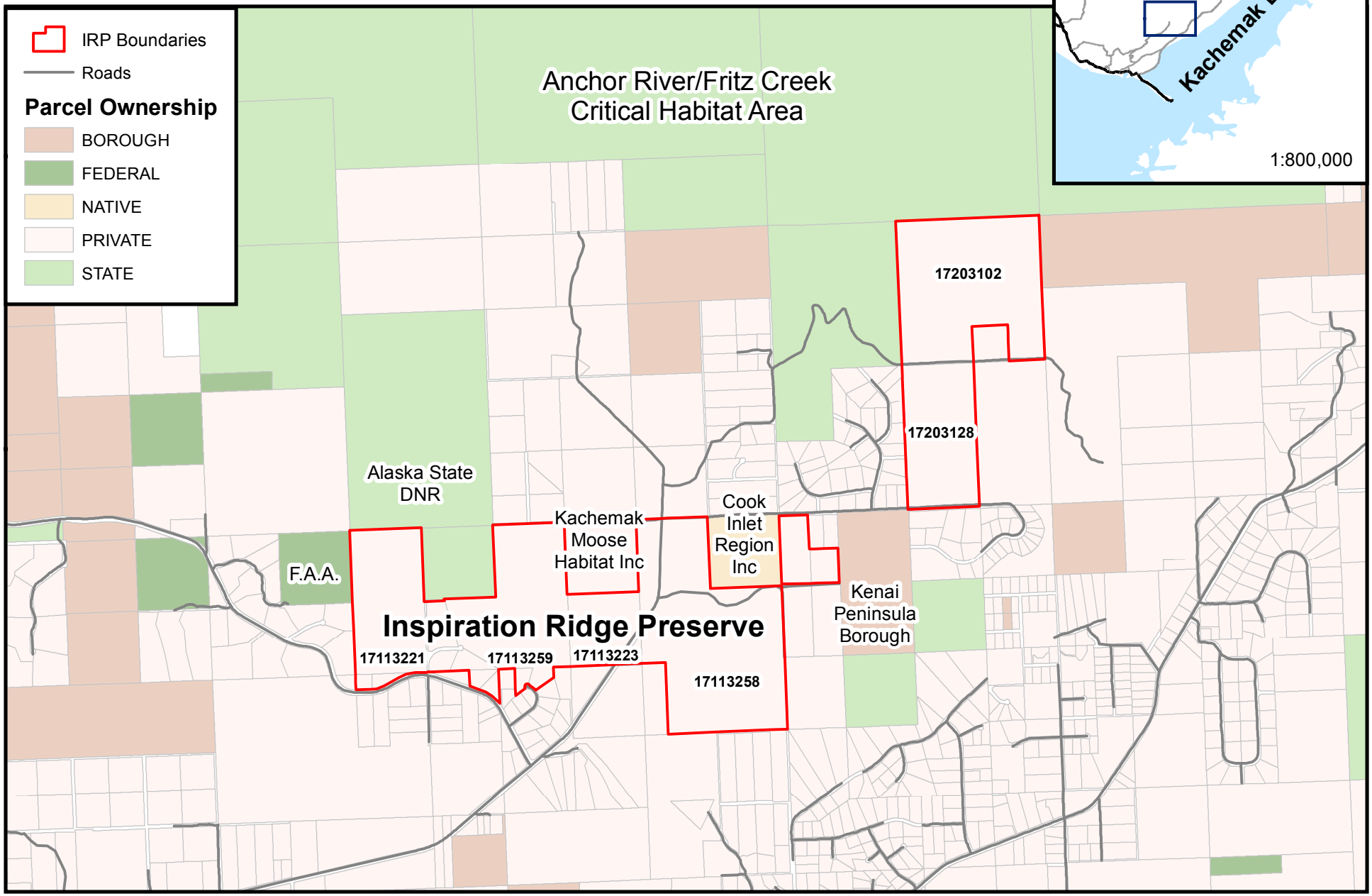
0 0.1 0.2 0.3 0.4 0.5 Miles

N

1:30,000

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Parcels/Roads: Kenai Peninsula Burough, GIS Dept.
Layout: SNRE students, fall 2016



Inspiration Ridge Preserve

Photo Points

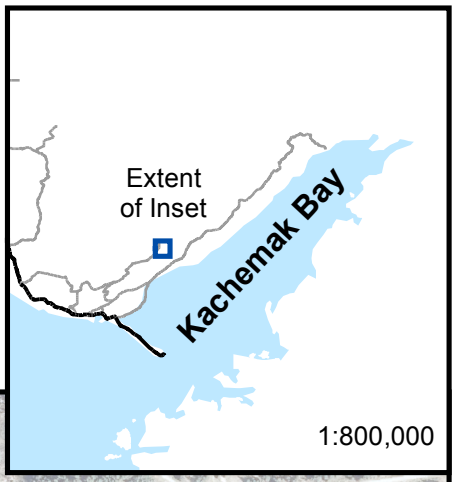
Coordinate System:
NAD 1983 Alaska Albers

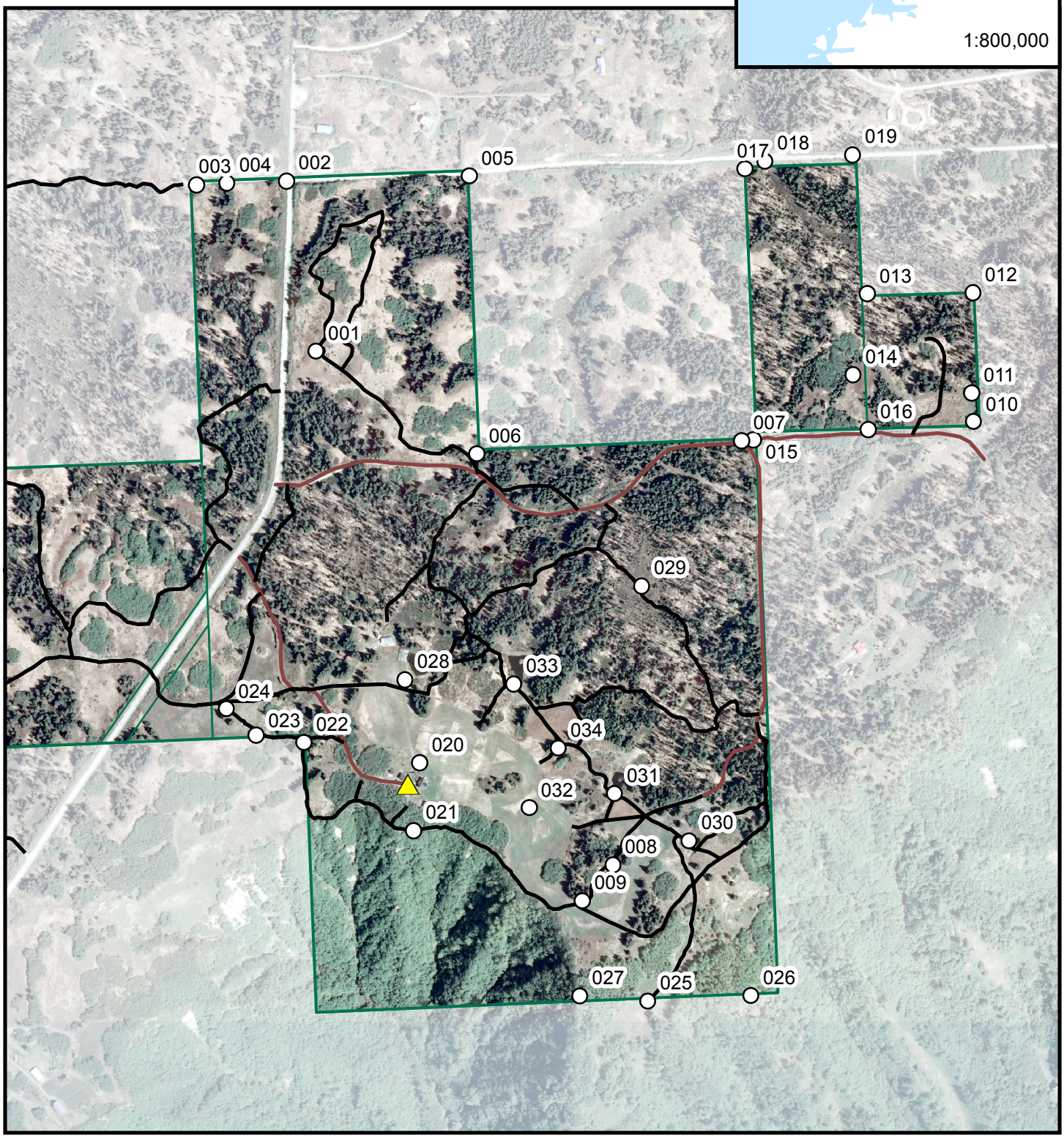
Sources:
Imagery: Kenai Peninsula Burough, GIS Dept.
Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016

PointType
- Photo point
- Headquarters
- Trails
- Driveways
- Boundaries

0 0.1 Miles

N
1:8,000



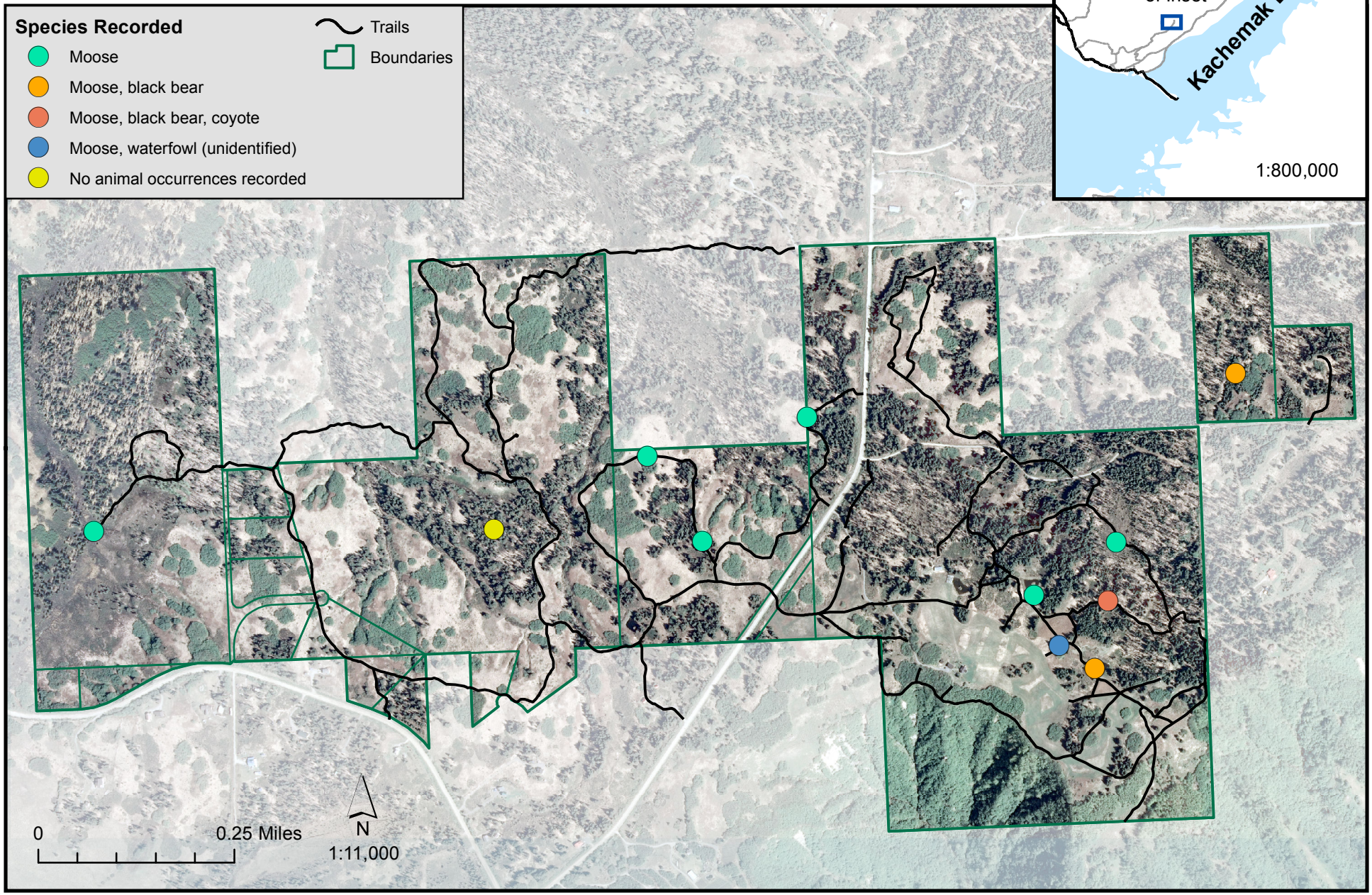


Inspiration Ridge Preserve

Camera Trap Locations

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Burough, GIS Dept.
Trails and Camera Points: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016



Inspiration Ridge Preserve

Fish Trap Locations

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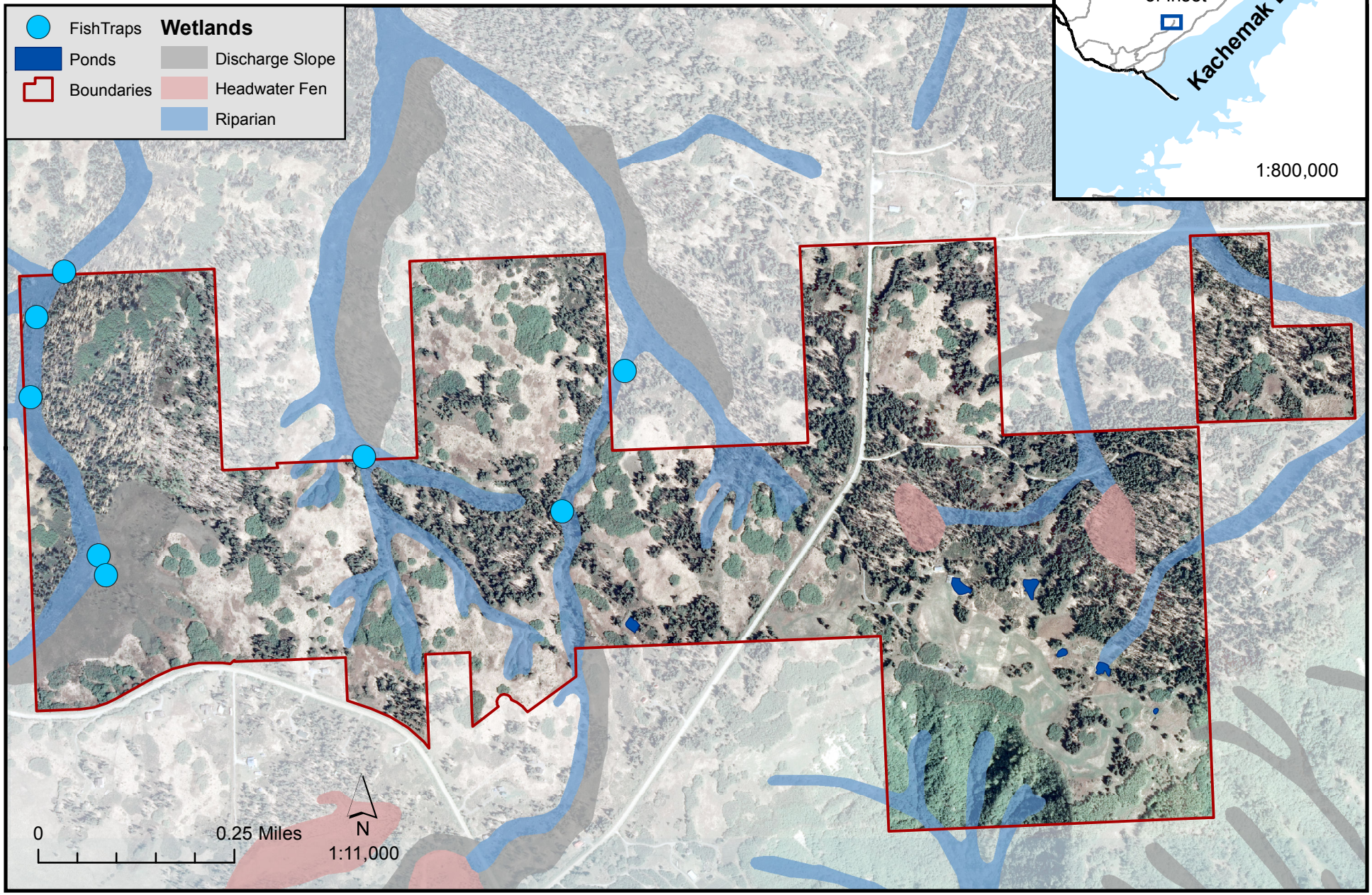
Sources:
Imagery and Hydrology: Kenai Peninsula Burough, GIS Dept.
Layout & digitization: SNRE students, fall 2016

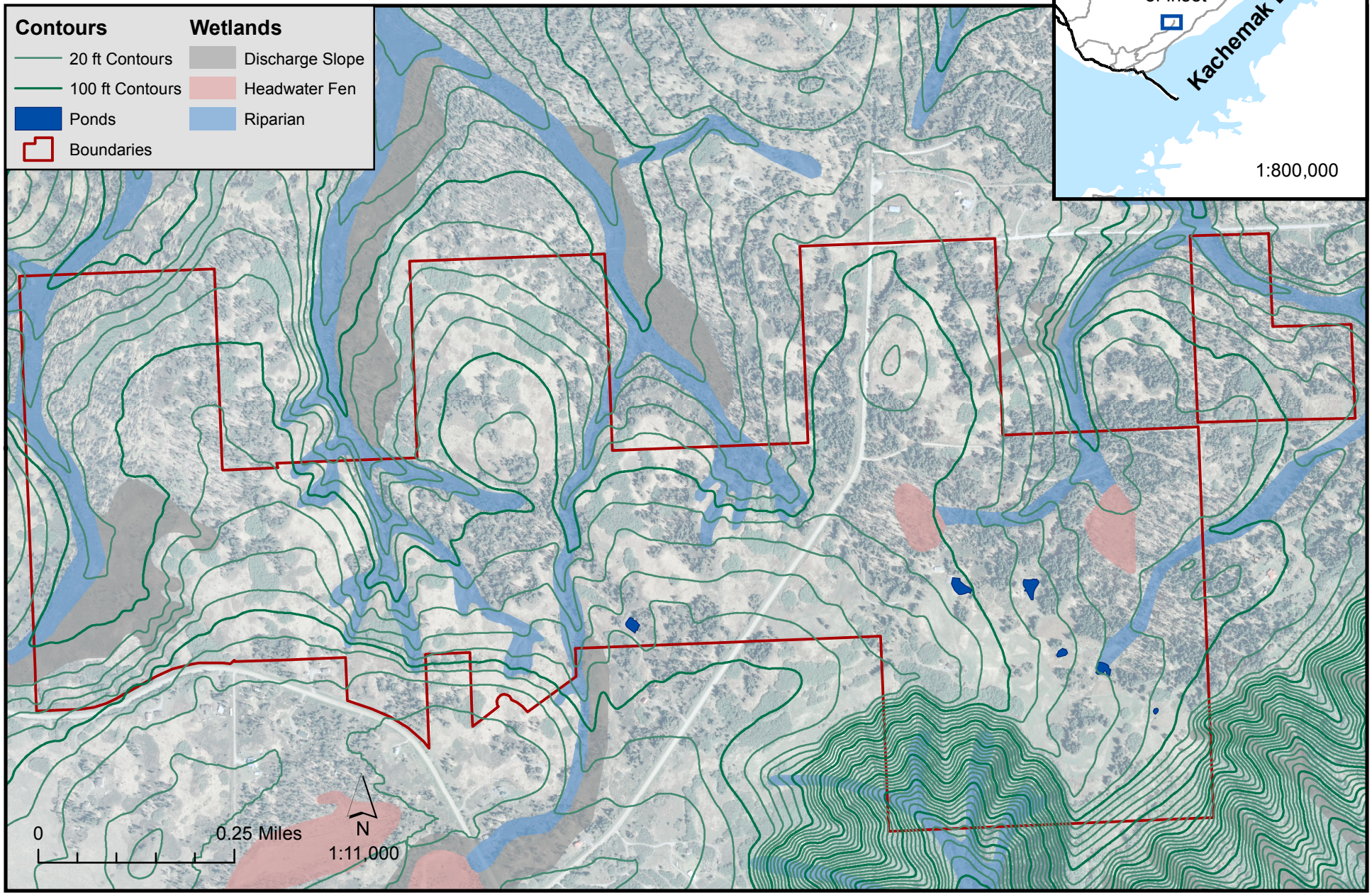


Inspiration Ridge Preserve

Hydrology

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery and Hydrology: Kenai Peninsula Burough, GIS Dept.
Layout & digitization: SNRE students, fall 2016



Inspiration Ridge Preserve

Elevation

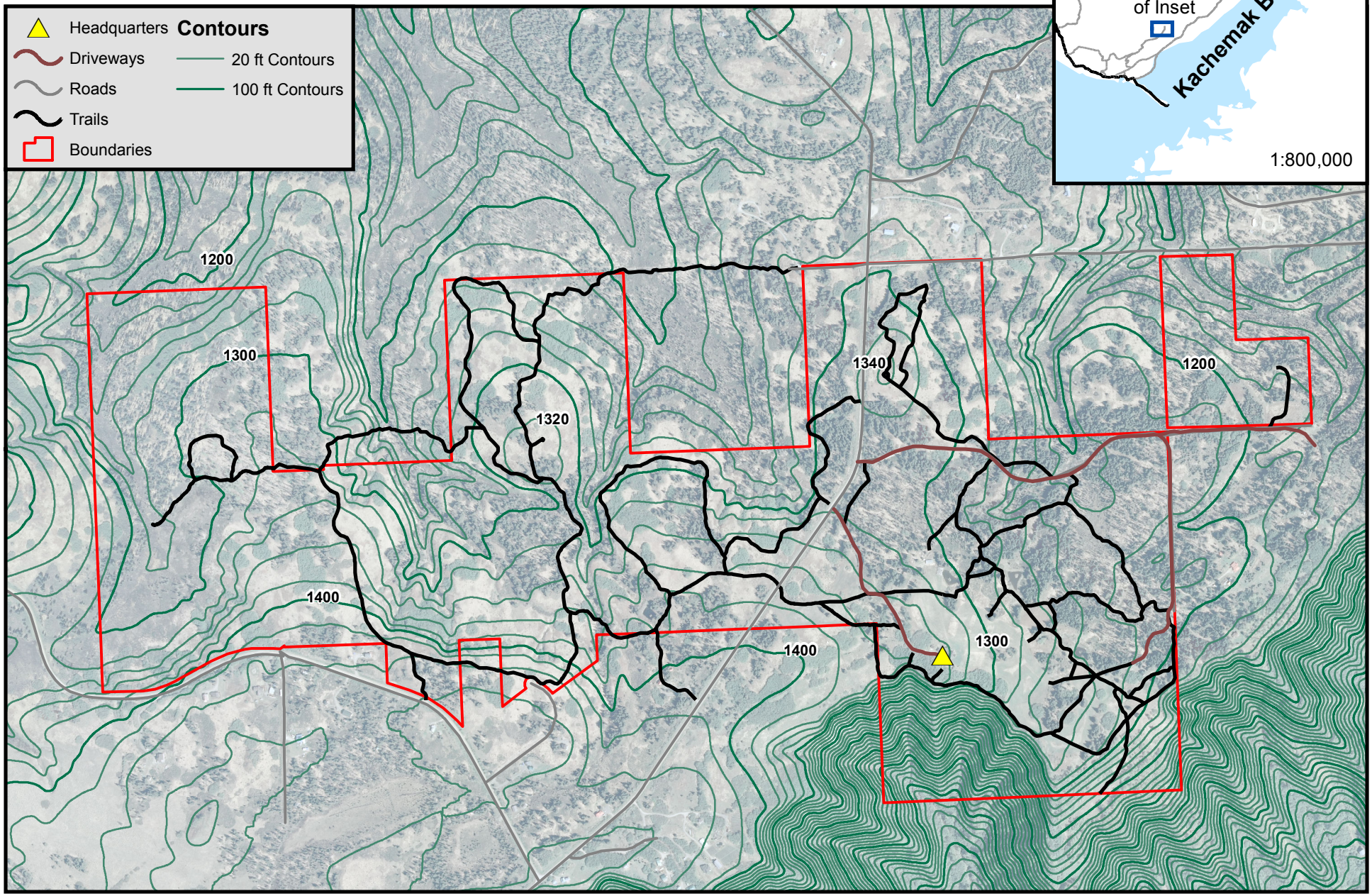
0 0.3 Miles

N

1:12,000

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016



Inspiration Ridge Preserve

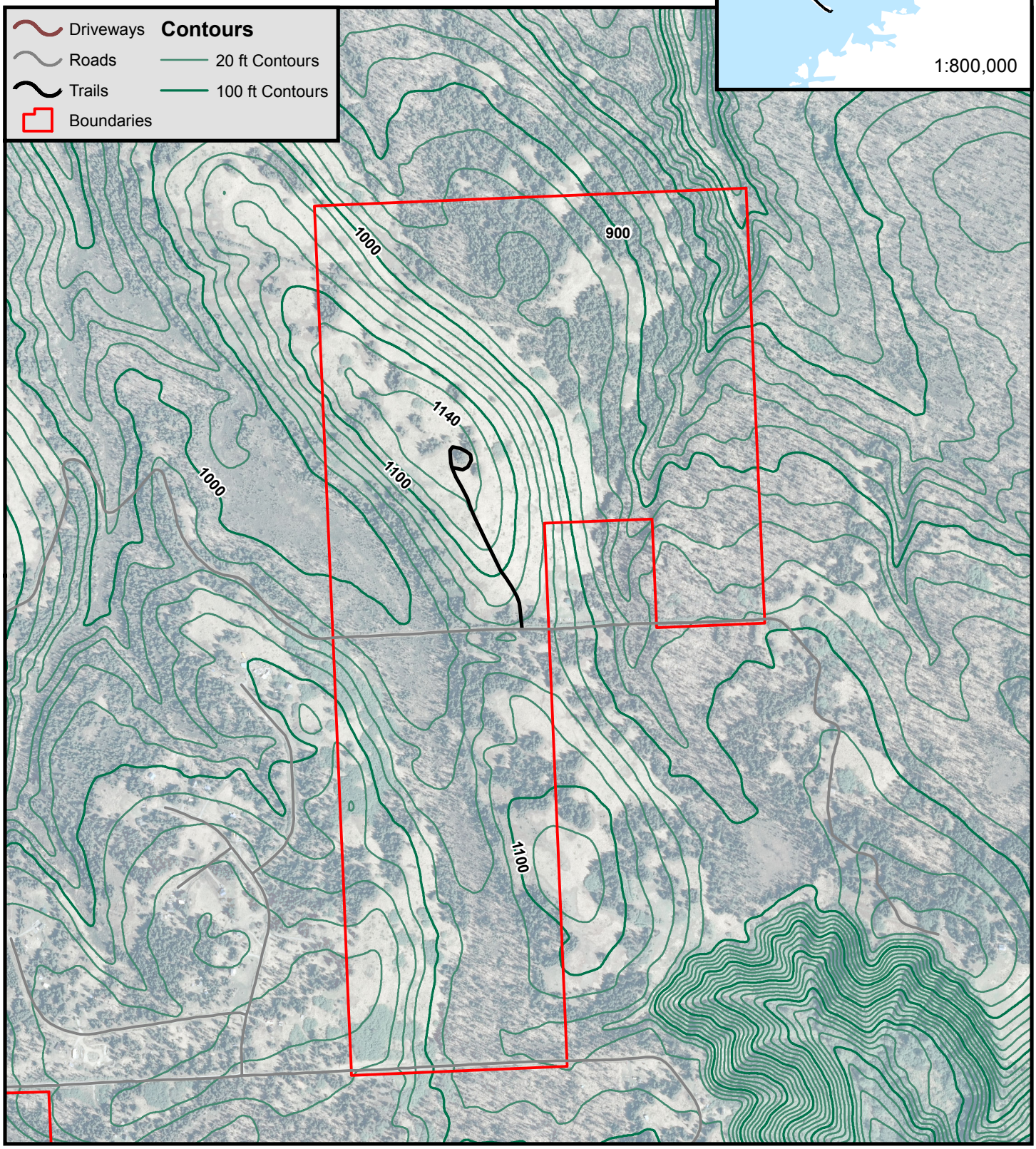
Elevation - Hogback

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016

0 0.2 Miles

N
1:10,000



Inspiration Ridge Preserve

Elevation - IRP

Coordinate System:
NAD 1983 Alaska Albers

Sources:
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Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016

0 0.2 Miles

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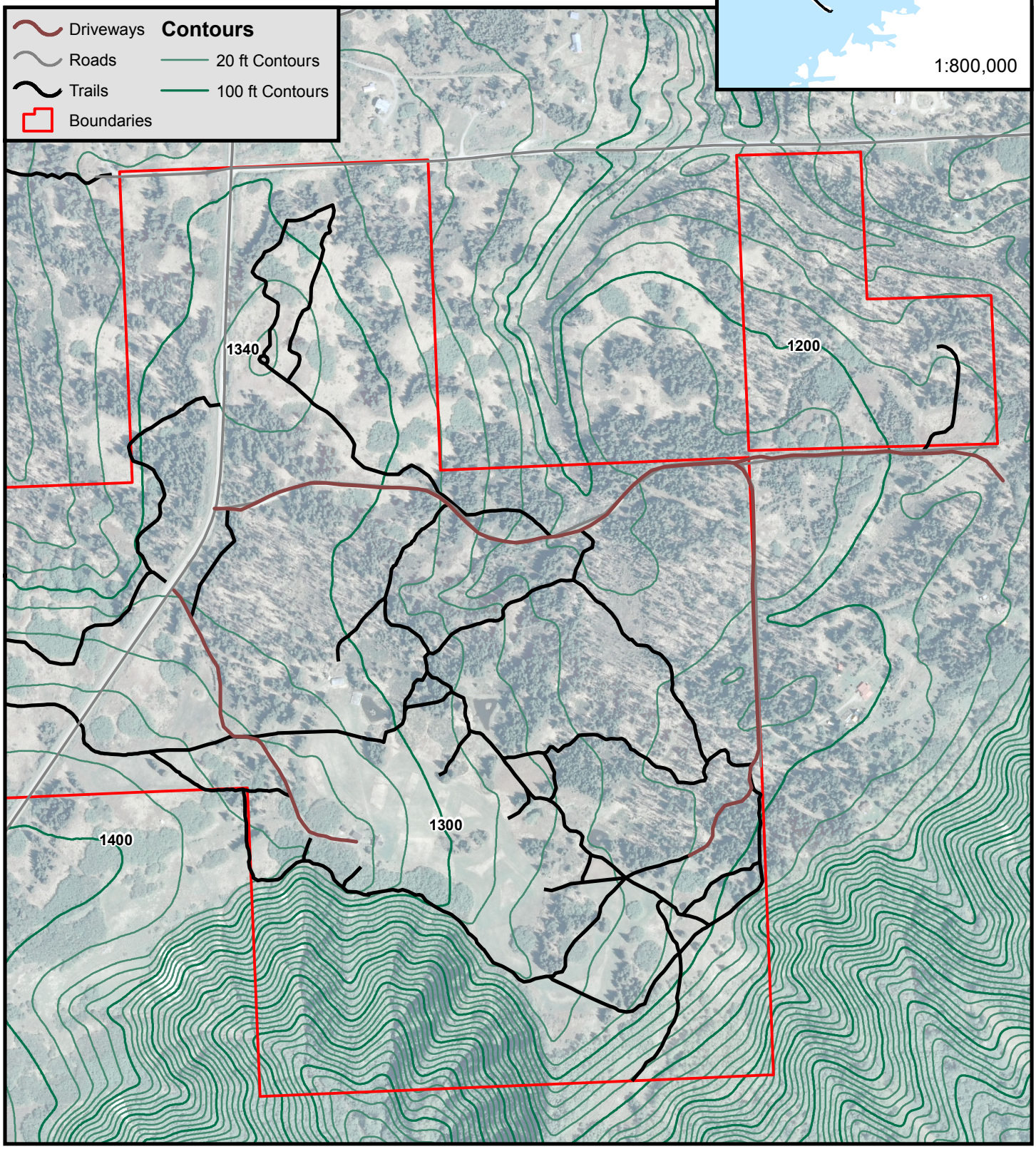
1:7,000



Inspiration Ridge Preserve

Elevation - Wong, 103, Mead

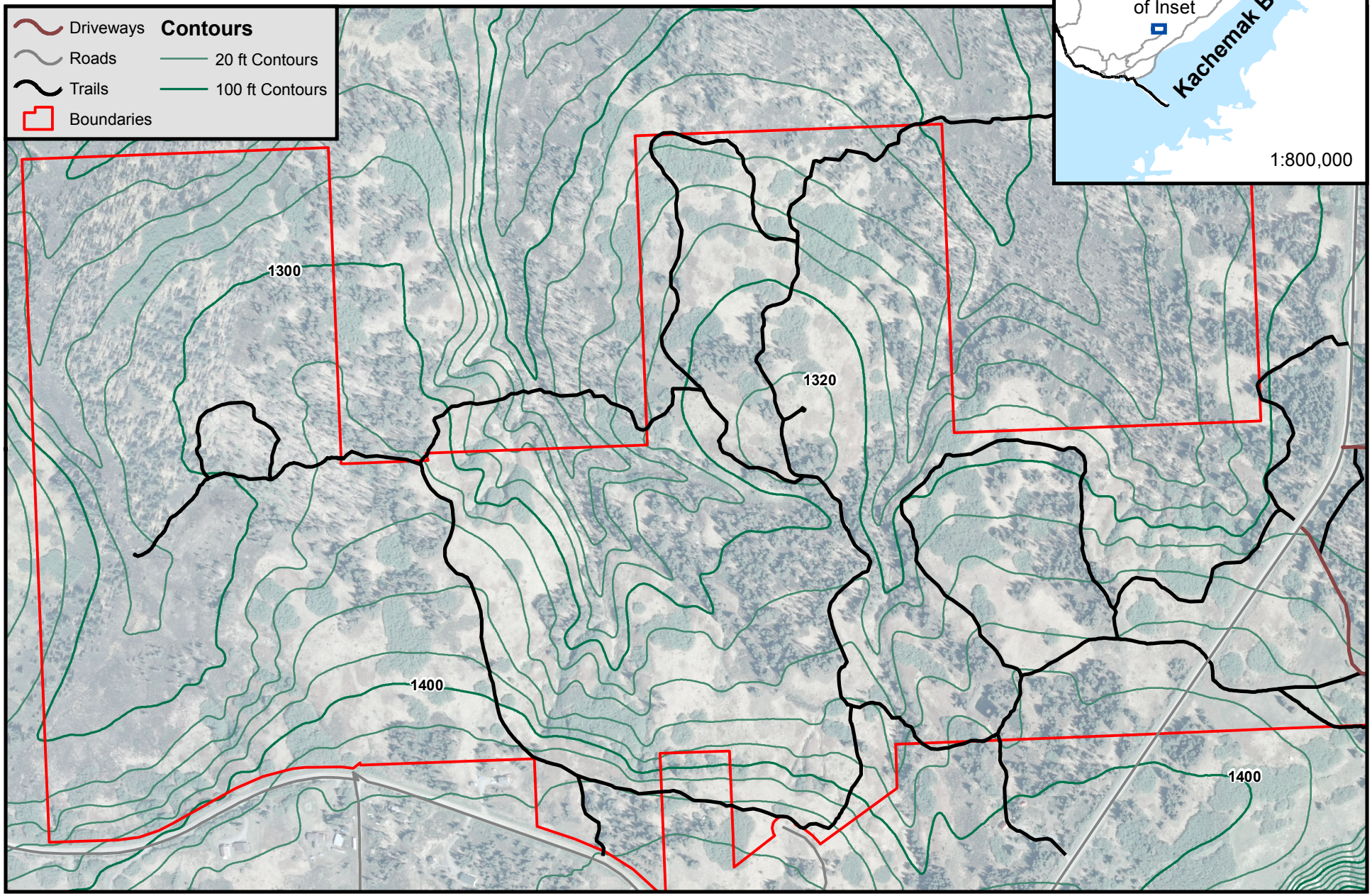
0 0.1 Miles

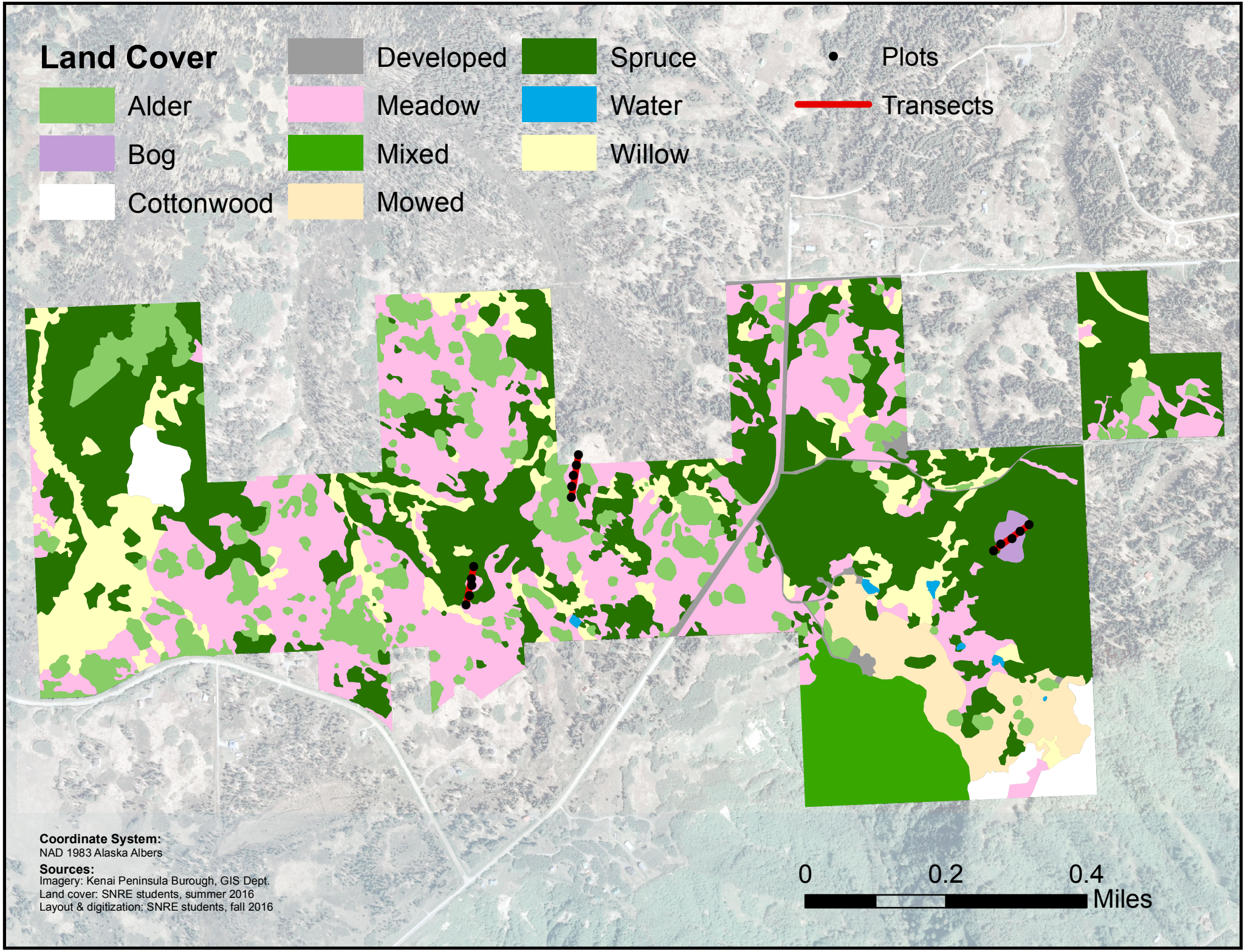
N

1:7,000

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016




Land Cover
Alder
Bog
Cottonwood
Developed
Meadow
Mixed
Mowed
Spruce
Water
Willow
Plots
Transects
Coordinate System:
NAD 1983 Alaska Albers
Sources:
Imagery: Kenai Peninsula Burough, GIS Dept.
Land cover: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016
0
0.2
0.4
Miles

Inspiration Ridge Preserve

Landcover

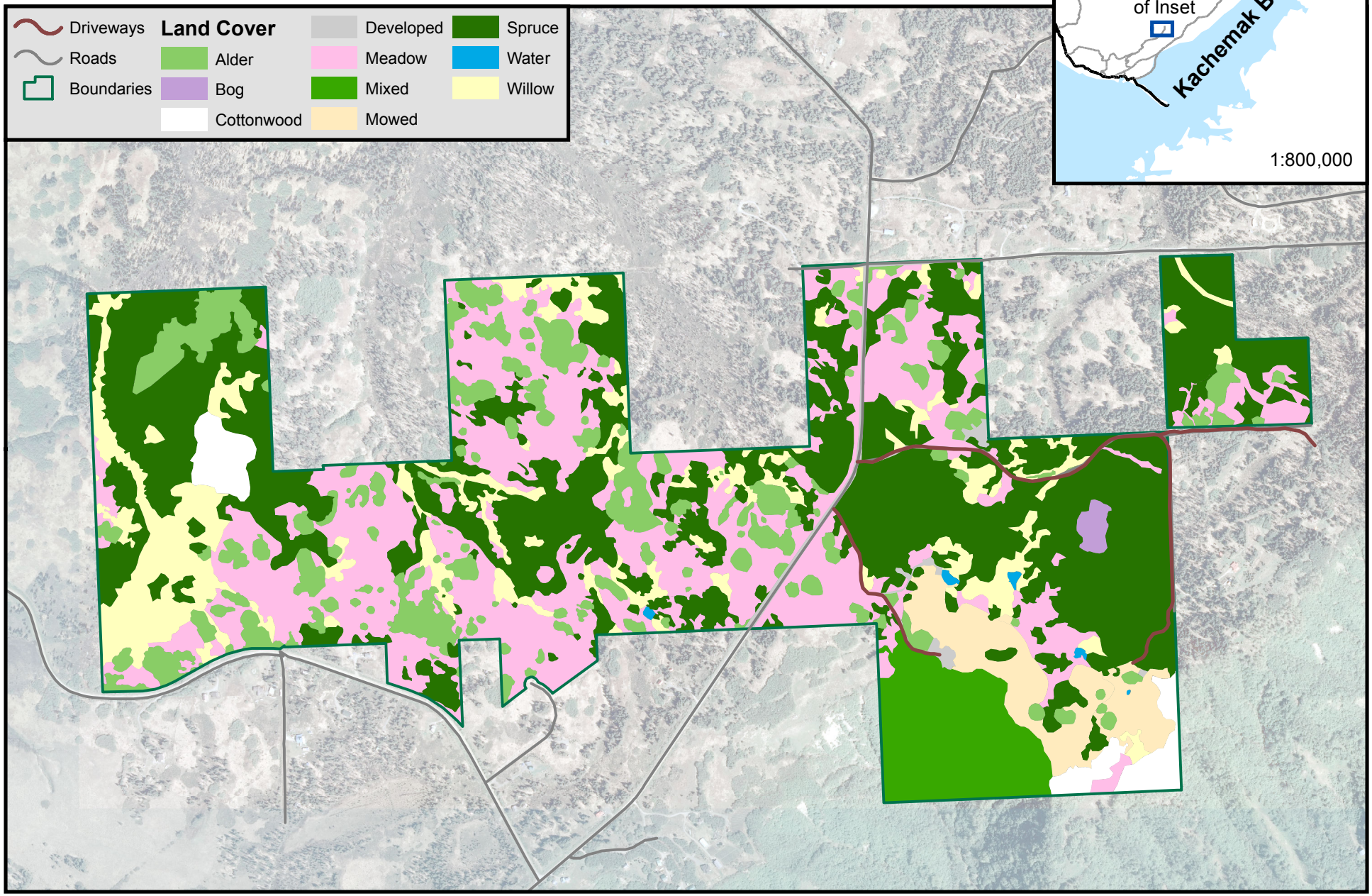
0 0.3 Miles

N

1:12,000

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Landcover: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016



Inspiration Ridge Preserve

Landcover - Hogback, Stefan 80

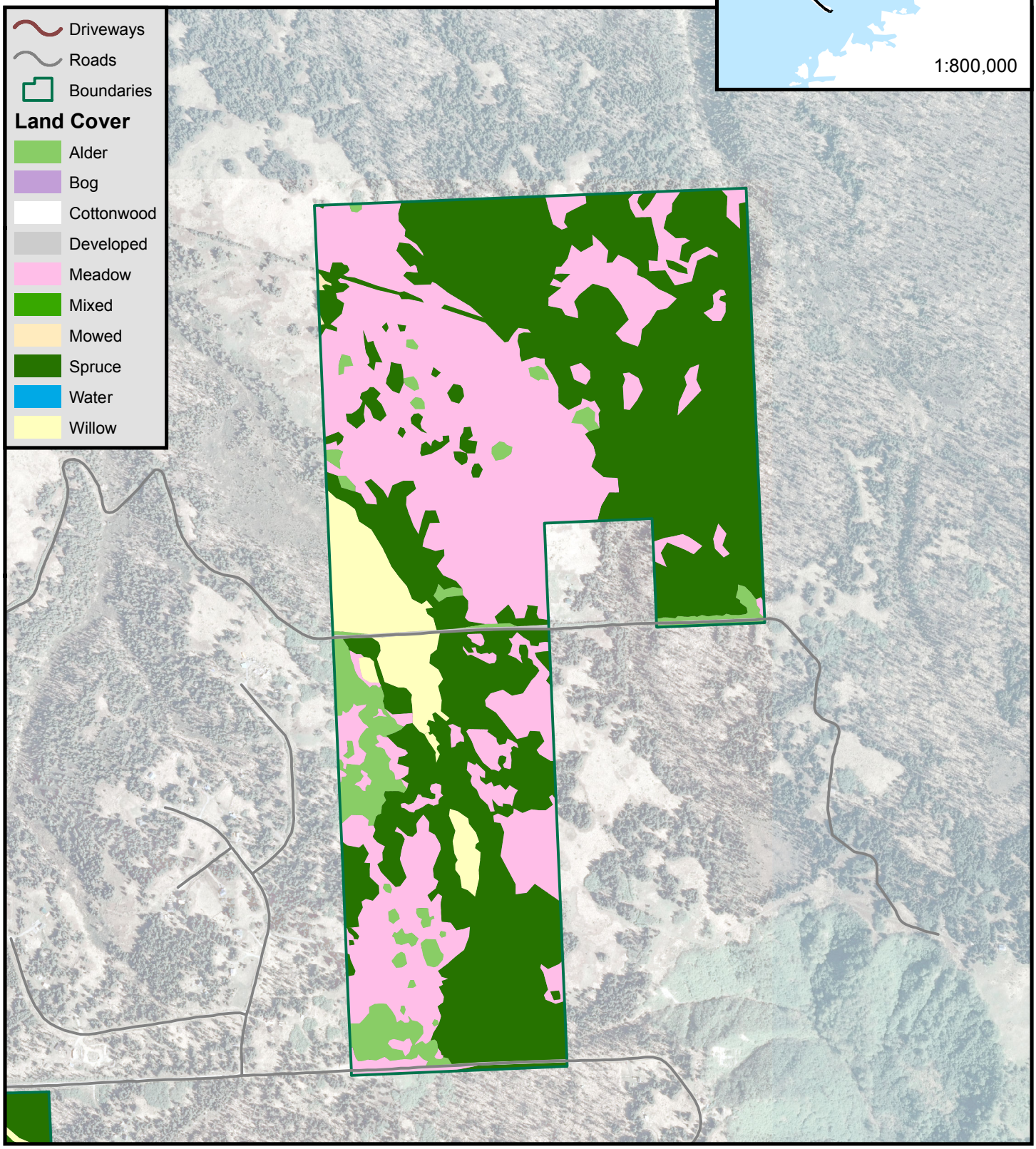
0 0.2 Miles

N

1:10,000

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Landcover: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016



Inspiration Ridge Preserve

Landcover - IRP

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Landcover: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016

0 — 0.2 Miles

N

1:7,000

Driveways
Roads
Boundaries

Land Cover

- Alder
- Bog
- Cottonwood
- Developed
- Meadow
- Mixed
- Mowed
- Spruce
- Water
- Willow

Inspiration Ridge Preserve

Landcover - Wong, 103, Mead

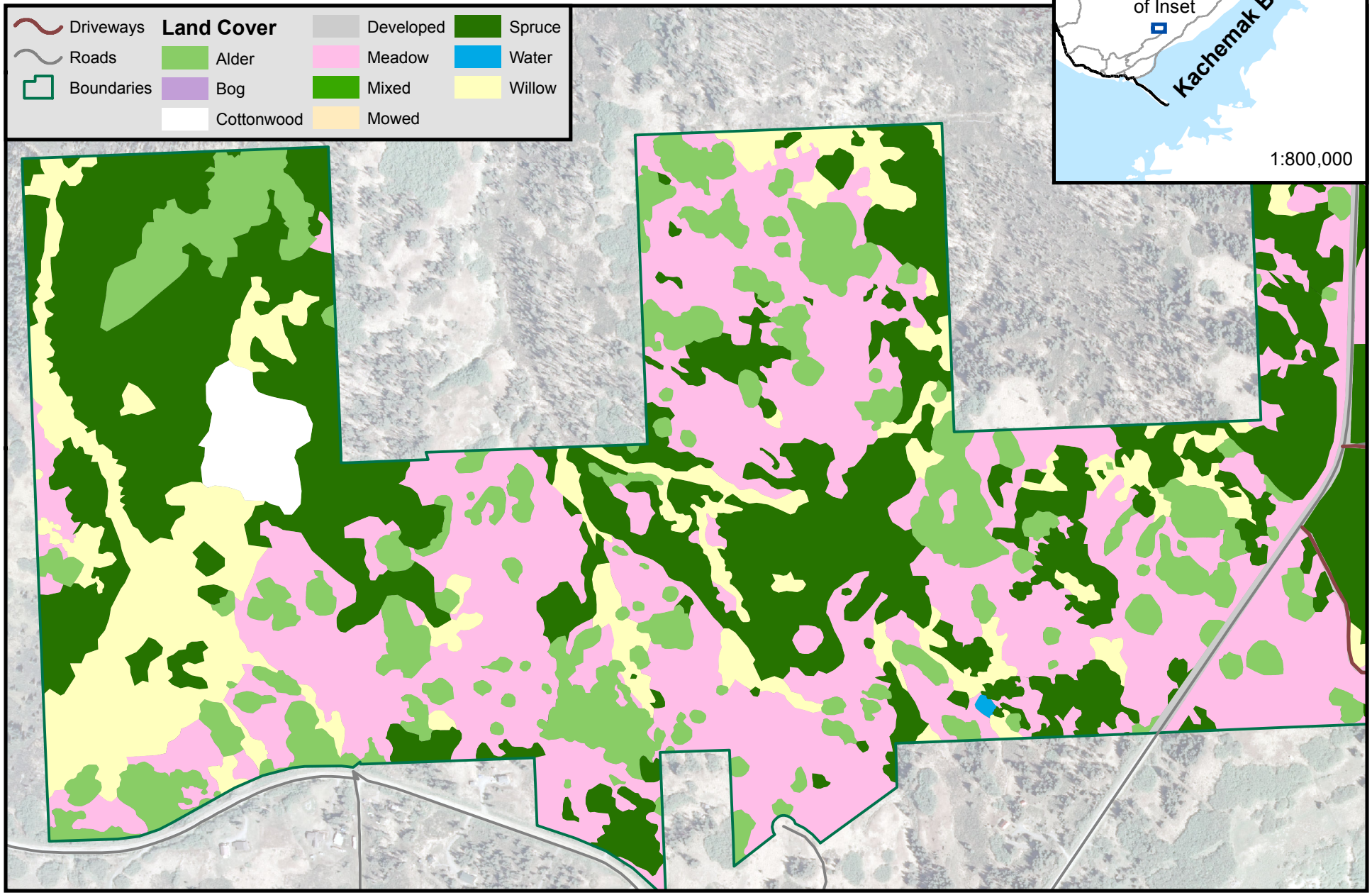
0 0.1 Miles

N

1:7,000

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Landcover: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016



Inspiration Ridge Preserve

Trails

0 0.3 Miles

N

1:12,000

Coordinate System:
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Sources:
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Trails: SNRE students, summer 2016
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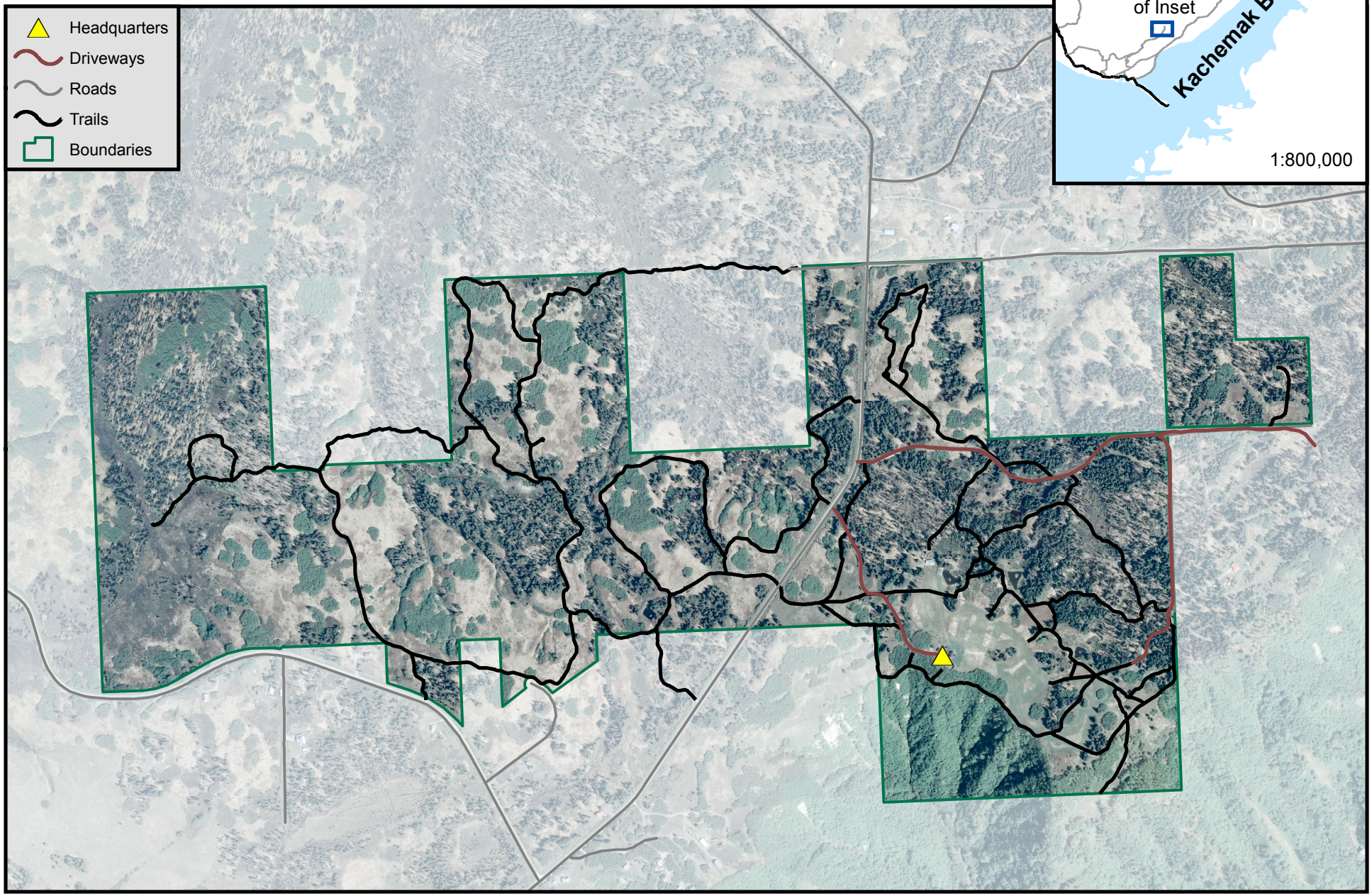


Inspiration Ridge Preserve

Trails - Hogback, Stefan 80

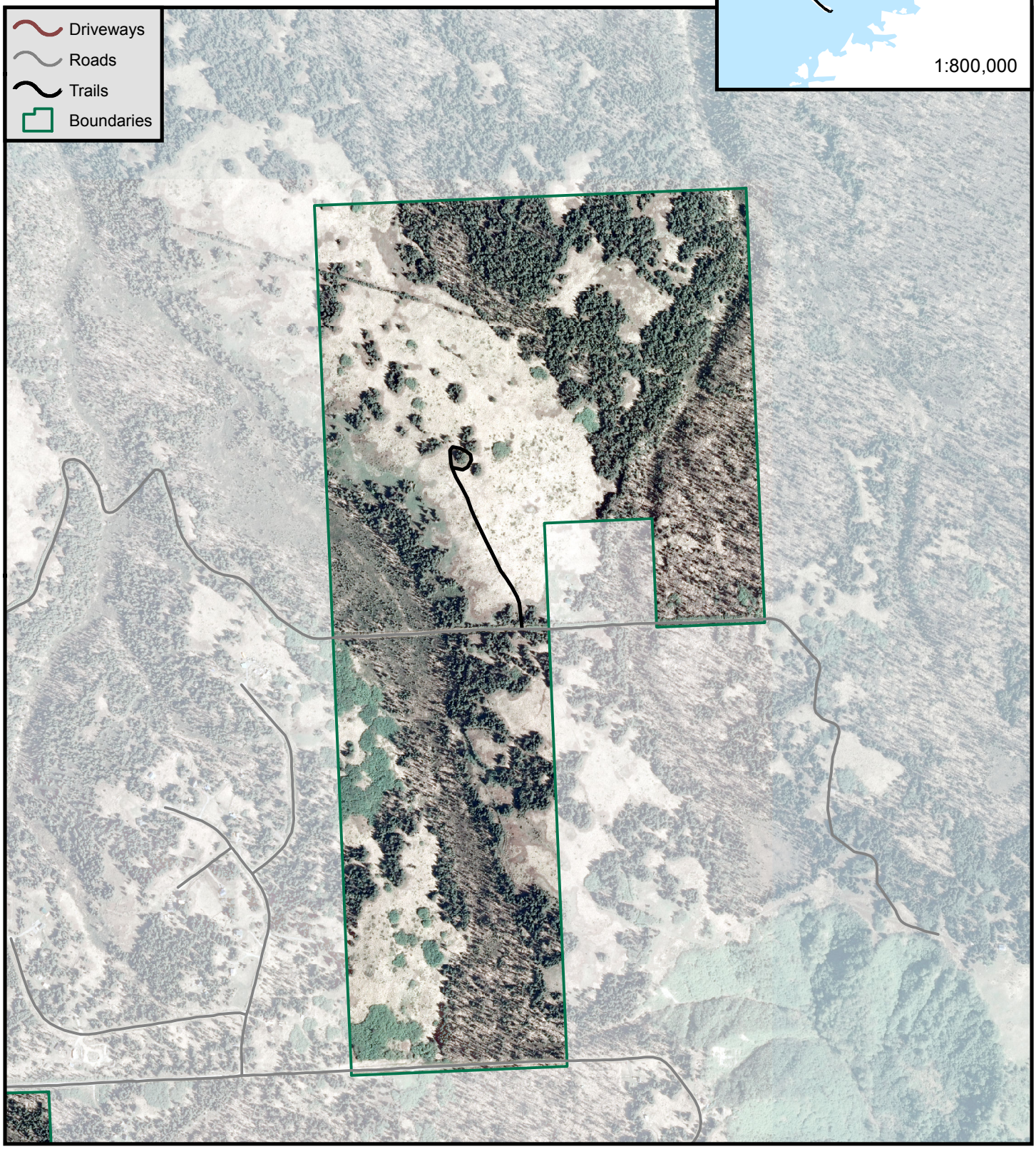
0 0.2 Miles

N

1:10,000

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016



Inspiration Ridge Preserve

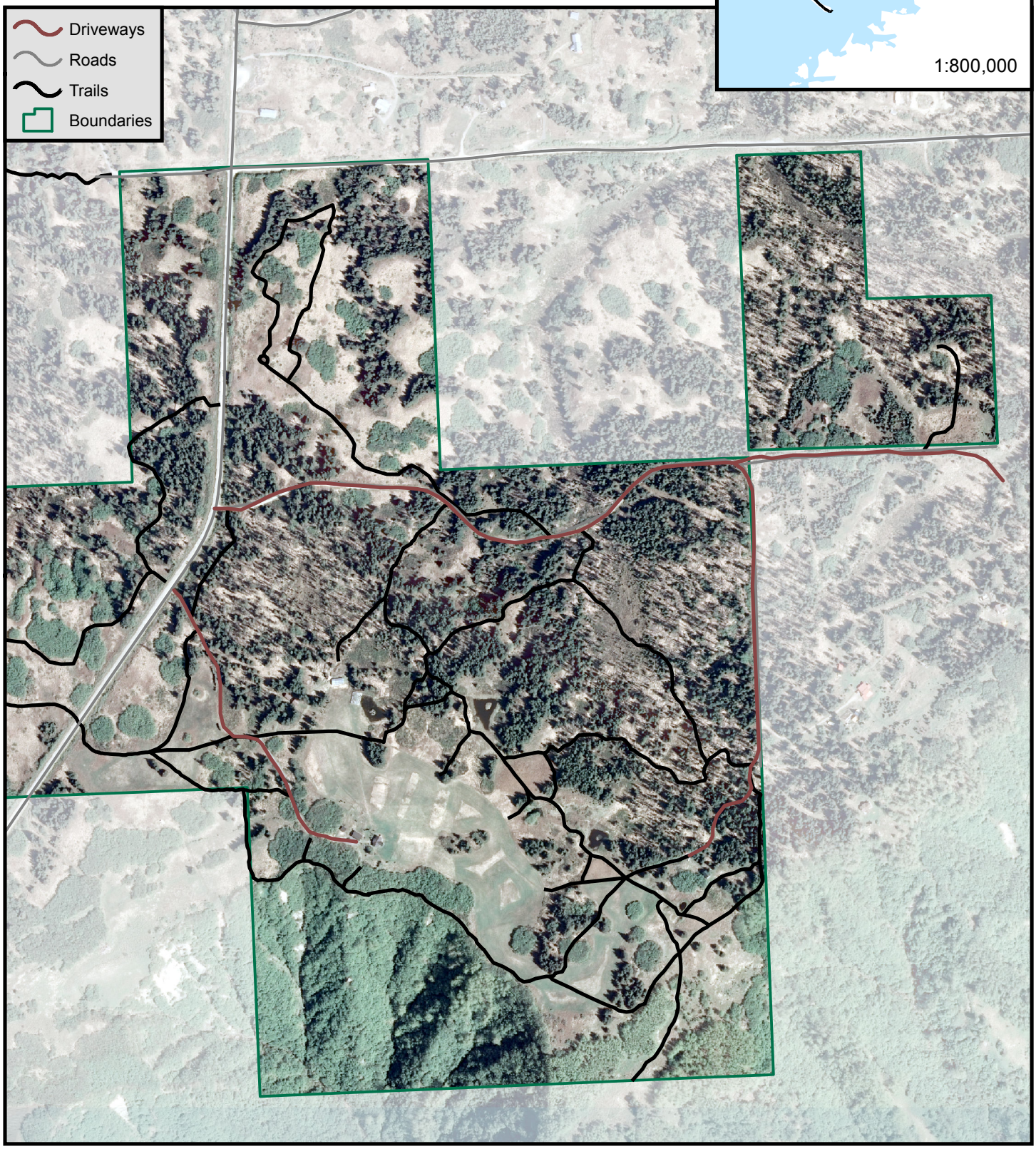
Trails - IRP

Coordinate System:
NAD 1983 Alaska Albers

Sources:
Imagery: Kenai Peninsula Borough, GIS Dept.
Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016

0 0.2 Miles

N
1:7,000



Inspiration Ridge Preserve

Trails - Wong, 103, Mead

0 0.1 Miles

N

1:7,000

Coordinate System:
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Sources:
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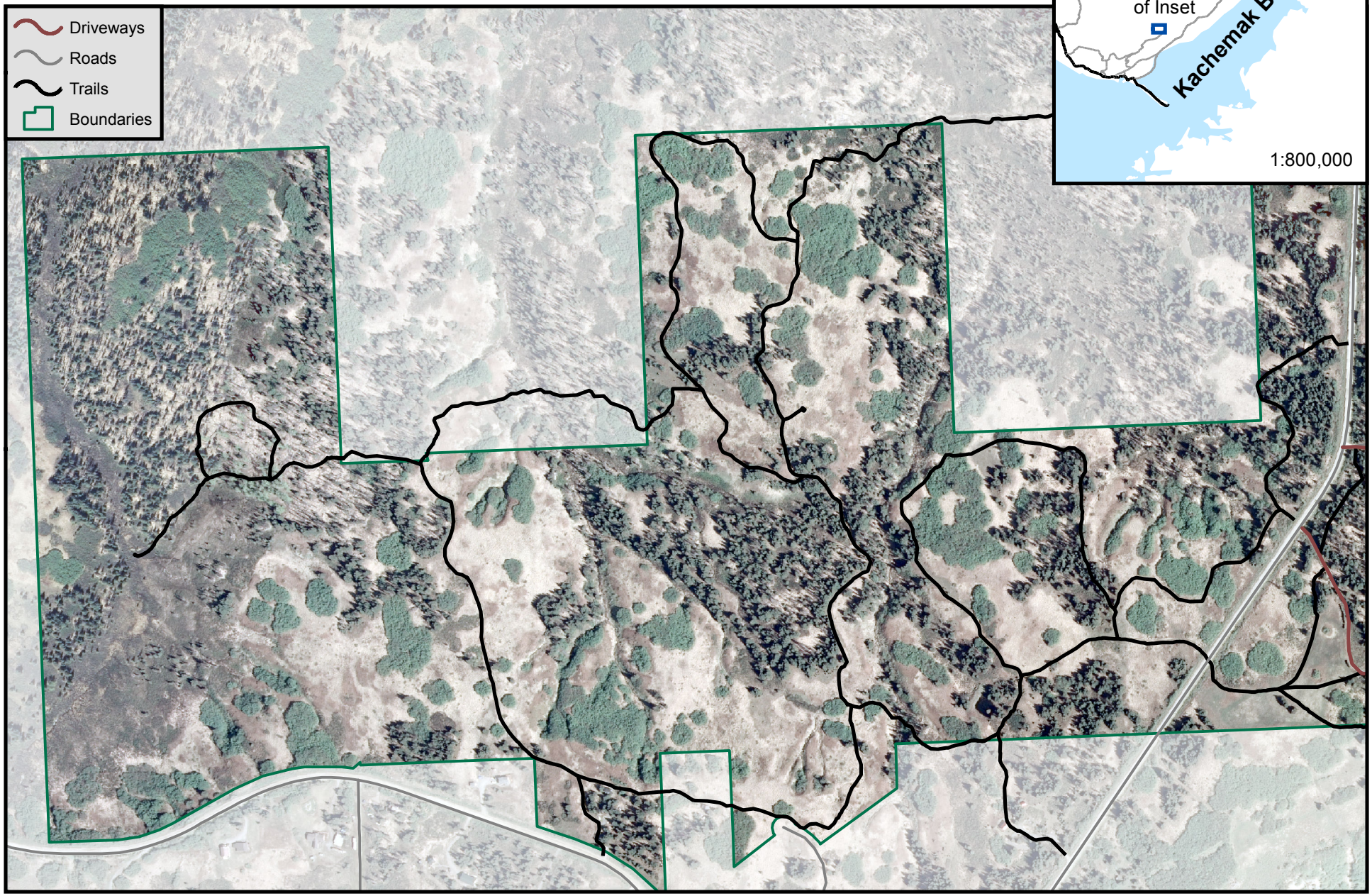
Trails: SNRE students, summer 2016
Layout & digitization: SNRE students, fall 2016



Appendix B. List of Properties

LIST OF PROPERTIES

#	Parcel #	Description	Acres
1	17113259	IRP Lot 2 CE	103
2	17113223	Mead 40 CE	40
3	17113221	Wong 80 CE	80
4	17139004	Ohlson Mt Sub Lot 1, Blk 1 (CE Wong)	2.65
5	17139005	Ohlson Mt Sub Lot 2, Blk 1 (CE Wong)	1.9
6	17203128	Stefun 80 CE	80
7	17203102	Hogback CE	150
8	17139117	Southview Meadows Lot 2	2.47
9	17113258	IRP Lot 1	186
10	17139001	Ohlson Mt. Sub. Lot 1, Blk 2	2.46
11	17139002	Ohlson Mt. Sub. Lot 2, Blk 2, Rental	2.63
12	17203140	Defibaugh No. 1 Lot 2A	7.64
13	17203139	Defibaugh No. 1 Lot 1A Rental	15.51
14	17145003	Lookout Meadows U1,Lt 13, BLK 2	4.53
15	17145004	Lookout Meadows U1,Lt 14, BLK 2	3.68
16	17145005	Lookout Meadows U1,Lt 11, BLK 2	3.26
17	17145006	Lookout Meadows U1,Lt 10, BLK 2	2.89
18	17145007	Lookout Meadows U1,Lt 9, BLK 2	2.92
	Total		691.54

Appendix C. Photo Monitoring Handbook

Photo monitoring points in IRP property

Point Name 001

Latitude:59.705029 Longitude: -151.412781

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	001	N	9352	Photo point (N, W, S) over the fireweed field and towards the Eagleaerie Ave. Top of the knoll with elderberry cluster in center.	007

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	001	W	9353	Photo point (N, W, S) over the fireweed field and towards the Skyline Drive. Top of the knoll with elderberry cluster in center.	007

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	001	S	9354	Photo point (N, W, S) over the fireweed field and towards the driveway. Top of the knoll with elderberry cluster in center.	007

Point Name 002
Latitude:59.707237 Longitude: -151.413361

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	002	SW	9358	Edge of Eagleaerie Ave. and Skyline Dr. ; Photo point (SW) of property corner on W side of road	015

Point Name 003

Latitude: 59.707237 Longitude: -151.415680

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	003	SE	9359	Photo point (SE) of top western corner of property	016

Point Name 004
Latitude:59.707245 Longitude: -151.414902

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	004	E	9360	Photo point (E) of fireweed meadow with alder along section line road	017

Point Name 005
Latitude:59.707211 Longitude: -151.408646

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	005	S	9361	Photo point (S) at top NE property corner on Eagleaerie Ave.	018

Point Name 006

Latitude:59.703621 Longitude: -151.408737

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	006	N	9362	Photo point (N, W, S) at 1996 property mark	020

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	006	W	9363	Photo point (N, W, S) at 1996 property mark	020

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	006	S	9364	Photo point (N, W, S) at 1996 property mark	020

Point Name 007
Latitude:59.703659 Longitude: -151.401917

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	007	SW	9366	Photo point (SW, NE, W, SE) Driveway intersection	024

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	007	NE	9367	Photo point (SW, NE, W, SE) Driveway intersection	024

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	007	W	9368	Photo point (SW, NE, W, SE) Driveway intersection	024

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	007	SE	9369	Photo point (SW, NE, W, SE) Driveway intersection	024

Point Name 008
Latitude:59.698242 Longitude: -151.405640

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	008	E	9381	Photo point 1 (E) of lower field; back on trail	050

Point Name 009
Latitude:59.697792 Longitude: -151.406479

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-22	009	SE	9382	Bench at Inspiration Point	052

Point Name 010

Latitude:59.703785 Longitude: -151.395920

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	010	SW	9393	SE corner of 2.5, SW (toward road), N (up property line, bushwhack)	004

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	010	N	9394	SE corner of 2.5, SW (toward road), N (up property line, bushwhack)	004

Point Name 011
Latitude:59.704159 Longitude: -151.395935

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	011	N	9397	Back to property line (doghair patch of spruce)	007

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	011	S	9398	Back to property line (doghair patch of spruce)	007

Point Name 012
Latitude:59.705448 Longitude: -151.395798

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	012	S	9399	NE-corner of 7.64, S-looking down East property line, W- property line and boundary, N – off property	010

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	012	W	9400	NE-corner of 7.64, S-looking down East property line, W- property line and boundary, N – off property	010

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	012	N	9401	NE-corner of 7.64, S-looking down East property line, W- property line and boundary, N – off property	010

Point Name 013
Latitude:59.705490 Longitude: -151.398529

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	013	S	9402	NW corner 7.5, N-property line toward ravine (midway of 15)	012

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	013	E	9403	NW corner 7.5, N-property line toward ravine (midway of 15)	012

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	013	N	9404	NW corner 7.5, N-property line toward ravine (midway of 15)	012

Point Name 014
Latitude:59.704456 Longitude: -151.398972

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	014	S	9405	Photo point (moose trail?) fireweed meadow/ property overlook	013

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	014	E	9407	(moose trail?) fireweed meadow/ property overlook	013

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	014	NE	9408	(moose trail?) fireweed meadow/ property overlook	013

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	014	N	9409	(moose trail?) fireweed meadow/ property overlook	013

Point Name 015
Latitude:59.703659 Longitude: -151.401611

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	015	N	9389	SW corner of Defibaugh 15-acre parcel along western boundary	002

Point Name 016
Latitude:59.703735 Longitude: -151.398636

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	016	N	9390	SE corner of 15-acre Defibaugh, SW of 7.64 acre photo point. N – looking in to property, W- looking down road, E- looking down road	003

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	016	W	9391	SE corner of 15-acre Defibaugh, SW of 7.64 acre photo point. N – looking in to property, W- looking down road, E- looking down road	003

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	016	E	9392	SE corner of 15-acre Defibaugh, SW of 7.64 acre photo point. N – looking in to property, W- looking down road, E- looking down road	003

Point Name 017
Latitude: 59.707165 Longitude: -151.401550

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	017	W	9411	NW corner of 15, Won Ciri land past property line, SE-up property line, E-property line	025

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	017	SE	9412	NW corner of 15, Won Ciri land past property line, SE-up property line, E-property line	025

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	017	E	9413	NW corner of 15, Won Ciri land past property line, SE-up property line, E-property line	025

Point Name 018
Latitude:59.707249 Longitude: -151.401016

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	018	SE	9416	photo point, riparian habitat (mainly willow) from Eagleaerie Ave. (cottonwoods coming in on cutbank)	027

Point Name 019

Latitude:59.707291 Longitude: -151.398758

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	019	S	9418	NE property corner of 15, S down property line, W - along N property line, E-away from property line, open spruce with fireweed	028

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	019	W	9419	NE property corner of 15, S down property line, W - along N property line, E-away from property line, open spruce with fireweed	028

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	019	E	9420	NE property corner of 15, S down property line, W - along N property line, E-away from property line, open spruce with fireweed	028

Point Name 020
Latitude:59.699657 Longitude: -151.410522

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	020	N	9422	NE of the Alpaca pen	046

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	020	NW	9423	NE of the Alpaca pen	046

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	020	E	9424	NE of the Alpaca pen	046

Point Name 021
Latitude:59.698788 Longitude: -151.410736

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	021	S	9426	Taken from the bench, Rim Trail	048

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	021	E	9427	Taken at the bench, Rim Trail	048

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	021	W	9428	Taken from the bench, Rim Trail	048

Point Name 022
Latitude:59.699982 Longitude: -151.413483

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	022	E	9429	Rim Trail	053

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	022	S	9430	Rim Trail	053

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	022	W	9431	Rim Trail	053

Point Name 023
Latitude:59.700100 Longitude: -151.414703

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	023	W	9432	Upper Field	054

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	023	N	9433	Upper Field	054

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	023	E	9434	From upper field	054

Point Name 024
Latitude:59.700451 Longitude: -151.415436

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-23	024	N	9436	Upper Field	056

Point Name 025
Latitude:59.696465 Longitude: -151.404877

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	025	NW	9446	Photo point - on trail/property line below cottonwoods, NW-up to property, S - off property, foot trail downhill, E-9448,W-9449,SE-9450.	004

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	025	S	9447	Photo point - on trail/property line below cottonwoods, NW-up to property, S - off property, foot trail downhill, E-9448,W-9449,SE-9450.	004

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	025	E	9448	Photo point - on trail/property line below cottonwoods, NW-up to property, S - off property, foot trail downhill, E-9448,W-9449,SE-9450.	004

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	025	W	9449	Photo point - on trail/property line below cottonwoods, NW-up to property, S - off property, foot trail downhill, E-9448,W-9449,SE-9450.	004

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	025	SE	9450	Photo point - on trail/property line below cottonwoods, NW-up to property, S - off property, foot trail downhill, E-9448,W-9449,SE-9450.	004

Point Name 026
Latitude:59.696484 Longitude: -151.402222

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	026	W	9453	Near SE corner of IRP 1 below the bluff. bear bed, bear poop, bear scat. W-property line, N-towards property line, E-along property line.	007

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	026	N	9454	Near SE corner of IRP 1 below the bluff. bear bed, bear poop, bear scat. W-property line, N-towards property line, E-along property line.	007

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	026	E	9455	Near SE corner of IRP 1 below the bluff. bear bed, bear poop, bear scat. W-property line, N-towards property line, E-along property line.	007

Point Name 027
Latitude:59.696568 Longitude: -151.406631

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	027	N	9439	Property line south, along S property line. N-towards property, E-along property line, W-along property line, with no trespassing sign	002

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	027	E	9440	Property line south, along S property line. N-towards property, E-along property line, W-along property line, with no trespassing sign	002

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	027	W	9441	Property line south, along S property line. N-towards property, E-along property line, W-along property line, with no trespassing sign	002

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	027	W	9442	Property line south, along S property line. N-towards property, E-along property line, W-along property line, with no trespassing sign	002

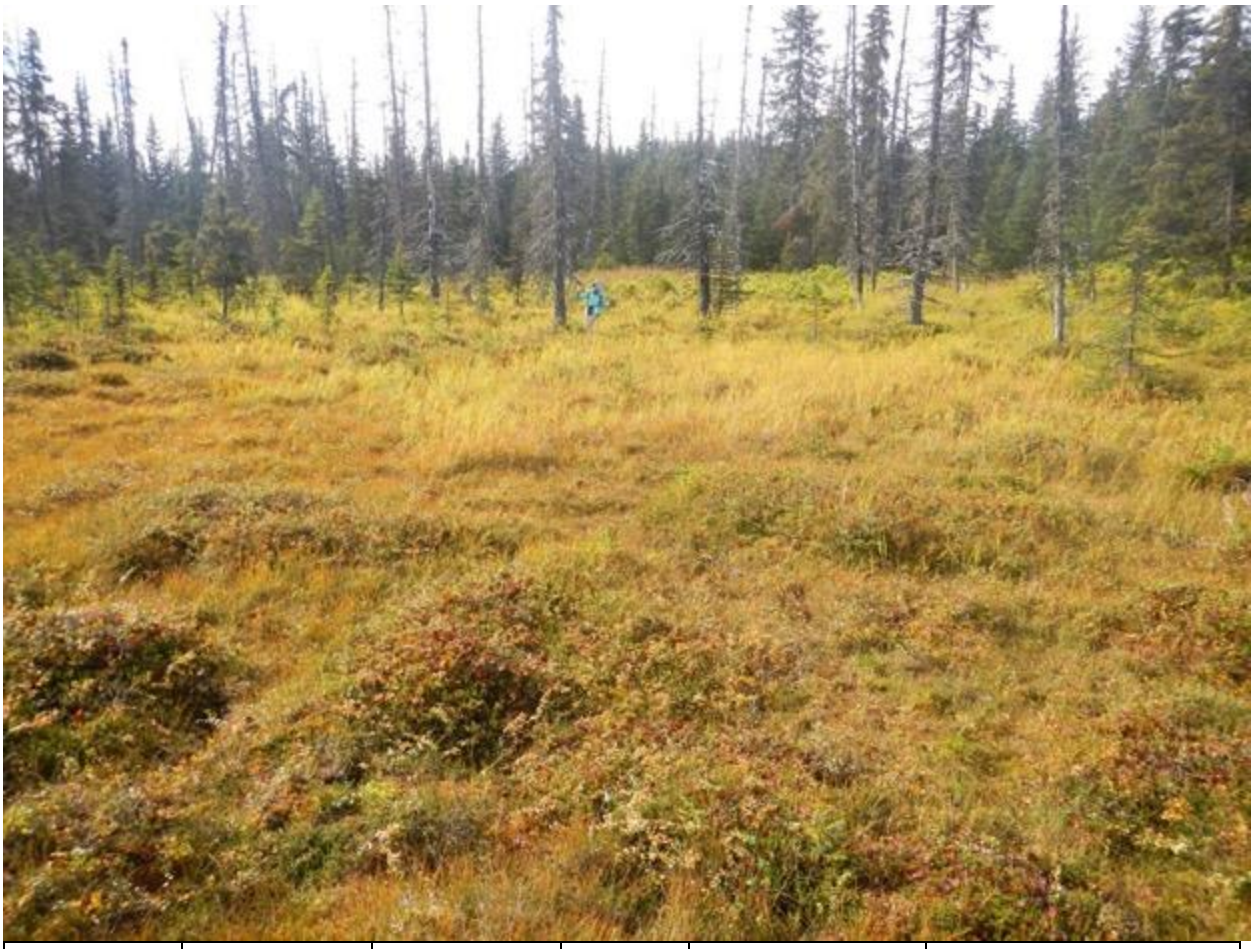
Point Name 028
Latitude:59.700741 Longitude: -151.410812

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	028	NE	9456	Alldredge Pond photo point	002

Point Name 029
Latitude:59.701828 Longitude: -151.404617

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	029	N	9457	Bog photo point	005

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	029	E	9458	Bog photo point	005



Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	029	S	9459	Bog photo point	005

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	029	W	9460	Bog photo point	005

Point Name 030
Latitude:59.698513 Longitude: -151.403671

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	030	E	9464	Photo point - Snipe Pond	019

Point Name 031
Latitude:59.699162 Longitude: -151.405533

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	031	NE	9467	photo point - Mallard Pond, NE-pond,E-towards mtns, W-up hill into property	021

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	031	E	9468	photo point - Mallard Pond, NE-pond,E-towards mtns, W-up hill into property	021

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	031	W	9469	photo point - mallard pond, NE-pond,E-towards mtns, W-up hill into property	021

Point Name 032
Latitude:59.699020 Longitude: -151.407745

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	032	N	9470	Field photo point, NW-to house	022

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	032	SE	9471	Field photo point, NW-to house	022

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	032	SW	9472	Field photopoint, NW-to house	022

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	032	NW	9474	Field photo point, NW-towards house (upper left of photo)	022

Point Name 033
Latitude:59.700626 Longitude: -151.408020

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	033	N	9475	Photo point at Goose Pond	024

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	033	E	9476	Photo point at Goose Pond	024

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	033	SW	9477	Photo point at Goose Pond	024

Point Name 034
Latitude:59.699780 Longitude: -151.406937

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	034	E	9478	Photo point at Frog Pond	025

Date	Point Name	Orientation	Picture	Notes	Original Point Name
2016-08-24	034	SW	9479	Photo point at Frog Pond	025

Appendix D. Wildlife Species List

Invertebrate Species at IRP
(Source: IRP Master Plan, IUCN, Alaska Department of Fish and Game)

Common Name	Scientific Name	IUCN Status
Mammals		
Mouse family	Muridae	
House mouse	*Mus musculus*	Least concern (LC)
Little brown bat	*Myotis lucifugus*	LC
Muskrat	*Ondatra zibethicus*	LC
Northern Red-backed Vole	*Myodes rutilus*	LC
Short-tailed lemming	*Synaptomys borealis*	LC
Tundra vole	*Microtus oeconomus*	LC
Shrew family	Soricidae	
American Pygmy Shrew	*Sorex hoyi*	LC
Cineres shrew	*Sorex cinereus*	LC
Montane Shrew	*Sorex monticolus*	LC
Shrew	*Sorex spp.*	LC
Squirrel family	Sciuridae	
Red squirrel	*Tamiasciurus hudsonicus*	LC
Beaver family		
American beaver	*Castor Canadensis*	LC
Rabbit and hare family	Leporidae	
Snowshoe hare	*Lepus americanus*	LC
New World porcupine family	Erethizontidae	
North American Porcupine	*Erethizon dorsatum*	LC
Deer family	Cervidae	
Moose	*Alces alces*	LC
Dog family	Canidae	
Coyote	*Canis latrans*	LC
Gray wolf	*Canis lupus*	LC
Cat family	Felidae	
Lynx	*Lynx Canadensis*	LC
Weasel family	Mustelidae	
Ermine	*Mustela erminea*LC	
Bear family	Ursidae	
American Black Bear	*Ursus americanus*	LC
Brown bear	*Ursus arctos*	LC
Amphibians		
Wood frog	*Lithobates sylvaticus*	LC
Birds		

SHOREBIRDS		
Wilson's Snipe	*Gallinago delicate*	LC
CRANES		
Lesser Sandhill Crane	*Antigone Canadensis*	LC
GULLS		
Mew Gulls	*Larus canus*	LC
HAWKS AND FALCONS		
Bald Eagle	*Haliaeetus leucocephalus*	LC
Gyrfalcon	*Falco rusticolus*	LC
Northern goshawk	*Accipiter striatus*	LC
Northern Harrier	*Circus hudsonius*	LC
Red-tailed Hawk	*Buteo jamaicensis*	LC
Sharp-shinned Hawk	*Accipiter striatus*	LC
GALLINACEOUS BIRDS		
Willow Ptarmigan	*Lagopus lagopus*	LC
Spruce Grouse	*Falcipennis Canadensis*	LC
OWLS		
Boreal Owl	*Aegolius funereus*	LC
Great Gray Owls	*Strix nebulosa*	LC
Great Horned owl	*Bubo virginianus*	LC
Northern saw-whet owl	*Aegolius acadicus*	LC
Snowy Owl	*Bubo scandiacus*	LC
KINGFISHERS		
Belted Kingfisher	*Megaceryle alcyon*	LC
WOODPECKERS		
Downy Woodpecker	*Dryobates pubescens*	LC
Hairy Woodpecker	*Leuconotopicus villosus*	LC
PERCHING BIRDS		
American Dipper	*Cinclus mexicanus*	LC
American Robin	*Turdus migratorius*	LC
Brown Creeper	*Certhia Americana*	LC
Bank Swallow	*Riparia riparia*	LC
Black-billed Magpie	*Pica hudsonia*	LC
Black-capped Chickadee	*Poecile atricapillus*	LC
Bohemian Waxwing	*Bombycilla garrulus*	LC
Boreal Chickadee	*Poecile hudsonicus*	LC
Common Raven	*Corvus corax*	LC
Common Redpoll	*Acanthis flammea*	LC
Dark-eyed Junco	*Junco hyemalis*	LC
Fox Sparrow	*Passerella iliaca*	LC
Golden-crowned Kinglet	*Regulus satrapa*	LC
Golden-crowned Sparrow	*Zonotrichia atricapilla*	LC
Gray Jay	*Perisoreus Canadensis*	LC
Grey-crowned Rosy Finch	*Leucosticte tephrocotis*	LC
Hermit Thrush	*Catharus guttatus*	LC
Lapland Longspur	*Calcarius lapponicus*	LC

Northern Shrike	*Falcunculus whitei*	LC
Olive-sided Flycatcher	*Contopus cooperi*	Near threatened
Orange-crowned Warbler	*Leiothlypis celata*	LC
Osprey	*Pandion haliaetus*	LC
Pine Siskin	*Spinus pinus*	LC
Red-breasted Nuthatch	*Sitta Canadensis*	LC
Ruby-crowned Kinglet	*Regulus calendula*	LC
Savannah Sparrow	Passerculus sandwichensis	LC
Snow Bunting	*Plectrophenax nivalis*	LC
Steller's Jay	*Cyanocitta stelleri*	LC
Townsend's Warbler	*Setophaga townsendi*	LC
Tree Swallow	*Tachycineta bicolor*	LC
Varied Thrush	*Ixoreus naevius*	LC
Violet-green Swallow	*Tachycineta thalassina*	LC
White-crowned Sparrow	*Zonotrichia leucophrys*	LC
White-winged Crossbill	*Loxia leucoptera*	LC
Wilson's Warbler	*Cardellina pusilla*	LC
Ringed-necked Pheasant (non-native)	*Phasianus colchicus*	LC
Northern Bobwhite (non-native)	*Colinus virginianus*	Near threatened

Appendix E. Survey Methodology

E.1. Photo Monitoring Methodology

Photo monitoring points were established on parcels of land on the Inspiration Ridge Preserve (IRP) not currently under conservation easement with the Kachemak Heritage Land Trust (KHLT). Photo monitoring methodology for these properties was developed in consultation with KHLT to insure protocols are consistent across all parcels.

Materials

- Camera
- GPS
- Photobook
- Compass
- Recording book

Site Selection

Photo point sites were selected at property corners, areas of interest such as unique ecological areas (i.e. the bog), and areas that showed good vantage points of the IRP (see Appendix A for exact locations of points).

Method

At each site, a GPS point was taken to mark the photo point location. A photo was taken in each direction that pointed onto the property or along the property line and notes of the date, photo number, direction each photo was facing (from the compass), and key descriptors were made. Additional photos of landmarks or areas of interest were also taken with corresponding number, direction, and notes.

E.2. GIS Mapping Methodology

Overview

ArcGIS was used as a data management tool for organizing and analyzing spatial data related to the IRP project. The general process taken through the project is summarized below:

1. Data collection
2. Data processing, creation, and analysis
3. Data presentation

Data Collection

Data collection was completed in two main phases. In the first phase (prior to fieldwork), a new geodatabase was created and spatial data was collected from several online sources including:

- The GIS Department of the Kenai Peninsula Borough

    - http://www.kpb.us/gis-dept
- The Alaska State Geo-Spatial Clearinghouse
    - http://www.asgdc.state.ak.us/

Data was imported into the geodatabase into various feature datasets according to their general category and whether they were considered 'working' or 'final' layers. For all feature datasets, the coordinate system was set to NAD 1983 Alaska Albers (2011).

In the second phase, data was collected on site in the summer of 2016 during other fieldwork activities. Most data was collected using GPS units provided by the Center of Alaskan Coastal Studies (CACS). Points of interest were marked including vegetation reference points, trail intersections and features, points demarcating evidence of animal activity, camera traps, fish traps, photo monitoring points, landmarks, etc. Notes describing each point of interest were recorded in a field notebook. GPS 'tracks' recorded the exact position of the trails as we hiked the property. In addition to GPS data, some data was collected from collaborating agencies, including KHLT and the Kachemak Bay National Estuarine Research Reserve (KBNERR).

Data Processing, Creation, and Analysis

To make the raw GPS data usable for mapping purposes, the data was imported into Google Earth and saved as permanent KML files. These KML files were then imported into the geodatabase and loaded in ArcGIS where they were joined with digitized field notes. Once the GPS points were joined, they were exported into separate feature classes according to their mapping purpose:

1. **GPS 'tracks'** were used to digitize the locations of trails on the IRP using the Editor tool of Arcmap.
2. **Vegetation reference points** were used in conjunction with aerial imagery from the Kenai Peninsula Borough to manually digitize landcover polygons using the same tool. Landcover polygon classes were defined according to dominant vegetation type. After it was finalized, this layer was converted to a GeoTiff file format so it could be imported to FragStats and used to calculate various landscape parameters.
3. **Photo monitoring points** were used to show where possible photo monitoring sites could be established. At each of these sites, photos were taken in a method consistent with the KHLT's activities. In this way, photos could be linked to specific latitude and longitude coordinates.
4. **Camera traps, fish traps, and other points representing wildlife activity** were grouped to show animal usage of the property.

Data Presentation

Each dataset was used to create maps specifically requested by Nina Faust and CACS for

management activities. Each map was based on a dual data frame template (an inset of Kachemak Bay was used to provide geographic context for the map viewer). Map orientation was determined by the size and shape of the parcels being represented. Scale was varied across the maps to maximize the extent of the area of interest.

E.3. Vegetation Survey Methodology

To determine the best approach for the vegetation survey, we reviewed several vegetation studies conducted in the same region or that had similar objectives. In the *CACS Wynn Nature Center Vegetation Mapping Project*, Ballard[63] set up seven 20-meter radius circular plots, within which she ran three transect lines along 30, 150, and 270 degrees from the point center, and recorded the plant species in six 1m x 1m nested frequency quadrats that were set up at 3m and 6m from the center. She also collected the dbh (diameter at breast height) of Lutz spruce in one of the plots. In the vegetation survey in Kalamazoo Nature Center, MI, Bosse *et al.*[64] used the Modified-Whittaker Plots method, where a 20m x 50m plot was set up along environmental gradients, and subplots of varying sizes were set up within the plot to assess plant communities at varying scales. They recorded a full plant species inventory in the large plot, and the percent cover within each subplot. In areas without natural vegetation stratification, they set up three 100-meter transects that were 25 meters apart, recorded of all plant species, and measured the percent cover of each species found in a 1m x 1m quadrat every 10 meters along the transect.

After evaluating the time and material requirements and implementation difficulty of each method, we decided to use a combination of transects and the nested frequency method. We establish three plots in three habitat types that have been identified with the help of Nina Faust to be of both special habitat interest and representative of habitat types on the property:

1. Bog (on the IRP property)
2. Transitional meadow (in the Mead 40)
3. Tree line along spruce forest (on the 103)

For each habitat, we set up a 100 meter transect that extends from outside the edge into the habitat. To select the location for the transect with a certain level of randomness, we stood near the edge of the habitat, and threw a stick backward over the shoulder. Using a random number generator application in iPhone, we picked a direction by generating a random number from 1-8, where 1 = North, 2 = Northeast, 3 = East, and so forth. From the point where the stick landed, we

[63] Ballard, Leanna S. "Wynn Nature Center vegetation mapping project". (2001). Retrieved from the CACS library on April 30, 2016.

[64] Bosse, K., Chapel, K., Huang, J., Langeland, G., & Li, B. "Developing a land management plan for Kalamazoo nature center's eight properties". MS project report. University of Michigan - Ann Arbor. April 2016. Retrieved from https://deepblue.lib.umich.edu/handle/2027.42/117651 on August 13, 2016.

ran the transect tape along the selected direction going 90 meters into the habitat and extending 10 meters perpendicular to the center transect line in order to capture the full transitioning of habitat types.

We set up 1m x 1m quadrats at 0m, 25m, 50m, 75m, and 100m of the transect line, the location of each marked by GPS. The quadrat, as shown in Figure 20, is divided into the following nested plots:

1. 1m x 1m
2. 0.5m x 1m
3. 0.5 x 0.5m
4. 0.1m x 0.1m

Plant species within the quadrat were thoroughly surveyed and scored by the number of nested plots they fall in. A species found in plot 4 gets a score of "4" because it is in all four plots, indicating it is likely to be a common species. A species found in plot 3 but not 4 is scored "3", and so forth. Species found in plot 1 only get a score of "1" as they are the least common species in the plot. We used the following plant identification sheets by Wynn Nature Center: *Plants in Bloom - June, Plants in Bloom - July, Plants in Bloom - August,* and *Bog plants*. For species that we were unable to identify in the field, we took pictures and identified them afterwards with the assistance of Beth Trowbridge and Henry Reiske. There are 6 unique species that we were unable to identify, which we named by their picture number (Appendix F).

Within 2 meters on either side of the transect, we surveyed woody plants. We recorded the DBH and location along the transect of trees that has a DBH of 2.5cm and over. We also counted the total number of spruce seedlings/saplings within the same range. As we finished each transect, we marked its starting and ending points by installing a wood stake attached with bright flag tape.

After organizing the data into an excel spreadsheet, we calculated the alpha, beta, and gamma diversity of all three transects. The alpha diversity is calculated by counting the number of species found in each transect. Beta diversity is derived from the species turnover between transect X_1 and X_2, i.e. the sum of unique species found in X_1 and X_2, respectively. Gamma diversity is the total number of species found in all three transects. In addition, we calculated the mean nested frequency of each species in each transect.

Sample data sheet

1.Vegetation plots

Date: Name of Surveyor: Transect # and Location:				
Score	4 (0.1*0.1m)	3 (0.5*0.5m)	2 (0.5*1m)	1 (1*1m)
Quadrat 1	Species 1 Species 2	Species 3	Species 4 Species 5 Species 6	Species 7
Quadrat 2				
Quadrat 3				
Quadrat 4				
Quadrat 5				

Table E-1. A sample data sheet used to collect data for the vegetation plots.

2. Woody plants survey

Date: Name of Surveyor: Transect # and Location: Total number of seedling/sapling		
Species	Circumference	Alive?

Table E-2. A sample data sheet used to collect data for the woody plants survey.

E.4. Camera Trap Methodology

We employed the use of camera traps at strategically selected sites around the IRP to gather information on wildlife presence and usage. Cameras were set up starting in late May 2016 and were left in place for durations spanning one week to several months, dependent on researcher availability to move them. Cameras were either attached to trees or to a stand-alone wooden post where suitable trees were not available. Cameras were positioned to capture wildlife activity on

known or suspected wildlife trails or use areas (including pond and bog habitats). Photos were analyzed manually (without the use of processing software) and data on the date, time of day, location, and contents of photo were recorded. Appendix A contains a map showing the specific camera locations and the photographed species.

To capture an accurate number of animal occurrence, images that were taken less than 20 minutes apart from each other and featured the same animal(s) were grouped as one occurrence. After grouping the images, descriptive statistics were calculated for animal species, time of occurrence, and month of occurrence.

E.5. Fish Trapping Methodology

Fish trapping methodology was developed in consultation with the State of Alaska Department of Fish and Game (ADFG) to ensure that procedures were in line with the standards of the state. Additionally, KBNERR staff advised on best practices.

Materials

- Fish trapping permit from ADFG
- Minnow Traps (5)
- Uncured Salmon eggs
- Perforated plastic bag
- Small net
- Bucket
- Small photarium
- Flagging tape
- Parachute cord
- Camera
- GPS

Permitting and Reporting

A catch permit was secured from the ADFG for the Wynn Nature Center and study site. Fish found during the trapping were reported to ADFG using the supplied excel template and photographs.

Trap Locations

Maps of the property and streams of interest were used to identify areas to inspect (Appendix A). The streams of interest are generally small and shallow that intermittently run underground and through willow thickets. The team selected areas of interest on different parts of the properties and walked the streams in those areas within the property lines looking for areas deep enough to submerge traps. GPS points were taken at each trap location in addition to flagging the

site and the path to the site, and marking GPS points when necessary to enable the team to locate traps. Pictures of the area, both up and downstream, were taken and recorded with date and times.

Baiting

Uncured salmon eggs (kept frozen until use to preserve them) were used as bait. Eggs (approximately 2-3 tablespoons) were placed in a perforated bag in each trap.

Trap Placement

When possible, traps were placed under the edge of a bank or overhang, out of fastest flow in backwaters or coves. At minimum, the hole of the trap was submerged underwater and the whole trap if possible. Traps were secured to the bank or a nearby bush with parachute cord to keep it from floating away or bears from taking it. Traps were numbered and tagged for reference.

Traps were checked about one hour after being placed to ensure that they remained in place. Traps were then left to soak overnight (approximately 24 hours) before retrieval.

Checking Traps

Traps were checked approximately 24 hours after they were placed. Traps were pulled, opened, and any fish caught were placed into a bucket filled with water. Fish were then placed into a photarium (when they would fit) to identify the species, photograph, and measure the length. Fish measured in a photarium were measured in total length. If fish did not fit in the photarium, they were measured against a PVC measuring board using 'fork length' (tip of the nose to the fork of the tail). Species were identified with the help of ADFG species guides.

Fish were released back into the stream after identification.

E.6. Small Mammal Survey Methodology

On August 23, 2016, we conducted a small mammal survey along a forest-meadow transact in IRP Parcel B (Parcel number: 17113259; see Appendix A) using 18 Sherman traps provided by CACS and Thomas McDonough from ADFG. Sunflower seeds were used as bait. We also put moss in each trap to protect the animals from hypothermia. At 6:00 PM, we placed the traps along the transect in locations that small mammals are likely to use, such as small mammal trails under grass and burrow openings under trees and shrubs. The location of each trap was geo-located. At 9:00 AM the following morning, we retrieved all traps.

E.7. Sound Monitoring Methodology

Following data collection, the spectrograms should be partitioned into 1kHz frequency intervals,

which isolate the frequencies of various soundscape components. The partitioning will give a Power Spectral Density (PSD), a measure of soundscape power expressed in watts/kHz. Matlab, or another similar type of data analysis software, should be used to compute the PSD values. Discriminating specific sound sources by frequency interval will be necessary in determining soundscape power overlap. This means that although some sounds will be sourced from different components (ie, anthrophony, biophony), their frequency intervals might be similar enough to cause similar effects upon wildlife.

Following discrimination among specific sound sources, the data should be analyzed in a statistical software program to calculate and visualize the soundscape. Previously calculated PSD values will determine the soundscape power across spatial and temporal scale. Lastly, percentage of each type of sound component (biophony, geophony, anthrophony) should be calculated to determine which sound events are the most prevalent on the IRP.

Appendix F. Survey Results

F.1. Vegetation Survey Results

A total of 44 plant species have been found in the three transects, including 24 species in transect 1 and 2, and 17 species in transect 3. The three habitats have highly distinct vegetation communities, with a species turnover of 32 between bog (T1) and meadow (T2), 23 between meadow (T2) and forest (T3), and 31 between bog (T1) and forest (T3). The most common species (mean frequency > 2) found in the bog habitat include sphagnum moss, field horsetail (*Equisetum arvense*), bog cranberry (*Vaccinium uliginosum*), trailing raspberry (*Rubus ipedatus*), and dwarf birch (*Betula nana*). The most common species in the meadow habitat are sphagnum moss, blue joint grass (*Calamagrostis canadensis*), field horsetail (*Equisetum arvense*), fireweed (*Epilobium angustifolium*), and trailing raspberry (*Rubus ipedatus*). Finally, sphagnum moss, blue joint grass (*Calamagrostis canadensis*), fireweed (*Epilobium angustifolium*), and trailing raspberry (*Rubus ipedatus*) are also commonly found in the forest habitat.

Table F-1. Vegetation survey results from transects 1-3. The mean nested frequency is calculated for each species in each transect. Alpha diversity is calculated by counting the number of species found in each transect. Beta diversity is derived from the species turnover between two transects. Gamma diversity is the total number of species found in all three transects.

Common Name	**Scientific Name**	**Mean nested frequency**		
		T1 – bog	**T2 - meadow**	**T3 - forest**
Alaska Bog Willow	*Salix fuscescens*	0.6		
Alaska Spirea	*Spiraea Beauverdiana*	0.4		
Barclay willow	*Salix barclayi,*	1.4		
Blue joint grass	*Calamagrostis canadensis*	1.2	3	3
Bog blueberry	*Vaccinium uliginosum*	1.6		
Bog cranberry	*Vaccinium uliginosum*	2.4		
Common hair-cap moss	*Polytrichum commune*	1.4		
Cotton grass	*Eriophorum angustifolium*	1.6		
Crowberry	*Empetrum nigrum*	1.2		
Dwarf birch	*Betula nana*	2		
Early Blueberry	*Vaccinium ovalifolium*	0.8		
Field Horsetail	*Equisetum arvense*	2.6	2.8	1.4

Fireweed	*Epilobium angustifolium*	1	2.6	2.2
Labrador tea	*Ledum palustre*	1		
Lichen		0.4		
Lutz spruce	*Picea xlutzii*	0.6	0.4	
Nagoonberry	*Rubus arcticus*	0.8	0.8	
Northern starflower	*Trientalis europaea ssp arctica*	0.4	1.2	1
Single delight	*Moneses uniflora*	0.4		1
Sitka Burnet	*Sanguisorba stipulata*	1.2		0.6
Sphagnum moss		3	3.6	3.4
Trailing raspberry	*Rubus ipedatus*	2	3	3.4
Watermelon berry	*Streptopus amplexifolius*	0.4		0.6
Western oak fern	*Gymnocarpium disjunctum*	1.4		0.8
Alaska violet	*Viola langsdorfii*		0.4	
Angelica	*Angelica lucida*		0.6	
Chocolate lily	*Fritillaria camschatcensis*		0.6	
Coastal Indian Paintbrush	*Castilleja unalaschensis*		0.4	
Cow parsnip	*Heracleum lanatum*		1.6	
Dandelion	*(species not identified)*		1.6	
Monk's hood	*Aconitum delphinifolium*		0.4	
Mountain wood fern	*Thelypteris quelpaertensis*		0.8	
Red alder	*Alnus rubra*		0.4	
Red elderberry	*Sambucus racemosa*		0.4	0.2
UNK - 9305			0.8	
UNK - Pic 9302			0.6	
UNK 9295			0.8	
UNK 9312			1.2	0.2
Yarrow	*Achillea borealis*		1.6	0.4
Yellow rattle	*Rhinanathus minor*		1.4	

Common hair-cap moss	*Polytrichum commune*			0.2
Side-bells pyrola	*Pyrola secunda*			0.6
UNK 9336,9337				0.8
UNK 9346				0.8
Alpha diversity (diversity in each transect)		24	24	17
Beta diversity (species turnover)		Bog (T1) vs Meadow(T2): 32	Meadow(T2) vs Forest (T3): 23	Bog(T1) vs Forest (T3): 21
Gamma diversity (total diversity of all transects)		44		

F.2. Camera Trap Results

In total, the cameras were deployed at ten locations between May and October 2016 and captured a total of 511 images of wildlife. Table F-2 shows the duration of each camera deployment and the species recorded. A total of 111 animal occurrences were recorded in the camera trap survey. The dominate species captured in the images were moose, accounting for 92.8% of all animal occurrences. Bears accounted for 5% of occurrences, while coyote and an unidentified duck species each accounted for 0.9% (Figure F-1).

A high level of animal activity was documented by camera traps between 4:00 - 10:00 and 16:00 -24:00 (Figure F-2.)

Table F-2. Species recorded by camera traps. Attribute information for camera traps deployed on the IRP, May-October 2016.

Camera ID	Start Date	End Date	Duration of Deployment	Species recorded
N/A	5/29/2016	6/7/2016	9	Moose, black bear, coyote
268	5/30/2016	6/7/2016	8	Moose, black bear
357	6/7/2016	8/5/2016	59	Moose
361	6/8/2016	8/5/2016	58	Moose
362	6/8/2016	8/5/2016	58	Moose

393	8/6/2016	8/23/2016	17	Moose
412	8/9/2016	8/24/2016	15	Moose
025	8/13/2016	8/23/2016	10	No animal occurrences recorded
023	8/25/2016	10/12/2016	48	Moose
026	8/30/2016	10/6/2016	37	Moose, black bear
025	8/24/2016	10/12/2016	49	Moose, waterfowl (unidentified)

.

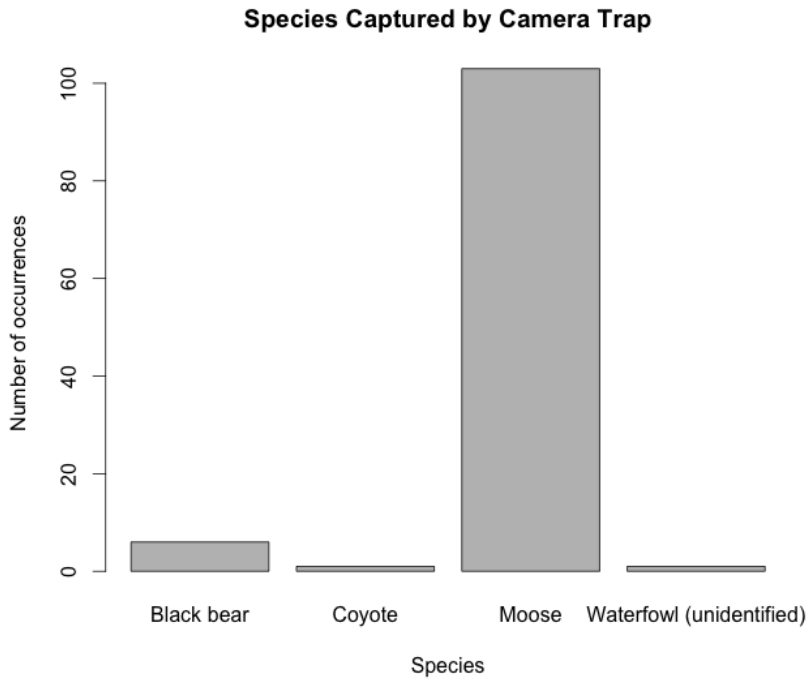


Figure F-1. Numbers of animal types captured by camera trap.

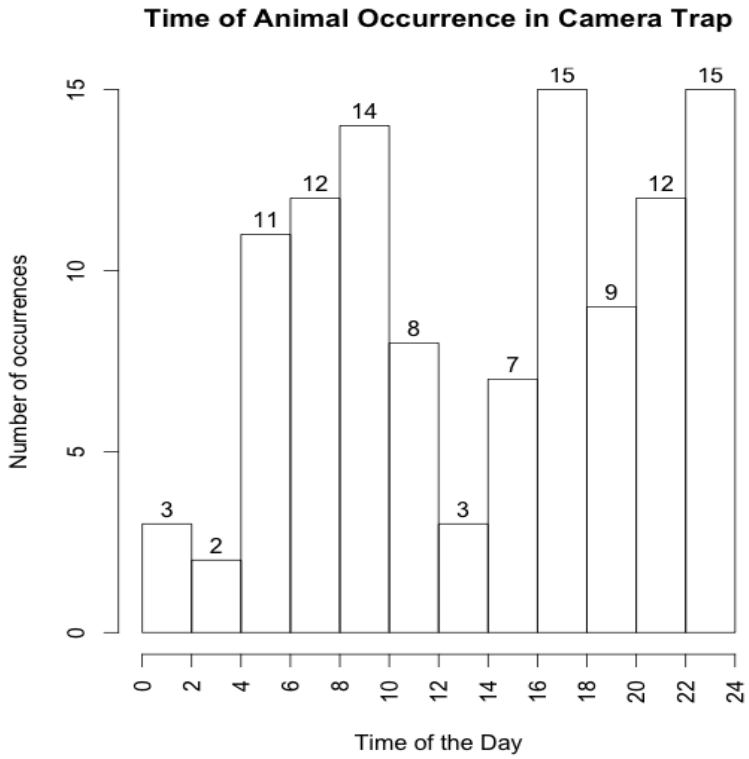


Figure F-2. Frequencies of animal occurrence in camera trap, by time of day (hours).

F.3. Fish Trapping Results

During the fish survey conducted by the team in summer 2016, 10 juvenile dolly varden trout (*Salvelinus malma*) were found (Figure F-3).

Location ID (optional)	Latitude	Longitude	Coordinate determination method	Name of water body	Date	Fish collection method	Species	Life stage	Length (mm) No estimates/ranges	Length method
51	59.70212	151.44194	GPS	Wong 80 Trap 1	8/14/2016	Minnow Trap	Dolly Varden	juvenile	100mm	Total
51	59.70212	151.44194	GPS	Wong 80 Trap 1	8/14/2016	Minnow Trap	Dolly Varden	juvenile	90mm	Total
51	59.70212	151.44194	GPS	Wong 80 Trap 1	8/14/2016	Minnow Trap	Dolly Varden	juvenile	90mm	Total
55	59.70507	151.44419	GPS	Wong 80 Trap 3	8/14/2016	Minnow Trap	Dolly Varden	juvenile	120mm	Total
55	59.70507	151.44419	GPS	Wong 80 Trap 3	8/14/2016	Minnow Trap	Dolly Varden	juvenile	125mm	Total
55	59.70507	151.44419	GPS	Wong 80 Trap 3	8/14/2016	Minnow Trap	Dolly Varden	juvenile	155mm	Total
S 27	59.70734	151.44278	GPS	Wong 80 Trap 5	8/14/2016	Minnow Trap	Dolly Varden	juvenile	80mm	Total
S 39	59.70373	151.43208	GPS	Mead 40 Trap 5	8/15/2016	Minnow Trap	Dolly Varden	juvenile	130 mm	Fork
S 47	59.70565	151.42016	GPS	Mead 40 Trap 3	8/15/2016	Minnow Trap	Dolly Varden	juvenile	110 mm	Fork
S 47	59.70565	151.42016	GPS	Mead 40 Trap 3	8/15/2016	Minnow Trap	Dolly Varden	juvenile	75mm	Fork

Figure F-3. Fish trapping data with location, date, trapping method, species, length, and measurement method are detailed.

F.4. Small Mammal Survey Results

In this survey, no animals were found in the traps. However, in 3 out of the 18 traps, the bait was gone, and small mammal scat was left in the trap, showing evidence of small mammal existence.

Appendix G. Soil Survey Report

United States Department of Agriculture

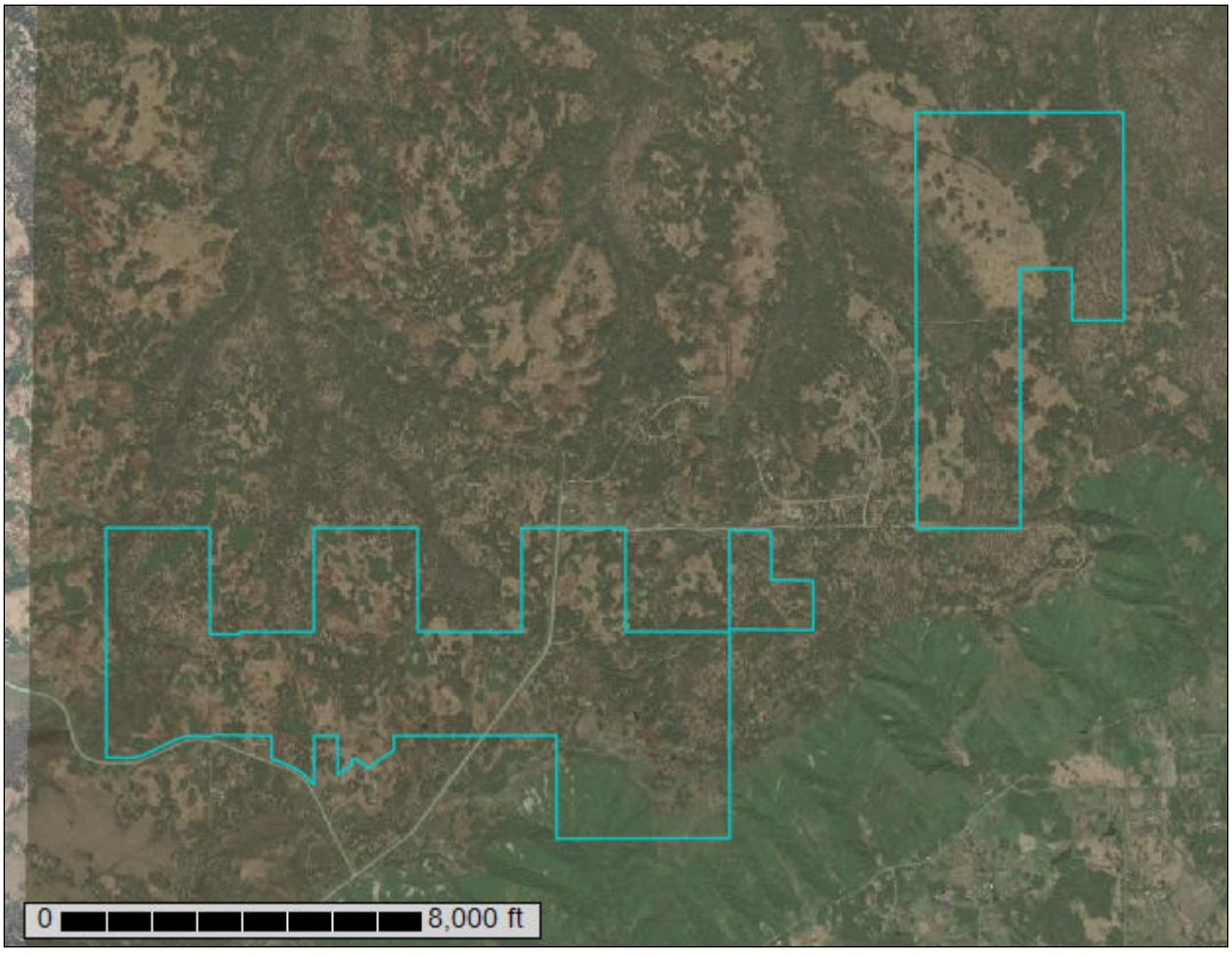
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Western Kenai Peninsula Area, Alaska

Inspiration Ridge Preserve



March 20, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

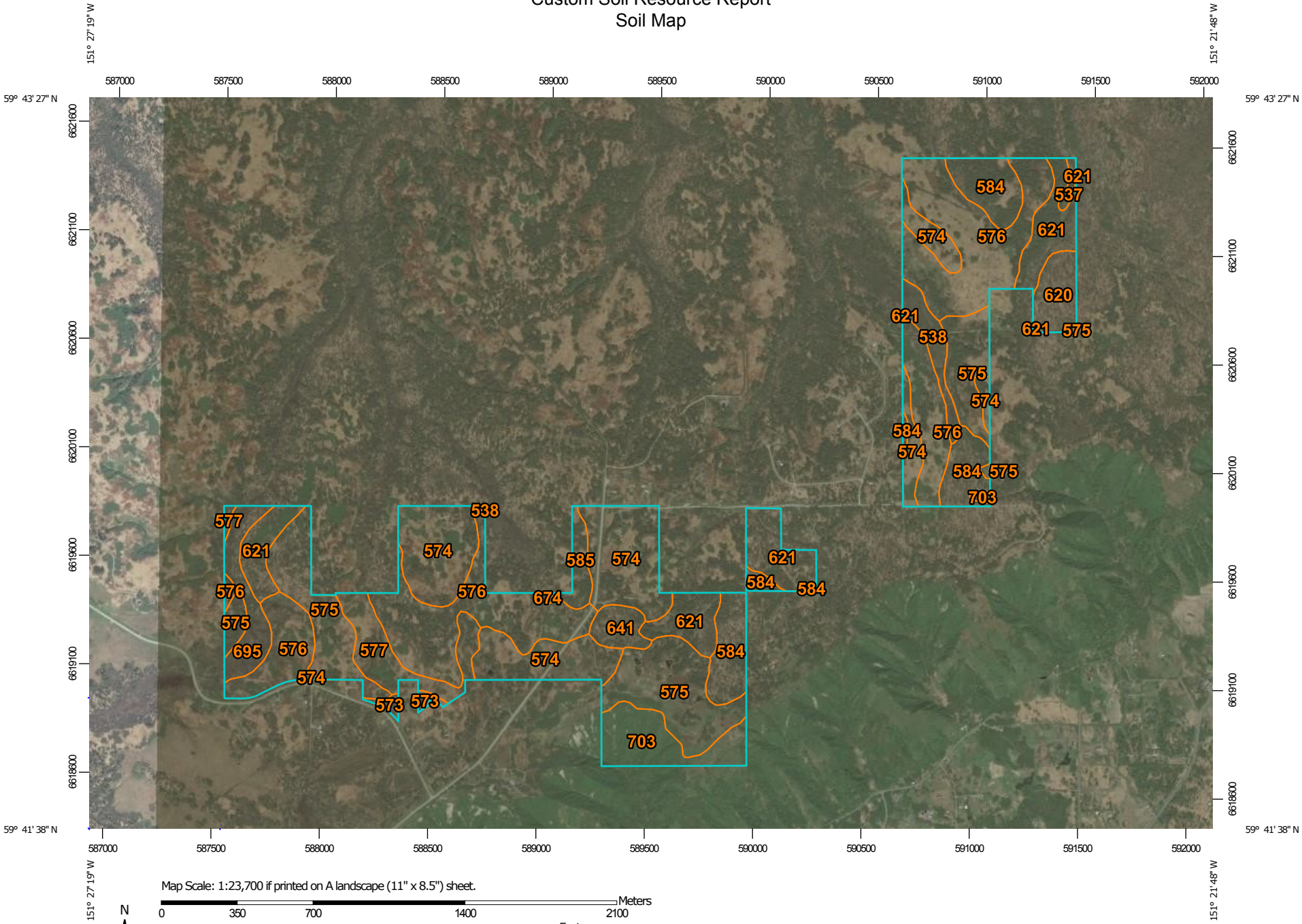
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Western Kenai Peninsula Area, Alaska
Survey Area Data: Version 14, Sep 27, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Western Kenai Peninsula Area, Alaska (AK652)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
537	Coal Creek silt loam, 4 to 8 percent slopes	2.2	0.3%
538	Coal Creek silt loam, 8 to 15 percent slopes	13.2	1.9%
573	Kachemak silt loam, 4 to 8 percent slopes	3.5	0.5%
574	Kachemak silt loam, 8 to 15 percent slopes	127.3	18.4%
575	Kachemak silt loam, 15 to 25 percent slopes	113.4	16.4%
576	Kachemak silt loam, 25 to 35 percent slopes	188.2	27.1%
577	Kachemak silt loam, 35 to 45 percent slopes	29.2	4.2%
584	Kachemak silt loam, forested, 8 to 15 percent slopes	57.1	8.2%
585	Kachemak silt loam, forested, 15 to 25 percent slopes	9.1	1.3%
620	Mutnala silt loam, 15 to 25 percent slopes	16.3	2.4%
621	Mutnala silt loam, 25 to 45 percent slopes	70.1	10.1%
641	Qutal silt loam, 4 to 8 percent slopes	10.8	1.6%
674	Spenard peat, 4 to 8 percent slopes	0.5	0.1%
695	Truuli muck, 0 to 4 percent slopes	21.1	3.0%
703	Typic Cryorthents, 100 to 150 percent slopes	31.5	4.5%
Totals for Area of Interest		**693.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the

characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered

practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Western Kenai Peninsula Area, Alaska

537—Coal Creek silt loam, 4 to 8 percent slopes

Map Unit Setting

National map unit symbol: 1lyc3
Elevation: 20 to 1,670 feet
Mean annual precipitation: 16 to 39 inches
Mean annual air temperature: 32 to 37 degrees F
Frost-free period: 75 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

Coal creek and similar soils: 88 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Coal Creek

Setting

Landform: Depressions on till plains
Landform position (two-dimensional): Footslope, toeslope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Colluvium and/or eolian deposits over glacial drift

Typical profile

Oi - 0 to 6 inches: slightly decomposed plant material
A - 6 to 15 inches: silt loam
Cg1 - 15 to 23 inches: silt loam
2Cg2 - 23 to 60 inches: gravelly silt loam

Properties and qualities

Slope: 4 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.57 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 14.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: Picea mariana/Empetrum nigrum-Betula nana (F170XY412AK)
Hydric soil rating: Yes

Minor Components

Starichkof

Percent of map unit: 10 percent
Landform: Fens

Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Wetland Complex (R170XY400AK)
Hydric soil rating: Yes

Mutnala

Percent of map unit: 2 percent
Landform: Moraines on till plains
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

538—Coal Creek silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 1lyc4
Elevation: 20 to 1,480 feet
Mean annual precipitation: 16 to 39 inches
Mean annual air temperature: 32 to 39 degrees F
Frost-free period: 75 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Coal creek and similar soils: 88 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Coal Creek

Setting

Landform: Depressions on till plains
Landform position (two-dimensional): Footslope, toeslope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Colluvium and/or eolian deposits over drift

Typical profile

Oi - 0 to 6 inches: slightly decomposed plant material
A - 6 to 15 inches: silt loam
Cg1 - 15 to 23 inches: silt loam
2Cg2 - 23 to 60 inches: gravelly silt loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.21 to 0.57 in/hr)
Depth to water table: About 6 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 14.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: Picea mariana/Empetrum nigrum-Betula nana (F170XY412AK)
Hydric soil rating: Yes

Minor Components

Qutal

Percent of map unit: 8 percent
Landform: Moraines on till plains, depressions on till plains
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/ Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: No

Doroshin

Percent of map unit: 4 percent
Landform: Depressions on till plains, fens on till plains
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Wetland Complex (R170XY400AK)
Hydric soil rating: Yes

573—Kachemak silt loam, 4 to 8 percent slopes

Map Unit Setting

National map unit symbol: 1lyd8
Elevation: 410 to 1,920 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kachemak and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kachemak

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
A - 3 to 8 inches: silt loam
B - 8 to 30 inches: silt loam
2C - 30 to 60 inches: silt loam

Properties and qualities

Slope: 4 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

Minor Components

Redoubt

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Tuxedni

Percent of map unit: 10 percent
Landform: Till plains
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

574—Kachemak silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 1lyd9
Elevation: 160 to 2,000 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kachemak and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kachemak

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
A - 3 to 8 inches: silt loam
B - 8 to 30 inches: silt loam
2C - 30 to 60 inches: silt loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

Minor Components

Tuxedni

Percent of map unit: 10 percent
Landform: Till plains, hills
Landform position (two-dimensional): Toeslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

Redoubt

Percent of map unit: 8 percent
Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Starichkof

Percent of map unit: 2 percent
Landform: Fens
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Wetland Complex (R170XY400AK)
Hydric soil rating: Yes

575—Kachemak silt loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 1lydb
Elevation: 200 to 2,020 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kachemak and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kachemak

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear

Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
A - 3 to 8 inches: silt loam
B - 8 to 30 inches: silt loam
2C - 30 to 60 inches: silt loam

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

Minor Components

Redoubt

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Tuxedni

Percent of map unit: 10 percent
Landform: Till plains
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

576—Kachemak silt loam, 25 to 35 percent slopes

Map Unit Setting

National map unit symbol: 1lydc

Elevation: 200 to 2,030 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kachemak and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kachemak

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
A - 3 to 8 inches: silt loam
B - 8 to 30 inches: silt loam
2C - 30 to 60 inches: silt loam

Properties and qualities

Slope: 25 to 35 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

Minor Components

Redoubt

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Tuxedni

Percent of map unit: 10 percent
Landform: Till plains, hills
Landform position (two-dimensional): Toeslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

577—Kachemak silt loam, 35 to 45 percent slopes

Map Unit Setting

National map unit symbol: 1lydd
Elevation: 310 to 2,310 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kachemak and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kachemak

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
A - 3 to 8 inches: silt loam
B - 8 to 30 inches: silt loam
2C - 30 to 60 inches: silt loam

Properties and qualities

Slope: 35 to 45 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

Minor Components

Tuxedni

Percent of map unit: 10 percent
Landform: Hills, till plains
Landform position (two-dimensional): Toeslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

584—Kachemak silt loam, forested, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 1lydm
Elevation: 480 to 2,020 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kachemak, forested, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kachemak, Forested

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
A - 3 to 8 inches: silt loam
B - 8 to 30 inches: silt loam
2C - 30 to 60 inches: silt loam

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

Minor Components

Tuxedni

Percent of map unit: 8 percent
Landform: Till plains
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

Redoubt

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Starichkof

Percent of map unit: 2 percent
Landform: Fens
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Wetland Complex (R170XY400AK)
Hydric soil rating: Yes

585—Kachemak silt loam, forested, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 1lydn

Elevation: 490 to 1,970 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Kachemak, forested, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kachemak, Forested

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oi - 0 to 3 inches: slightly decomposed plant material
A - 3 to 8 inches: silt loam
B - 8 to 30 inches: silt loam
2C - 30 to 60 inches: silt loam

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

Minor Components

Redoubt

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, shoulder
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Tuxedni

Percent of map unit: 10 percent
Landform: Till plains
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

620—Mutnala silt loam, 15 to 25 percent slopes

Map Unit Setting

National map unit symbol: 1lyfs
Elevation: 0 to 1,850 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 37 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Mutnala and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mutnala

Setting

Landform: Moraines on till plains
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Ash influenced loess over loamy till

Typical profile

Oe - 0 to 4 inches: moderately decomposed plant material
E,B - 4 to 7 inches: silt loam
Bw - 7 to 23 inches: silt loam
2C - 23 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 15 to 25 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 14.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Minor Components

Spenard
Percent of map unit: 10 percent
Landform: Moraines on till plains
Landform position (two-dimensional): Footslope, toeslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: Yes

Qutal
Percent of map unit: 5 percent
Landform: Moraines on till plains, depressions on till plains
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: No

621—Mutnala silt loam, 25 to 45 percent slopes

Map Unit Setting
National map unit symbol: 1lyft
Elevation: 230 to 1,480 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 36 to 37 degrees F
Frost-free period: 90 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition
Mutnala and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mutnala

Setting
Landform: Moraines on till plains
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Linear

Parent material: Ash influenced loess over loamy till

Typical profile

Oe - 0 to 4 inches: moderately decomposed plant material
E,B - 4 to 7 inches: silt loam
Bw - 7 to 23 inches: silt loam
2C - 23 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 25 to 45 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 14.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Minor Components

Qutal

Percent of map unit: 5 percent
Landform: Moraines on till plains, depressions on till plains
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: No

Spenard

Percent of map unit: 5 percent
Landform: Moraines on till plains
Landform position (two-dimensional): Footslope, toeslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: Yes

Kichatna

Percent of map unit: 5 percent
Landform: Terraces on outwash plains
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear

Ecological site: Picea-Betula papyrifera/Ledum-Vaccinium vitis-idaea/Cornus canadensis (F170XY009AK)
Hydric soil rating: No

641—Qutal silt loam, 4 to 8 percent slopes

Map Unit Setting

National map unit symbol: 1lygg
Elevation: 0 to 1,740 feet
Mean annual precipitation: 20 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Qutal and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Qutal

Setting

Landform: Moraines on till plains, depressions on till plains
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial drift

Typical profile

Oe - 0 to 3 inches: moderately decomposed plant material
E,B - 3 to 10 inches: silt loam
Bw - 10 to 24 inches: silt loam
2Cg - 24 to 48 inches: silt loam
3C - 48 to 60 inches: very gravelly sand

Properties and qualities

Slope: 4 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 20 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 15.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/ Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: No

Minor Components

Spenard
Percent of map unit: 10 percent
Landform: Depressions on till plains
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/ Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: Yes

Whitsol
Percent of map unit: 10 percent
Landform: Till plains
Ecological site: Picea lutzii-Betula papyrifera/Gymnocarpium dryopteris-Rubus pedatus (F170XY435AK)
Hydric soil rating: No

674—Spenard peat, 4 to 8 percent slopes

Map Unit Setting
National map unit symbol: 1lyhj
Elevation: 0 to 1,790 feet
Mean annual precipitation: 16 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition
Spenard and similar soils: 67 percent
Minor components: 33 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Spenard

Setting
Landform: Depressions on till plains
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Ash influenced loess over glacial till

Typical profile
Oi - 0 to 9 inches: peat
E - 9 to 14 inches: silt loam
Bs - 14 to 25 inches: silt loam
2C - 25 to 60 inches: silt loam

Properties and qualities

Slope: 4 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.71 to 1.98 in/hr)
Depth to water table: About 8 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 12.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: D
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/ Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: Yes

Minor Components

Qutal

Percent of map unit: 15 percent
Landform: Depressions on till plains, moraines on till plains
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/ Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: No

Mutnala

Percent of map unit: 15 percent
Landform: Moraines on till plains
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: Picea glauca-Betula papyrifera/Calamagrostis canadensis-Equisetum arvense (F170XD443AK)
Hydric soil rating: No

Doroshin

Percent of map unit: 3 percent
Landform: Fens on till plains, depressions on till plains
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Wetland Complex (R170XY400AK)
Hydric soil rating: Yes

695—Truuli muck, 0 to 4 percent slopes

Map Unit Setting

National map unit symbol: 1lyj6
Elevation: 100 to 2,000 feet
Mean annual precipitation: 16 to 39 inches
Mean annual air temperature: 34 to 39 degrees F
Frost-free period: 85 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Truuli and similar soils: 88 percent
Minor components: 12 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Truuli

Setting

Landform: Depressions on terraces, depressions on till plains
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Ash influenced loess over loamy till

Typical profile

Oa - 0 to 9 inches: muck
A - 9 to 19 inches: very fine sandy loam
2Bg,2Cg1 - 19 to 43 inches: silt loam
3Cg2 - 43 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 4 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 8 to 18 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very high (about 18.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C
Ecological site: Picea glauca-Betula papyrifera/Menziesia ferruginea/ Gymnocarpium dryopteris (F170XY018AK)
Hydric soil rating: Yes

Minor Components

Nikolai

Percent of map unit: 8 percent
Landform: Depressions on till plains, depressions on coastal plains
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Picea lutzii/Calamagrostis canadensis (F170XD414AK)
Hydric soil rating: Yes

Tuxedni

Percent of map unit: 4 percent
Landform: Till plains
Ecological site: Rolling Uplands (R170XD427AK)
Hydric soil rating: No

703—Typic Cryorthents, 100 to 150 percent slopes

Map Unit Setting

National map unit symbol: 1lyjg
Elevation: 0 to 1,430 feet
Mean annual precipitation: 20 to 30 inches
Mean annual air temperature: 36 to 39 degrees F
Frost-free period: 90 to 130 days
Farmland classification: Not prime farmland

Map Unit Composition

Typic cryorthents and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Typic Cryorthents

Setting

Landform: Sea cliffs
Landform position (two-dimensional): Backslope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Debris slide deposits derived from interbedded sedimentary rock

Typical profile

Oi - 0 to 1 inches: gravelly slightly decomposed plant material
C1 - 1 to 33 inches: gravelly very fine sandy loam
C2 - 33 to 60 inches: very gravelly silt loam

Properties and qualities

Slope: 100 to 150 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium

Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: Alpine ridges (R169XY101AK)
Hydric soil rating: No

Minor Components

Badland, sea cliffs

Percent of map unit: 10 percent
Landform: Cliffs
Hydric soil rating: Unranked

Beluga

Percent of map unit: 5 percent
Landform: Alluvial fans
Landform position (two-dimensional): Backslope, footslope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Lower Bench Toe Slopes (R170XD424AK)
Hydric soil rating: Yes

Kachemak

Percent of map unit: 5 percent
Landform: Moraines on till plains
Landform position (two-dimensional): Backslope, shoulder, summit
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Picea xlutzii/Salix barclayi-Empetrum nigrum/Equisetum arvense (F224XY429AK)
Hydric soil rating: No

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Glossary

Many of the terms relating to landforms, geology, and geomorphology are defined in more detail in the "National Soil Survey Handbook."

ABC soil

A soil having an A, a B, and a C horizon.

Ablation till

Loose, relatively permeable earthy material deposited during the downwasting of nearly static glacial ice, either contained within or accumulated on the surface of the glacier.

AC soil

A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

Aeration, soil

The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil

Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvial cone

A semiconical type of alluvial fan having very steep slopes. It is higher, narrower, and steeper than a fan and is composed of coarser and thicker layers of material deposited by a combination of alluvial episodes and (to a much lesser degree) landslides (debris flow). The coarsest materials tend to be concentrated at the apex of the cone.

Alluvial fan

A low, outspread mass of loose materials and/or rock material, commonly with gentle slopes. It is shaped like an open fan or a segment of a cone. The material was deposited by a stream at the place where it issues from a narrow mountain valley or upland valley or where a tributary stream is near or at its junction with the main stream. The fan is steepest near its apex, which points upstream, and slopes gently and convexly outward (downstream) with a gradual decrease in gradient.

Alluvium

Unconsolidated material, such as gravel, sand, silt, clay, and various mixtures of these, deposited on land by running water.

Alpha,alpha-dipyridyl

A compound that when dissolved in ammonium acetate is used to detect the presence of reduced iron (Fe II) in the soil. A positive reaction implies reducing conditions and the likely presence of redoximorphic features.

Animal unit month (AUM)

The amount of forage required by one mature cow of approximately 1,000 pounds weight, with or without a calf, for 1 month.

Aquic conditions

Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Argillic horizon

A subsoil horizon characterized by an accumulation of illuvial clay.

Arroyo

The flat-floored channel of an ephemeral stream, commonly with very steep to vertical banks cut in unconsolidated material. It is usually dry but can be transformed into a temporary watercourse or short-lived torrent after heavy rain within the watershed.

Aspect

The direction toward which a slope faces. Also called slope aspect.

Association, soil

A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity)

The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low: 0 to 3
Low: 3 to 6
Moderate: 6 to 9
High: 9 to 12
Very high: More than 12

Backslope

The position that forms the steepest and generally linear, middle portion of a hillslope. In profile, backslopes are commonly bounded by a convex shoulder above and a concave footslope below.

Backswamp

A flood-plain landform. Extensive, marshy or swampy, depressed areas of flood plains between natural levees and valley sides or terraces.

Badland

A landscape that is intricately dissected and characterized by a very fine drainage network with high drainage densities and short, steep slopes and narrow interfluves. Badlands develop on surfaces that have little or no vegetative cover overlying unconsolidated or poorly cemented materials (clays, silts, or sandstones) with, in some cases, soluble minerals, such as gypsum or halite.

Bajada

A broad, gently inclined alluvial piedmont slope extending from the base of a mountain range out into a basin and formed by the lateral coalescence of a series of alluvial fans. Typically, it has a broadly undulating transverse profile, parallel to the mountain front, resulting from the convexities of component fans. The term is generally restricted to constructional slopes of intermontane basins.

Basal area

The area of a cross section of a tree, generally referring to the section at breast height and measured outside the bark. It is a measure of stand density, commonly expressed in square feet.

Base saturation

The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Base slope (geomorphology)

A geomorphic component of hills consisting of the concave to linear (perpendicular to the contour) slope that, regardless of the lateral shape, forms an apron or wedge at the bottom of a hillside dominated by colluvium and slope-wash sediments (for example, slope alluvium).

Bedding plane

A planar or nearly planar bedding surface that visibly separates each successive layer of stratified sediment or rock (of the same or different lithology)

from the preceding or following layer; a plane of deposition. It commonly marks a change in the circumstances of deposition and may show a parting, a color difference, a change in particle size, or various combinations of these. The term is commonly applied to any bedding surface, even one that is conspicuously bent or deformed by folding.

Bedding system

A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

Bedrock

The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography

A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

Bench terrace

A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum

Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout (map symbol)

A saucer-, cup-, or trough-shaped depression formed by wind erosion on a preexisting dune or other sand deposit, especially in an area of shifting sand or loose soil or where protective vegetation is disturbed or destroyed. The adjoining accumulation of sand derived from the depression, where recognizable, is commonly included. Blowouts are commonly small.

Borrow pit (map symbol)

An open excavation from which soil and underlying material have been removed, usually for construction purposes.

Bottom land

An informal term loosely applied to various portions of a flood plain.

Boulders

Rock fragments larger than 2 feet (60 centimeters) in diameter.

Breaks

A landscape or tract of steep, rough or broken land dissected by ravines and gullies and marking a sudden change in topography.

Breast height

An average height of 4.5 feet above the ground surface; the point on a tree where diameter measurements are ordinarily taken.

Brush management

Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the hazard of erosion. It can improve the habitat for some species of wildlife.

Butte

An isolated, generally flat-topped hill or mountain with relatively steep slopes and talus or precipitous cliffs and characterized by summit width that is less than the height of bounding escarpments; commonly topped by a caprock of resistant material and representing an erosion remnant carved from flat-lying rocks.

Cable yarding

A method of moving felled trees to a nearby central area for transport to a processing facility. Most cable yarding systems involve use of a drum, a pole, and wire cables in an arrangement similar to that of a rod and reel used for fishing. To reduce friction and soil disturbance, felled trees generally are reeled in while one end is lifted or the entire log is suspended.

Calcareous soil

A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche

A general term for a prominent zone of secondary carbonate accumulation in surficial materials in warm, subhumid to arid areas. Caliche is formed by both geologic and pedologic processes. Finely crystalline calcium carbonate forms a nearly continuous surface-coating and void-filling medium in geologic (parent) materials. Cementation ranges from weak in nonindurated forms to very strong in indurated forms. Other minerals (e.g., carbonates, silicate, and sulfate) may occur as accessory cements. Most petrocalcic horizons and some calcic horizons are caliche.

California bearing ratio (CBR)

The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy

The leafy crown of trees or shrubs. (See Crown.)

Canyon

A long, deep, narrow valley with high, precipitous walls in an area of high local relief.

Capillary water

Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena

A sequence, or “chain,” of soils on a landscape that formed in similar kinds of parent material and under similar climatic conditions but that have different characteristics as a result of differences in relief and drainage.

Cation

An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity

The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps

See Terracettes.

Cement rock

Shaly limestone used in the manufacture of cement.

Channery soil material

Soil material that has, by volume, 15 to 35 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches (15 centimeters) along the longest axis. A single piece is called a channer.

Chemical treatment

Control of unwanted vegetation through the use of chemicals.

Chiseling

Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard, compacted layers to a depth below normal plow depth.

Cirque

A steep-walled, semicircular or crescent-shaped, half-bowl-like recess or hollow, commonly situated at the head of a glaciated mountain valley or high on the side of a mountain. It was produced by the erosive activity of a mountain glacier. It commonly contains a small round lake (tarn).

Clay

As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay depletions

See Redoximorphic features.

Clay film

A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Clay spot (map symbol)

A spot where the surface texture is silty clay or clay in areas where the surface layer of the soils in the surrounding map unit is sandy loam, loam, silt loam, or coarser.

Claypan

A dense, compact subsoil layer that contains much more clay than the overlying materials, from which it is separated by a sharply defined boundary. The layer restricts the downward movement of water through the soil. A claypan is commonly hard when dry and plastic and sticky when wet.

Climax plant community

The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse textured soil

Sand or loamy sand.

Cobble (or cobblestone)

A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material

Material that has 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material has 35 to 60 percent of these rock fragments, and extremely cobbly soil material has more than 60 percent.

COLE (coefficient of linear extensibility)

See Linear extensibility.

Colluvium

Unconsolidated, unsorted earth material being transported or deposited on side slopes and/or at the base of slopes by mass movement (e.g., direct gravitational action) and by local, unconcentrated runoff.

Complex slope

Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil

A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Concretions

See Redoximorphic features.

Conglomerate

A coarse grained, clastic sedimentary rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

Conservation cropping system

Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the effects of the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage

A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil

Refers to the degree of cohesion and adhesion of soil material and its resistance to deformation when ruptured. Consistence includes resistance of soil material to rupture and to penetration; plasticity, toughness, and stickiness of puddled soil material; and the manner in which the soil material behaves when subject to compression. Terms describing consistence are defined in the “Soil Survey Manual.”

Contour stripcropping

Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section

The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Coprogenous earth (sedimentary peat)

A type of limnic layer composed predominantly of fecal material derived from aquatic animals.

Corrosion (geomorphology)

A process of erosion whereby rocks and soil are removed or worn away by natural chemical processes, especially by the solvent action of running water, but also by other reactions, such as hydrolysis, hydration, carbonation, and oxidation.

Corrosion (soil survey interpretations)

Soil-induced electrochemical or chemical action that dissolves or weakens concrete or uncoated steel.

Cover crop

A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Crop residue management

Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cropping system

Growing crops according to a planned system of rotation and management practices.

Cross-slope farming

Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown

The upper part of a tree or shrub, including the living branches and their foliage.

Cryoturbate

A mass of soil or other unconsolidated earthy material moved or disturbed by frost action. It is typically coarser than the underlying material.

Cuesta

An asymmetric ridge capped by resistant rock layers of slight or moderate dip (commonly less than 15 percent slopes); a type of homocline produced by differential erosion of interbedded resistant and weak rocks. A cuesta has a long, gentle slope on one side (dip slope) that roughly parallels the inclined beds; on the other side, it has a relatively short and steep or clifflike slope (scarp) that cuts through the tilted rocks.

Culmination of the mean annual increment (CMAI)

The average annual increase per acre in the volume of a stand. Computed by dividing the total volume of the stand by its age. As the stand increases in age, the mean annual increment continues to increase until mortality begins to reduce the rate of increase. The point where the stand reaches its maximum annual rate of growth is called the culmination of the mean annual increment.

Cutbanks cave

The walls of excavations tend to cave in or slough.

Decreasers

The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing

Postponing grazing or resting grazing land for a prescribed period.

Delta

A body of alluvium having a surface that is fan shaped and nearly flat; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer

A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depression, closed (map symbol)

A shallow, saucer-shaped area that is slightly lower on the landscape than the surrounding area and that does not have a natural outlet for surface drainage.

Depth, soil

Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Desert pavement

A natural, residual concentration or layer of wind-polished, closely packed gravel, boulders, and other rock fragments mantling a desert surface. It forms where wind action and sheetwash have removed all smaller particles or where rock fragments have migrated upward through sediments to the surface. It typically protects the finer grained underlying material from further erosion.

Diatomaceous earth

A geologic deposit of fine, grayish siliceous material composed chiefly or entirely of the remains of diatoms.

Dip slope

A slope of the land surface, roughly determined by and approximately conforming to the dip of the underlying bedrock.

Diversion (or diversion terrace)

A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Divided-slope farming

A form of field stripcropping in which crops are grown in a systematic arrangement of two strips, or bands, across the slope to reduce the hazard of water erosion. One strip is in a close-growing crop that provides protection from erosion, and the other strip is in a crop that provides less protection from erosion. This practice is used where slopes are not long enough to permit a full stripcropping pattern to be used.

Drainage class (natural)

Refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized—*excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained,* and *very poorly drained*. These classes are defined in the “Soil Survey Manual.”

Drainage, surface

Runoff, or surface flow of water, from an area.

Drainageway

A general term for a course or channel along which water moves in draining an area. A term restricted to relatively small, linear depressions that at some time move concentrated water and either do not have a defined channel or have only a small defined channel.

Draw

A small stream valley that generally is shallower and more open than a ravine or gulch and that has a broader bottom. The present stream channel may appear inadequate to have cut the drainageway that it occupies.

Drift

A general term applied to all mineral material (clay, silt, sand, gravel, and boulders) transported by a glacier and deposited directly by or from the ice or transported by running water emanating from a glacier. Drift includes unstratified material (till) that forms moraines and stratified deposits that form outwash plains, eskers, kames, varves, and glaciofluvial sediments. The term is generally applied to Pleistocene glacial deposits in areas that no longer contain glaciers.

Drumlin

A low, smooth, elongated oval hill, mound, or ridge of compact till that has a core of bedrock or drift. It commonly has a blunt nose facing the direction from which the ice approached and a gentler slope tapering in the other direction. The longer axis is parallel to the general direction of glacier flow. Drumlins are products of streamline (laminar) flow of glaciers, which molded the subglacial floor through a combination of erosion and deposition.

Duff

A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Dune

A low mound, ridge, bank, or hill of loose, windblown granular material (generally sand), either barren and capable of movement from place to place or covered and stabilized with vegetation but retaining its characteristic shape.

Earthy fill

See Mine spoil.

Ecological site

An area where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. An ecological site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other ecological sites in kind and/or proportion of species or in total production.

Eluviation

The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation

A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

Eolian deposit

Sand-, silt-, or clay-sized clastic material transported and deposited primarily by wind, commonly in the form of a dune or a sheet of sand or loess.

Ephemeral stream

A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation

A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion

The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (accelerated)

Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion (geologic)

Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion pavement

A surficial lag concentration or layer of gravel and other rock fragments that remains on the soil surface after sheet or rill erosion or wind has removed the finer soil particles and that tends to protect the underlying soil from further erosion.

Erosion surface

A land surface shaped by the action of erosion, especially by running water.

Escarpment

A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Most commonly applied to cliffs produced by differential erosion. Synonym: scarp.

Escarpment, bedrock (map symbol)

A relatively continuous and steep slope or cliff, produced by erosion or faulting, that breaks the general continuity of more gently sloping land surfaces. Exposed material is hard or soft bedrock.

Escarpment, nonbedrock (map symbol)

A relatively continuous and steep slope or cliff, generally produced by erosion but in some places produced by faulting, that breaks the continuity of more gently sloping land surfaces. Exposed earthy material is nonsoil or very shallow soil.

Esker

A long, narrow, sinuous, steep-sided ridge of stratified sand and gravel deposited as the bed of a stream flowing in an ice tunnel within or below the ice (subglacial) or between ice walls on top of the ice of a wasting glacier and left

behind as high ground when the ice melted. Eskers range in length from less than a kilometer to more than 160 kilometers and in height from 3 to 30 meters.

Extrusive rock

Igneous rock derived from deep-seated molten matter (magma) deposited and cooled on the earth's surface.

Fallow

Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fan remnant

A general term for landforms that are the remaining parts of older fan landforms, such as alluvial fans, that have been either dissected or partially buried.

Fertility, soil

The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat)

The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity

The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity*.

Fill slope

A sloping surface consisting of excavated soil material from a road cut. It commonly is on the downhill side of the road.

Fine textured soil

Sandy clay, silty clay, or clay.

Firebreak

An area cleared of flammable material to stop or help control creeping or running fires. It also serves as a line from which to work and to facilitate the movement of firefighters and equipment. Designated roads also serve as firebreaks.

First bottom

An obsolete, informal term loosely applied to the lowest flood-plain steps that are subject to regular flooding.

Flaggy soil material

Material that has, by volume, 15 to 35 percent flagstones. Very flaggy soil material has 35 to 60 percent flagstones, and extremely flaggy soil material has more than 60 percent flagstones.

Flagstone

A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain

The nearly level plain that borders a stream and is subject to flooding unless protected artificially.

Flood-plain landforms

A variety of constructional and erosional features produced by stream channel migration and flooding. Examples include backswamps, flood-plain splays, meanders, meander belts, meander scrolls, oxbow lakes, and natural levees.

Flood-plain splay

A fan-shaped deposit or other outspread deposit formed where an overloaded stream breaks through a levee (natural or artificial) and deposits its material (commonly coarse grained) on the flood plain.

Flood-plain step

An essentially flat, terrace-like alluvial surface within a valley that is frequently covered by floodwater from the present stream; any approximately horizontal surface still actively modified by fluvial scour and/or deposition. May occur individually or as a series of steps.

Fluvial

Of or pertaining to rivers or streams; produced by stream or river action.

Foothills

A region of steeply sloping hills that fringes a mountain range or high-plateau escarpment. The hills have relief of as much as 1,000 feet (300 meters).

Footslope

The concave surface at the base of a hillslope. A footslope is a transition zone between upslope sites of erosion and transport (shoulders and backslopes) and downslope sites of deposition (toeslopes).

Forb

Any herbaceous plant not a grass or a sedge.

Forest cover

All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type

A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragipan

A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Genesis, soil

The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai

Commonly, a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope. Typically, the microrelief of clayey soils that shrink and swell considerably with changes in moisture content.

Glaciofluvial deposits

Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur in the form of outwash plains, valley trains, deltas, kames, eskers, and kame terraces.

Glaciolacustrine deposits

Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are bedded or laminated.

Gleyed soil

Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping

Growing crops in strips that grade toward a protected waterway.

Grassed waterway

A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel

Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravel pit (map symbol)

An open excavation from which soil and underlying material have been removed and used, without crushing, as a source of sand or gravel.

Gravelly soil material

Material that has 15 to 35 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Gravelly spot (map symbol)

A spot where the surface layer has more than 35 percent, by volume, rock fragments that are mostly less than 3 inches in diameter in an area that has less than 15 percent rock fragments.

Green manure crop (agronomy)

A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water

Water filling all the unblocked pores of the material below the water table.

Gully (map symbol)

A small, steep-sided channel caused by erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage whereas a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock

Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hard to reclaim

Reclamation is difficult after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Hardpan

A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Head slope (geomorphology)

A geomorphic component of hills consisting of a laterally concave area of a hillside, especially at the head of a drainageway. The overland waterflow is converging.

Hemic soil material (mucky peat)

Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High-residue crops

Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established. These crops return large amounts of organic matter to the soil.

Hill

A generic term for an elevated area of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline. Slopes are generally more than 15 percent. The distinction between a hill and a mountain is arbitrary and may depend on local usage.

Hillslope

A generic term for the steeper part of a hill between its summit and the drainage line, valley flat, or depression floor at the base of a hill.

Horizon, soil

A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the “Soil Survey Manual.” The major horizons of mineral soil are as follows:

O horizon: An organic layer of fresh and decaying plant residue.

L horizon: A layer of organic and mineral limnic materials, including coprogenous earth (sedimentary peat), diatomaceous earth, and marl.

A horizon: The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon: The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon: The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon: The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon: Soft, consolidated bedrock beneath the soil.

R layer: Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

M layer: A root-limiting subsoil layer consisting of nearly continuous, horizontally oriented, human-manufactured materials.

W layer: A layer of water within or beneath the soil.

Humus

The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups

Refers to soils grouped according to their runoff potential. The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties include depth to a seasonal high water table, the infiltration rate, and depth to a layer that significantly restricts the downward movement of water. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

Igneous rock

Rock that was formed by cooling and solidification of magma and that has not been changed appreciably by weathering since its formation. Major varieties include plutonic and volcanic rock (e.g., andesite, basalt, and granite).

Illuviation

The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil

A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Increasers

Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration

The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity

The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate

The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate

The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Very low: Less than 0.2
Low: 0.2 to 0.4
Moderately low: 0.4 to 0.75
Moderate: 0.75 to 1.25
Moderately high: 1.25 to 1.75
High: 1.75 to 2.5
Very high: More than 2.5

Interfluve

A landform composed of the relatively undissected upland or ridge between two adjacent valleys containing streams flowing in the same general direction. An elevated area between two drainageways that sheds water to those drainageways.

Interfluve (geomorphology)

A geomorphic component of hills consisting of the uppermost, comparatively level or gently sloping area of a hill; shoulders of backwearing hillslopes can narrow the upland or can merge, resulting in a strongly convex shape.

Intermittent stream

A stream, or reach of a stream, that does not flow year-round but that is commonly dry for 3 or more months out of 12 and whose channel is generally below the local water table. It flows only during wet periods or when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Invaders

On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, plants invade following disturbance of the surface.

Iron depletions

See Redoximorphic features.

Irrigation

Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin: Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border: Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding: Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation: Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle): Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow: Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler: Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation: Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding: Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame

A low mound, knob, hummock, or short irregular ridge composed of stratified sand and gravel deposited by a subglacial stream as a fan or delta at the margin of a melting glacier; by a supraglacial stream in a low place or hole on the surface of the glacier; or as a ponded deposit on the surface or at the margin of stagnant ice.

Karst (topography)

A kind of topography that formed in limestone, gypsum, or other soluble rocks by dissolution and that is characterized by closed depressions, sinkholes, caves, and underground drainage.

Knoll

A small, low, rounded hill rising above adjacent landforms.

Ksat

See Saturated hydraulic conductivity.

Lacustrine deposit

Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Lake plain

A nearly level surface marking the floor of an extinct lake filled by well sorted, generally fine textured, stratified deposits, commonly containing varves.

Lake terrace

A narrow shelf, partly cut and partly built, produced along a lakeshore in front of a scarp line of low cliffs and later exposed when the water level falls.

Landfill (map symbol)

An area of accumulated waste products of human habitation, either above or below natural ground level.

Landslide

A general, encompassing term for most types of mass movement landforms and processes involving the downslope transport and outward deposition of soil and rock materials caused by gravitational forces; the movement may or may not involve saturated materials. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones

Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Lava flow (map symbol)

A solidified, commonly lobate body of rock formed through lateral, surface outpouring of molten lava from a vent or fissure.

Leaching

The removal of soluble material from soil or other material by percolating water.

Levee (map symbol)

An embankment that confines or controls water, especially one built along the banks of a river to prevent overflow onto lowlands.

Linear extensibility

Refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. Linear extensibility is used to determine the shrink-swell potential of soils. It is an expression of the volume change between the water content of the clod at $^{1}/_{3}$- or $^{1}/_{10}$-bar tension (33kPa or 10kPa tension) and oven dryness. Volume change is influenced by the amount and type of clay minerals in the soil. The volume change is the percent change for the whole soil. If it is expressed as a fraction, the resulting value is COLE, coefficient of linear extensibility.

Liquid limit

The moisture content at which the soil passes from a plastic to a liquid state.

Loam

Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess

Material transported and deposited by wind and consisting dominantly of silt-sized particles.

Low strength

The soil is not strong enough to support loads.

Low-residue crops

Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Marl

An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal proportions; formed primarily under freshwater lacustrine conditions but also formed in more saline environments.

Marsh or swamp (map symbol)

A water-saturated, very poorly drained area that is intermittently or permanently covered by water. Sedges, cattails, and rushes are the dominant vegetation in marshes, and trees or shrubs are the dominant vegetation in swamps. Not used in map units where the named soils are poorly drained or very poorly drained.

Mass movement

A generic term for the dislodgment and downslope transport of soil and rock material as a unit under direct gravitational stress.

Masses

See Redoximorphic features.

Meander belt

The zone within which migration of a meandering channel occurs; the flood-plain area included between two imaginary lines drawn tangential to the outer bends of active channel loops.

Meander scar

A crescent-shaped, concave or linear mark on the face of a bluff or valley wall, produced by the lateral erosion of a meandering stream that impinged upon and undercut the bluff.

Meander scroll

One of a series of long, parallel, close-fitting, crescent-shaped ridges and troughs formed along the inner bank of a stream meander as the channel migrated laterally down-valley and toward the outer bank.

Mechanical treatment

Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil

Very fine sandy loam, loam, silt loam, or silt.

Mesa

A broad, nearly flat topped and commonly isolated landmass bounded by steep slopes or precipitous cliffs and capped by layers of resistant, nearly horizontal rocky material. The summit width is characteristically greater than the height of the bounding escarpments.

Metamorphic rock

Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement at depth in the earth’s crust. Nearly all such rocks are crystalline.

Mine or quarry (map symbol)

An open excavation from which soil and underlying material have been removed and in which bedrock is exposed. Also denotes surface openings to underground mines.

Mine spoil

An accumulation of displaced earthy material, rock, or other waste material removed during mining or excavation. Also called earthy fill.

Mineral soil

Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage

Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area

A kind of map unit that has little or no natural soil and supports little or no vegetation.

Miscellaneous water (map symbol)

Small, constructed bodies of water that are used for industrial, sanitary, or mining applications and that contain water most of the year.

Moderately coarse textured soil

Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil

Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon

A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine

In terms of glacial geology, a mound, ridge, or other topographically distinct accumulation of unsorted, unstratified drift, predominantly till, deposited primarily by the direct action of glacial ice in a variety of landforms. Also, a general term for a landform composed mainly of till (except for kame moraines, which are composed mainly of stratified outwash) that has been deposited by a glacier. Some types of moraines are disintegration, end, ground, kame, lateral, recessional, and terminal.

Morphology, soil

The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil

Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Mountain

A generic term for an elevated area of the land surface, rising more than 1,000 feet (300 meters) above surrounding lowlands, commonly of restricted summit area (relative to a plateau) and generally having steep sides. A mountain can

occur as a single, isolated mass or in a group forming a chain or range. Mountains are formed primarily by tectonic activity and/or volcanic action but can also be formed by differential erosion.

Muck

Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mucky peat

See Hemic soil material.

Mudstone

A blocky or massive, fine grained sedimentary rock in which the proportions of clay and silt are approximately equal. Also, a general term for such material as clay, silt, claystone, siltstone, shale, and argillite and that should be used only when the amounts of clay and silt are not known or cannot be precisely identified.

Munsell notation

A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Natric horizon

A special kind of argillic horizon that contains enough exchangeable sodium to have an adverse effect on the physical condition of the subsoil.

Neutral soil

A soil having a pH value of 6.6 to 7.3. (See Reaction, soil.)

Nodules

See Redoximorphic features.

Nose slope (geomorphology)

A geomorphic component of hills consisting of the projecting end (laterally convex area) of a hillside. The overland waterflow is predominantly divergent. Nose slopes consist dominantly of colluvium and slope-wash sediments (for example, slope alluvium).

Nutrient, plant

Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter

Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low: Less than 0.5 percent
Low: 0.5 to 1.0 percent
Moderately low: 1.0 to 2.0 percent
Moderate: 2.0 to 4.0 percent
High: 4.0 to 8.0 percent
Very high: More than 8.0 percent

Outwash

Stratified and sorted sediments (chiefly sand and gravel) removed or “washed out” from a glacier by meltwater streams and deposited in front of or beyond the end moraine or the margin of a glacier. The coarser material is deposited nearer to the ice.

Outwash plain

An extensive lowland area of coarse textured glaciofluvial material. An outwash plain is commonly smooth; where pitted, it generally is low in relief.

Paleoterrace

An erosional remnant of a terrace that retains the surface form and alluvial deposits of its origin but was not emplaced by, and commonly does not grade to, a present-day stream or drainage network.

Pan

A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan*.

Parent material

The unconsolidated organic and mineral material in which soil forms.

Peat

Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped

An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment

A layer of sediment, eroded from the shoulder and backslope of an erosional slope, that lies on and is being (or was) transported across a gently sloping erosional surface at the foot of a receding hill or mountain slope.

Pedon

The smallest volume that can be called “a soil.” A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation

The movement of water through the soil.

Perennial water (map symbol)

Small, natural or constructed lakes, ponds, or pits that contain water most of the year.

Permafrost

Ground, soil, or rock that remains at or below 0 degrees C for at least 2 years. It is defined on the basis of temperature and is not necessarily frozen.

pH value

A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Phase, soil

A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and flooding.

Piping

Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Pitting

Pits caused by melting around ice. They form on the soil after plant cover is removed.

Plastic limit

The moisture content at which a soil changes from semisolid to plastic.

Plasticity index

The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plateau (geomorphology)

A comparatively flat area of great extent and elevation; specifically, an extensive land region that is considerably elevated (more than 100 meters) above the adjacent lower lying terrain, is commonly limited on at least one side by an abrupt descent, and has a flat or nearly level surface. A comparatively large part of a plateau surface is near summit level.

Playa

The generally dry and nearly level lake plain that occupies the lowest parts of closed depressions, such as those on intermontane basin floors. Temporary flooding occurs primarily in response to precipitation and runoff. Playa deposits are fine grained and may or may not have a high water table and saline conditions.

Plinthite

The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

Plowpan

A compacted layer formed in the soil directly below the plowed layer.

Ponding

Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded

Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Pore linings

See Redoximorphic features.

Potential native plant community

See Climax plant community.

Potential rooting depth (effective rooting depth)

Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning

Deliberately burning an area for specific management purposes, under the appropriate conditions of weather and soil moisture and at the proper time of day.

Productivity, soil

The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil

A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use

Grazing at an intensity that maintains enough cover to protect the soil and maintain or improve the quantity and quality of the desirable vegetation. This practice increases the vigor and reproduction capacity of the key plants and

promotes the accumulation of litter and mulch necessary to conserve soil and water.

Rangeland

Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Reaction, soil

A measure of acidity or alkalinity of a soil, expressed as pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Ultra acid: Less than 3.5
Extremely acid: 3.5 to 4.4
Very strongly acid: 4.5 to 5.0
Strongly acid: 5.1 to 5.5
Moderately acid: 5.6 to 6.0
Slightly acid: 6.1 to 6.5
Neutral: 6.6 to 7.3
Slightly alkaline: 7.4 to 7.8
Moderately alkaline: 7.9 to 8.4
Strongly alkaline: 8.5 to 9.0
Very strongly alkaline: 9.1 and higher

Red beds

Sedimentary strata that are mainly red and are made up largely of sandstone and shale.

Redoximorphic concentrations

See Redoximorphic features.

Redoximorphic depletions

See Redoximorphic features.

Redoximorphic features

Redoximorphic features are associated with wetness and result from alternating periods of reduction and oxidation of iron and manganese compounds in the soil. Reduction occurs during saturation with water, and oxidation occurs when the soil is not saturated. Characteristic color patterns are created by these processes. The reduced iron and manganese ions may be removed from a soil if vertical or lateral fluxes of water occur, in which case there is no iron or manganese precipitation in that soil. Wherever the iron and manganese are oxidized and precipitated, they form either soft masses or hard concretions or nodules. Movement of iron and manganese as a result of redoximorphic processes in a soil may result in redoximorphic features that are defined as follows:

1. Redoximorphic concentrations.—These are zones of apparent accumulation of iron-manganese oxides, including:
   A. Nodules and concretions, which are cemented bodies that can be removed from the soil intact. Concretions are distinguished from nodules on the basis of internal organization. A concretion typically has concentric layers that are visible to the naked eye. Nodules do not have visible organized internal structure; *and*
   B. Masses, which are noncemented concentrations of substances within the soil matrix; *and*
   C. Pore linings, i.e., zones of accumulation along pores that may be either coatings on pore surfaces or impregnations from the matrix adjacent to the pores.
2. Redoximorphic depletions.—These are zones of low chroma (chromas less than those in the matrix) where either iron-manganese oxides alone or both iron-manganese oxides and clay have been stripped out, including:
   A. Iron depletions, i.e., zones that contain low amounts of iron and manganese oxides but have a clay content similar to that of the adjacent matrix; *and*
   B. Clay depletions, i.e., zones that contain low amounts of iron, manganese, and clay (often referred to as silt coatings or skeletans).
3. Reduced matrix.—This is a soil matrix that has low chroma *in situ* but undergoes a change in hue or chroma within 30 minutes after the soil material has been exposed to air.

Reduced matrix

See Redoximorphic features.

Regolith

All unconsolidated earth materials above the solid bedrock. It includes material weathered in place from all kinds of bedrock and alluvial, glacial, eolian, lacustrine, and pyroclastic deposits.

Relief

The relative difference in elevation between the upland summits and the lowlands or valleys of a given region.

Residuum (residual soil material)

Unconsolidated, weathered or partly weathered mineral material that accumulated as bedrock disintegrated in place.

Rill

A very small, steep-sided channel resulting from erosion and cut in unconsolidated materials by concentrated but intermittent flow of water. A rill generally is not an obstacle to wheeled vehicles and is shallow enough to be smoothed over by ordinary tillage.

Riser

The vertical or steep side slope (e.g., escarpment) of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural, steplike landforms, such as successive stream terraces.

Road cut

A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments

Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rock outcrop (map symbol)

An exposure of bedrock at the surface of the earth. Not used where the named soils of the surrounding map unit are shallow over bedrock or where “Rock outcrop” is a named component of the map unit.

Root zone

The part of the soil that can be penetrated by plant roots.

Runoff

The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil

A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Saline spot (map symbol)

An area where the surface layer has an electrical conductivity of 8 mmhos/cm more than the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has an electrical conductivity of 2 mmhos/cm or less.

Sand

As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone

Sedimentary rock containing dominantly sand-sized particles.

Sandy spot (map symbol)

A spot where the surface layer is loamy fine sand or coarser in areas where the surface layer of the named soils in the surrounding map unit is very fine sandy loam or finer.

Sapric soil material (muck)

The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saturated hydraulic conductivity (Ksat)

The ease with which pores of a saturated soil transmit water. Formally, the proportionality coefficient that expresses the relationship of the rate of water movement to hydraulic gradient in Darcy's Law, a law that describes the rate of water movement through porous media. Commonly abbreviated as "Ksat." Terms describing saturated hydraulic conductivity are:

Very high: 100 or more micrometers per second (14.17 or more inches per hour)

High: 10 to 100 micrometers per second (1.417 to 14.17 inches per hour)

Moderately high: 1 to 10 micrometers per second (0.1417 inch to 1.417 inches per hour)

Moderately low: 0.1 to 1 micrometer per second (0.01417 to 0.1417 inch per hour)

Low: 0.01 to 0.1 micrometer per second (0.001417 to 0.01417 inch per hour)

Very low: Less than 0.01 micrometer per second (less than 0.001417 inch per hour).

To convert inches per hour to micrometers per second, multiply inches per hour by 7.0572. To convert micrometers per second to inches per hour, multiply micrometers per second by 0.1417.

Saturation

Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification

The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Sedimentary rock

A consolidated deposit of clastic particles, chemical precipitates, or organic remains accumulated at or near the surface of the earth under normal low temperature and pressure conditions. Sedimentary rocks include consolidated equivalents of alluvium, colluvium, drift, and eolian, lacustrine, and marine deposits. Examples are sandstone, siltstone, mudstone, claystone, shale, conglomerate, limestone, dolomite, and coal.

Sequum

A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil

A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Severely eroded spot (map symbol)

An area where, on the average, 75 percent or more of the original surface layer has been lost because of accelerated erosion. Not used in map units in which “severely eroded,” “very severely eroded,” or “gullied” is part of the map unit name.

Shale

Sedimentary rock that formed by the hardening of a deposit of clay, silty clay, or silty clay loam and that has a tendency to split into thin layers.

Sheet erosion

The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Short, steep slope (map symbol)

A narrow area of soil having slopes that are at least two slope classes steeper than the slope class of the surrounding map unit.

Shoulder

The convex, erosional surface near the top of a hillslope. A shoulder is a transition from summit to backslope.

Shrink-swell

The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Shrub-coppice dune

A small, streamlined dune that forms around brush and clump vegetation.

Side slope (geomorphology)

A geomorphic component of hills consisting of a laterally planar area of a hillside. The overland waterflow is predominantly parallel. Side slopes are dominantly colluvium and slope-wash sediments.

Silica

A combination of silicon and oxygen. The mineral form is called quartz.

Silica-sesquioxide ratio

The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt

As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone

An indurated silt having the texture and composition of shale but lacking its fine lamination or fissility; a massive mudstone in which silt predominates over clay.

Similar soils

Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole (map symbol)

A closed, circular or elliptical depression, commonly funnel shaped, characterized by subsurface drainage and formed either by dissolution of the surface of underlying bedrock (e.g., limestone, gypsum, or salt) or by collapse of underlying caves within bedrock. Complexes of sinkholes in carbonate-rock terrain are the main components of karst topography.

Site index

A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides (pedogenic)

Grooved, striated, and/or glossy (shiny) slip faces on structural peds, such as wedges; produced by shrink-swell processes, most commonly in soils that have a high content of expansive clays.

Slide or slip (map symbol)

A prominent landform scar or ridge caused by fairly recent mass movement or descent of earthy material resulting from failure of earth or rock under shear stress along one or several surfaces.

Slope

The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope alluvium

Sediment gradually transported down the slopes of mountains or hills primarily by nonchannel alluvial processes (i.e., slope-wash processes) and characterized by particle sorting. Lateral particle sorting is evident on long slopes. In a profile sequence, sediments may be distinguished by differences in size and/or specific gravity of rock fragments and may be separated by stone lines. Burnished peds and sorting of rounded or subrounded pebbles or cobbles distinguish these materials from unsorted colluvial deposits.

Slow refill

The slow filling of ponds, resulting from restricted water transmission in the soil.

Slow water movement

Restricted downward movement of water through the soil. See Saturated hydraulic conductivity.

Sodic (alkali) soil

A soil having so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Sodic spot (map symbol)

An area where the surface layer has a sodium adsorption ratio that is at least 10 more than that of the surface layer of the named soils in the surrounding map unit. The surface layer of the surrounding soils has a sodium adsorption ratio of 5 or less.

Sodicity

The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium adsorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to $Ca^{++} + Mg^{++}$. The degrees of sodicity and their respective ratios are:

Slight: Less than 13:1
Moderate: 13-30:1
Strong: More than 30:1

Sodium adsorption ratio (SAR)

A measure of the amount of sodium (Na) relative to calcium (Ca) and magnesium (Mg) in the water extract from saturated soil paste. It is the ratio of the Na concentration divided by the square root of one-half of the Ca + Mg concentration.

Soft bedrock

Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil

A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief and by the passage of time.

Soil separates

Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand: 2.0 to 1.0
Coarse sand: 1.0 to 0.5
Medium sand: 0.5 to 0.25
Fine sand: 0.25 to 0.10
Very fine sand: 0.10 to 0.05
Silt: 0.05 to 0.002
Clay: Less than 0.002

Solum

The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the material below the solum. The living roots and plant and animal activities are largely confined to the solum.

Spoil area (map symbol)

A pile of earthy materials, either smoothed or uneven, resulting from human activity.

Stone line

In a vertical cross section, a line formed by scattered fragments or a discrete layer of angular and subangular rock fragments (commonly a gravel- or cobble-sized lag concentration) that formerly was draped across a topographic surface and was later buried by additional sediments. A stone line generally caps material that was subject to weathering, soil formation, and erosion before burial. Many stone lines seem to be buried erosion pavements, originally formed by sheet and rill erosion across the land surface.

Stones

Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony

Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stony spot (map symbol)

A spot where 0.01 to 0.1 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surrounding soil has no surface stones.

Strath terrace

A type of stream terrace; formed as an erosional surface cut on bedrock and thinly mantled with stream deposits (alluvium).

Stream terrace

One of a series of platforms in a stream valley, flanking and more or less parallel to the stream channel, originally formed near the level of the stream; represents the remnants of an abandoned flood plain, stream bed, or valley floor produced during a former state of fluvial erosion or deposition.

Stripcropping

Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

Structure, soil

The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are:

Platy: Flat and laminated

Prismatic: Vertically elongated and having flat tops

Columnar: Vertically elongated and having rounded tops

Angular blocky: Having faces that intersect at sharp angles (planes)

Subangular blocky: Having subrounded and planar faces (no sharp angles)

Granular: Small structural units with curved or very irregular faces

Structureless soil horizons are defined as follows:

Single grained: Entirely noncoherent (each grain by itself), as in loose sand

Massive: Occurring as a coherent mass

Stubble mulch

Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind erosion and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil

Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling

Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum

The part of the soil below the solum.

Subsurface layer

Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow

The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Summit

The topographically highest position of a hillslope. It has a nearly level (planar or only slightly convex) surface.

Surface layer

The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the “plow layer,” or the “Ap horizon.”

Surface soil

The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Talus

Rock fragments of any size or shape (commonly coarse and angular) derived from and lying at the base of a cliff or very steep rock slope. The accumulated mass of such loose broken rock formed chiefly by falling, rolling, or sliding.

Taxadjuncts

Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior. Soils are recognized as taxadjuncts only when one or more of their characteristics are slightly outside the range defined for the family of the series for which the soils are named.

Terminal moraine

An end moraine that marks the farthest advance of a glacier. It typically has the form of a massive arcuate or concentric ridge, or complex of ridges, and is underlain by till and other types of drift.

Terrace (conservation)

An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field

generally is built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geomorphology)

A steplike surface, bordering a valley floor or shoreline, that represents the former position of a flood plain, lake, or seashore. The term is usually applied both to the relatively flat summit surface (tread) that was cut or built by stream or wave action and to the steeper descending slope (scarp or riser) that has graded to a lower base level of erosion.

Terracettes

Small, irregular steplike forms on steep hillslopes, especially in pasture, formed by creep or erosion of surficial materials that may be induced or enhanced by trampling of livestock, such as sheep or cattle.

Texture, soil

The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying “coarse,” “fine,” or “very fine.”

Thin layer

Otherwise suitable soil material that is too thin for the specified use.

Till

Dominantly unsorted and nonstratified drift, generally unconsolidated and deposited directly by a glacier without subsequent reworking by meltwater, and consisting of a heterogeneous mixture of clay, silt, sand, gravel, stones, and boulders; rock fragments of various lithologies are embedded within a finer matrix that can range from clay to sandy loam.

Till plain

An extensive area of level to gently undulating soils underlain predominantly by till and bounded at the distal end by subordinate recessional or end moraines.

Tilth, soil

The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toeslope

The gently inclined surface at the base of a hillslope. Toeslopes in profile are commonly gentle and linear and are constructional surfaces forming the lower part of a hillslope continuum that grades to valley or closed-depression floors.

Topsoil

The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements

Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Tread

The flat to gently sloping, topmost, laterally extensive slope of terraces, flood-plain steps, or other stepped landforms; commonly a recurring part of a series of natural steplike landforms, such as successive stream terraces.

Tuff

A generic term for any consolidated or cemented deposit that is 50 percent or more volcanic ash.

Upland

An informal, general term for the higher ground of a region, in contrast with a low-lying adjacent area, such as a valley or plain, or for land at a higher elevation than the flood plain or low stream terrace; land above the footslope zone of the hillslope continuum.

Valley fill

The unconsolidated sediment deposited by any agent (water, wind, ice, or mass wasting) so as to fill or partly fill a valley.

Variegation

Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve

A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Very stony spot (map symbol)

A spot where 0.1 to 3.0 percent of the soil surface is covered by rock fragments that are more than 10 inches in diameter in areas where the surface of the surrounding soil is covered by less than 0.01 percent stones.

Water bars

Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering

All physical disintegration, chemical decomposition, and biologically induced changes in rocks or other deposits at or near the earth's surface by atmospheric or biologic agents or by circulating surface waters but involving essentially no transport of the altered material.

Well graded

Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wet spot (map symbol)

A somewhat poorly drained to very poorly drained area that is at least two drainage classes wetter than the named soils in the surrounding map unit.

Wilting point (or permanent wilting point)

The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow

The uprooting and tipping over of trees by the wind.