



Draft - Final Environmental Assessment for the Fire Management Plan

Kenai National Wildlife Refuge

April 2013

The mission of the U.S. Fish and Wildlife Service is working with others to conserve, protect, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people.



The mission of the National Wildlife Refuge System is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans.

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for the
Fire Management Plan
Kenai National Wildlife Refuge**

April 30, 2013

**Prepared by
US Fish and Wildlife Service, Region 7**

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Abbreviations

ADF&G	Alaska Department of Fish and Game
AIWFMP	Alaska Interagency Wildland Fire Management Plan
ANILCA	Alaska National Interest Lands Conservation Act
CAA	Clean Air Act
CCP	comprehensive conservation plan
CEQ	Council on Environmental Quality
CFDRS	Canadian Forest Fire Danger Rating System
CFR	Code of Federal Regulations
COI	community of interest
CWPP	community wildfire protection plan
DAQ	Division of Air Quality
DOI	Department of the Interior
EA	environmental assessment
EPA	US Environmental Protection Agency
FMP	fire management plan
FMU	fire management unit
FONSI	finding of no significant impact
FWS	US Fish and Wildlife Service
GIS	Geographic Information System
KKAO	Kenai-Kodiak Area Office
MIST	Minimum Impact Suppression Techniques
MFRI	mean fire return interval
MRC	Moose Research Center
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NRCS	Natural Resource Conservation Service
NWCG	National Wildfire Coordinating Group
NWR	national wildlife refuge
PL	public law
PM	particulate matter
SD	standard deviation
SMP	smoke management plan
USC	United States Code
WFDSS	Wildland Fire Decision Support System
WUI	wildland urban interface

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Chapter 1. Purpose of and Need for Action

1.1 Introduction

The United States Fish and Wildlife Service (“Service”) is proposing to revise the Fire Management Plan (FMP) for the Kenai National Wildlife Refuge (NWR). This environmental assessment (EA) is being prepared to evaluate the effects associated with the proposed FMP. This EA complies with the *National Environmental Policy Act* (NEPA) in accordance with Council on Environmental Quality regulations (40 CFR 1500-1509) and Department of the Interior (DOI) (516 DM 8) and Service (550 FW 3) policies (see Section 1.10 below for additional regulatory compliance). NEPA requires examination of the effects of proposed actions on the natural and human environment. Chapter 2 of this EA presents two alternatives, and Chapter 3 describes potential environmental consequences of each alternative.

1.2 Comprehensive Conservation Plans

The Service refers to its overall land management plans as comprehensive conservation plans (CCPs). The purpose of a CCP is to guide the management, protection, and restoration of wildlife habitat and protection of significant values on Service lands. The long-range CCPs are evaluated after 15 years but may be updated earlier as better management information is developed or resource priorities change.

Each Service unit is responsible for land management planning, including setting land use goals and objectives, implementing appropriate actions to accomplish the objectives, achieving outcomes and results, and evaluating the outcomes and results against the intended objectives. The CCP identifies fire’s role in a particular area and for a specific benefit. The objectives in the CCP provide the basis for the development of fire management objectives and the fire management program in a designated area (USDI/USDA 2013).

The *Record of Decision for the Revised Comprehensive Conservation Plan and Environmental Impact Statement for Kenai National Wildlife Refuge, Alaska* (USFWS 2010a) was signed by the Service’s Regional Director on November 17, 2009. The Record of Decision and CCP are available at <http://alaska.fws.gov/nwr/planning/kenpol.htm>.

1.3 Fire Management Policy and Direction

DOI and Service policies require that every area with burnable vegetation must have an approved FMP (DOI Manual Part 620 DM 1.4 and Service Manual 516 FW 1) that describes actions to prepare for and respond to a wildfire (fire suppression); plans for and manages vegetation by management actions, including prescribed fire; and completes other fire management business. The FMP must meet agency policy and direction contained in the following documents:

- *National Fire Plan: A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Comprehensive Strategy* (USDI/USDA 2001a)

- *Managing Impacts of Wildfires on Communities and the Environment and Protecting People and Sustaining Resources in Fire Adapted Ecosystems – A Cohesive Strategy* (also known as the *National Fire Plan* (USDI/USDA 2001b))
- *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10 Year Comprehensive Strategy Implementation Plan* (an adjunct to the *National Fire Plan* 2001) (USDI/USDA 2006)
- *Guidance for Implementation of Federal Wildland Fire Policy* (USDI/USDA 2009)
- *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10 Year Comprehensive Strategy Implementation Plan* (USDI/USDA 2011)

Among other policies, the FMP must provide for firefighter and public safety while it adheres to the DOI policy stated in 620 Department Manual 1 by giving full consideration to the use of wildland fire as a natural process during the fire management planning process.

The goal of an FMP is to plan and implement actions to help accomplish the mission of the National Wildlife Refuge System, which is to administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (095 FW 3.2).

As described in Service Manual (621 FW 2.2), the Refuge FMP provides the planning framework for all Refuge fire management decision making and identifies the approved course of action relating to fire as described in other plans. The FMP identifies actions to preserve, protect, and enhance natural and cultural resources (with specific regard to wildland fire) and provides the background and guidelines for managing wildfires and prescribed fires.

1.4 Fire Management Plans

An FMP identifies and integrates all wildland fire management (both planned and unplanned ignitions) and associated activities within the context of an approved CCP — an FMP is considered a step-down plan of a CCP. The FMP is supplemented by operations plans, including but not limited to preparedness plans, preplanned dispatch plans, fuels treatment plans, and prevention plans (USDI/USDA 2013). FMPs serve to promote interagency communication, coordination, and cooperation, which are vital to the effective and efficient use of the nation’s wildland fire management resources (NWCG 2011) (see “Section 4.2. Fire Management Coordination” in Chapter 4 of this EA).

The FMP proposed for Kenai NWR will integrate all wildland fire management activities within the context of the Refuge’s CCP (<http://alaska.fws.gov/nwr/planning/kenpol.htm>) and will help achieve land and resource management goals and objectives identified in the CCP (USDI/USDA 2013).

To maintain currency, FMPs are reviewed annually, using the nationally established annual review process. Plans are revised when significant changes occur or substantial changes in management are proposed. Minor plan revisions may be accomplished through amendments added to the plan and signed by the line officer and servicing fire management officer. Major scheduled revisions to FMPs follow the

15-year CCP revision cycle to provide consistency in objectives and management strategy formulation. Without a current FMP, prescribed fires may not be conducted, and a response to unplanned ignitions may only consider suppression strategies. Preparedness and prevention activities can continue in the interim period as outlined in the 2001 FMP (USFWS 2010a).

The proposed FMP will replace the previous Kenai NWR FMP approved on September 28, 2001. The FMP will follow the outline of the April 2009 interagency format and will incorporate current policy and terminology relating to interagency and Service fire management programs.

1.5 Environmental Assessment for the FMP

This EA proposes the use of prescribed fire, naturally ignited fire, and mechanical treatments to achieve fire management goals and objectives on Kenai NWR. The proposed treatments are based on the Refuge's CCP and fire management planning efforts. This EA will serve as the umbrella compliance document under NEPA for fire and fuels management actions. The management actions proposed in the selected alternative (based on the analysis in this EA), and as approved in the EA's Finding of No Significant Impact, will become the updated Kenai NWR FMP.

The goal of this EA is to present an *ecosystem-based approach* for protecting natural resources at Kenai NWR. An *ecosystem-based approach* is an environmental management methodology that recognizes the full array of interactions, including humans, within an ecosystem rather than considering single issues, such as just humans, species, or ecosystem services in isolation.

1.6 Location

Kenai NWR is located on the Kenai Peninsula in southcentral Alaska (Figure 1-1). The Refuge is one of 16 refuges in Alaska that, collectively, make up the Service's Alaska Region (Region 7) of the National Wildlife Refuge System. The Kenai NWR encompasses approximately 1.98 million acres of diverse landscapes and habitats from the Harding Icefield and the 6,000-foot Kenai Mountains west; to the glacial moraines, pothole lakes, forests, and wetlands of the Kenai Lowlands; and south from the Turnagain Arm of Cook Inlet to Kachemak Bay. About two-thirds of the Refuge (1.3 million acres) is designated wilderness in three distinct units: the Dave Spencer Wilderness (187,279 acres); the Mystery Creek Wilderness (46,086 acres); and the Andrew Simons Wilderness (1,087,434 acres).

Lands adjacent to the Kenai NWR are managed or owned by the Chugach National Forest, Kenai Fjords National Park, state of Alaska, Kenai Peninsula Borough, Alaska Native corporations, and private individuals. Most of the eastern boundary of the Refuge borders Forest Service and National Park Service lands. The northern boundary of the Refuge lies along the southern shoreline of Turnagain Arm (Cook Inlet). The western boundaries are classified as wildland urban interface (WUI), where state of Alaska lands, Alaska Native corporation lands, private lands, and the communities of Nikiski, Kenai, Soldotna, Sterling, Funny River, Kasilof, Clam Gulch, Ninilchik, Nikolaevsk, and Anchor Point (from north to south) border or are near the Refuge. To the south, the Refuge is bordered by Kachemak Bay, state of Alaska lands, and Kenai Fjords National Park. "Figure 1-2. Kenai Peninsula land status" depicts the land ownership on the Refuge and Table 1-1 lists the land ownerships and number of acres.

Figure 1-1. Kenai NWR location

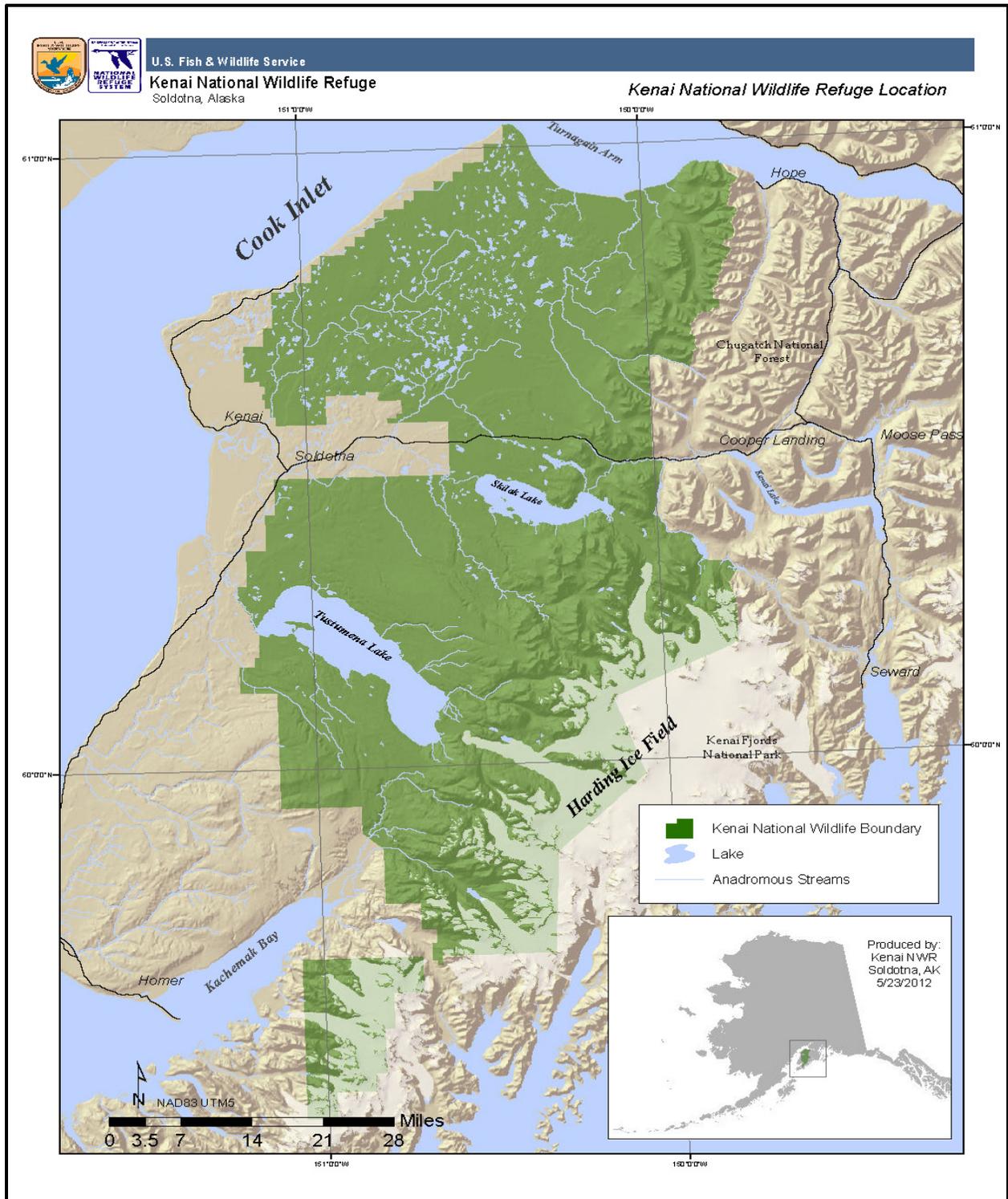


Figure 1-2. Kenai Peninsula land status

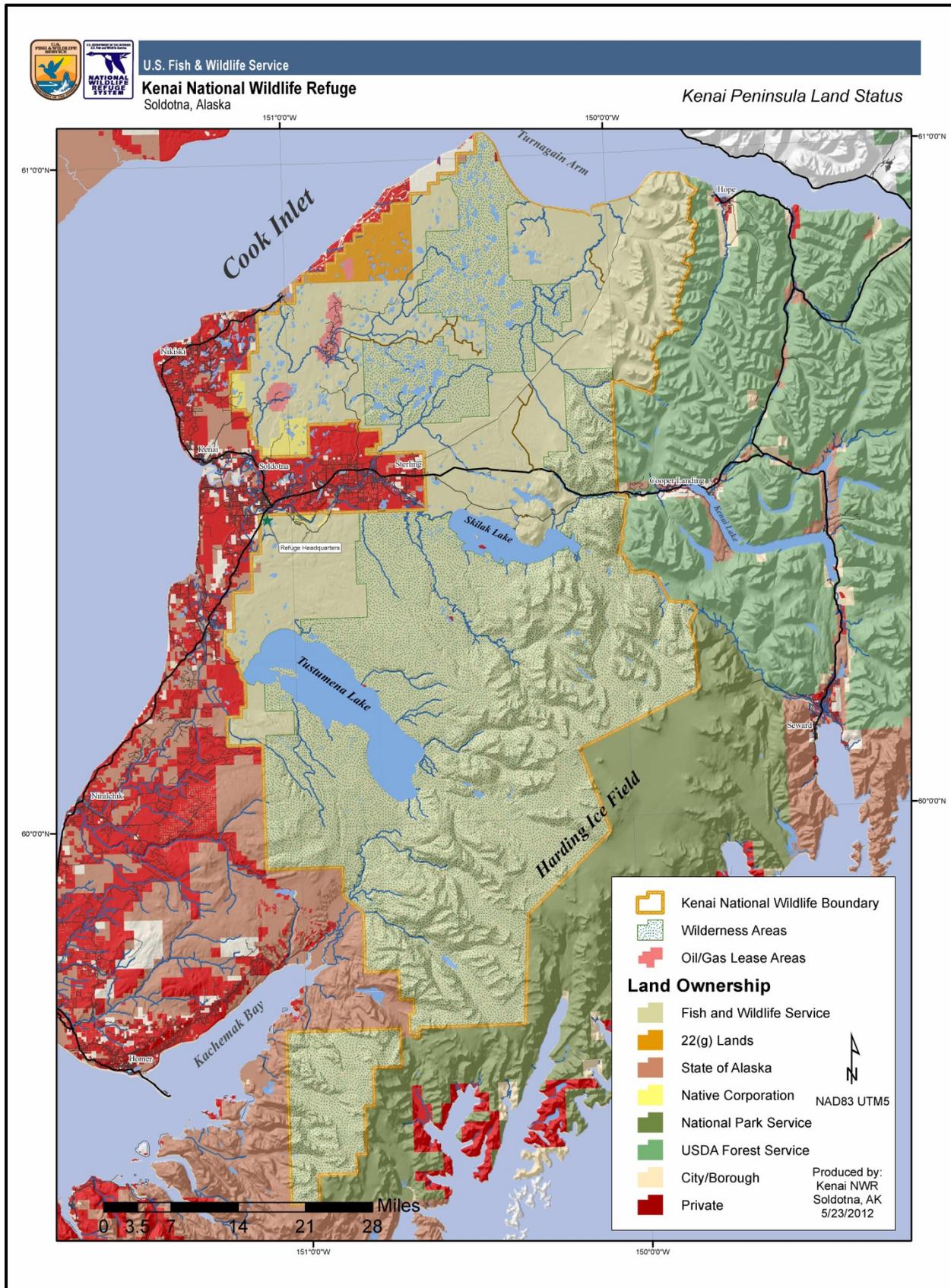


Table 1-1. Land ownership acres

Owner	Acres
US Fish and Wildlife Service	1,938,889
Wilderness	1,319,500
Non-wilderness	667,702
Private	525
State of Alaska	1,362
Alaska Native Corporation	46,041
Native Allotments	385

1.7 Purpose of Action

Service Manual (621 FW 2.2) requires that an FMP provides the planning framework for all Refuge fire management decision making and identifies the approved course of action relating to fire as described in other plans. An FMP identifies actions to preserve, protect, and enhance natural and cultural resources (with specific regard to wildland fire) and provides the background and guidelines for managing wildfires and prescribed fires. The purposes of the proposed FMP for Kenai NWR are to

1. protect life, property, human improvements, and cultural resources from the threat of wildland fire through prevention, education, mitigation, and restoration actions on and adjacent to the Kenai NWR; and
2. maintain the ecological integrity of the Kenai NWR by using prescribed fire (planned ignitions), wildfire, and mechanical treatment methods.

The fuel and fire management actions proposed in the alternatives (Chapter 2) are based on current fuels conditions on the Refuge, Service policy and direction, and the goals and objectives contained in the CCP for the Refuge. CCP objectives concerning fire will be discussed in detail in the FMP. The CCP is available for review at <http://alaska.fws.gov/nwr/planning/kenpol.htm>.

1.8 Need for Action

The following discussion summarizes the need for action (based on existing conditions) to demonstrate the link between those conditions and the purpose of fire management actions at the Refuge and on adjacent lands.

PURPOSE 1: Protect life, property, human improvements, and cultural resources from the threat of wildland fire through prevention, education, mitigation, and restoration actions on and adjacent to the Kenai NWR.

Need Based on Existing Conditions. The Service has a responsibility to provide for the prevention and management of unwanted wildfires that may adversely affect refuge infrastructure and neighboring public and private lands.

There is a need to prepare for potential wildfires. Preparation for potential wildfires includes measures such as maintaining access and egress routes; creating and maintaining fire breaks, fuel breaks, and defensible space; reducing the potential for unplanned fire occurrence; and ensuring that properly trained and equipped personnel are prepared to respond.

There is a need to protect Service assets and natural and cultural resources from wildfires ignited either on or off the Refuge and to protect Refuge neighbors from fires ignited on the Refuge. To facilitate this protection, the Refuge must proactively and strategically manage hazardous fuels on and adjacent to the Refuge in order to reduce the threat and the impacts of wildfires. Hazardous fuel reduction treatments should be implemented in the WUI and in other areas where hazardous fuel conditions exist.

A variety of methods, including prescribed fire and mechanical treatments, are needed to reduce unwanted hazardous fuels and thus minimize the spread and intensity of wildfire. Fuel treatments can include reducing or removing excessive ground and ladder fuels and increasing the distance between trees. Fuel treatments also help improve the management decision space and the opportunities for managing wildfires with multiple objectives (resource management as well as suppression).

There is a need to protect significant values at Kenai NWR. The estimated replacement cost of government-owned assets on Refuge lands is \$102,909,849. The assets include buildings (including furnishing and fixtures), fences, information kiosks, signs, pedestrian boardwalks and bridges, observation decks, parking areas, public use comfort stations, and utilities (gas and electric—piping, wiring, poles). This list is just a sampling of the type of Service assets that could be at risk from a wildfire.

There is a need to collaborate with other federal, state, local, and tribal governments on how to best manage fire on the landscape for the benefit of Peninsula residents, communities, and Refuge resources. This includes the development and maintenance of Community Wildfire Protection Plans (CWPPs), interagency wildfire prevention plans, incident management plans, and hazardous fuels mitigation plans.

PURPOSE 2: Maintain the ecological integrity of the Kenai NWR by using prescribed fire (planned ignitions), wildfire, and mechanical treatment methods.

Need Based on Existing Conditions. There is a need to maintain the presence of fire on Refuge lands. Fire has affected terrestrial ecosystems since ancient times. Historically, fire was the primary disturbance regime that affected vegetation composition and structure (Collins and Gibson 1990). Fire is considered a significant ecological factor, and ecosystems have become adapted to frequent fires (Odum 1971). Fire suppression has had an effect on vegetation that would have existed historically or ordinarily in the presence of fire. According to Odum (1971), “The failure to recognize that ecosystems may be fire adapted has resulted in a great deal of mismanagement of man’s natural resources.”

In some areas of the Refuge, especially WUI areas along the Refuge boundary, native habitats have been affected by the spread of nonnative invasive plant species. In other areas of the Refuge, especially WUI areas along the Refuge boundary, there has been a decrease in the historical scope and occurrence of fire on the landscape.

There is a need to allow natural (lightning-ignited) fires to burn on the landscapes of the Refuge, especially in wilderness areas, to maintain healthy fire-adapted ecosystems. Human-caused and lightning-ignited wildfires that have occurred in WUI and intermix areas of the Kenai Peninsula over the last 50 years have been vigorously suppressed. Since 2000 on the Refuge, five naturally ignited wilderness wildfires (Mystery Hills, Pipe Creek, King County Creek, Moose Lake, and Shanta Creek) have been wholly or partially suppressed to protect communities. These stand-replacement wildfires could have consumed thousands or tens of thousands of additional acres had the fires been allowed to burn.

One result of these past fire management practices is that forests in WUI areas and along the western boundaries of the Refuge are now at least moderately altered from a natural condition. Hazardous fuels, such as black spruce, beetle-killed white spruce and bluejoint reedgrass (*Calamagrostis canadensis*), have built up in some of these areas.

1.9 Decision to be Made

The Responsible Official (decision maker) for this action is the Kenai NWR Manager. The Refuge Manager will use the purpose of and need for the proposed fire management actions (described above in Sections 1.7 and 1.8), together with potential adverse and beneficial effects (see Chapter 3), as evaluation criteria to select the alternative that would best fulfill the purpose and respond to the need for action and that satisfactorily meets environmental guidelines. The Refuge Manager will decide whether there might be any significant adverse effects associated with the alternatives that would require the preparation of an environmental impact statement or whether the selected alternative would not result in significant adverse effects. The management actions contained in the selected alternative and as approved in the Finding of No Significant Impact will become the updated FMP for the Refuge.

1.10 Regulatory Compliance

The *National Wildlife Refuge System Improvement Act of 1997* provides guidelines and directives for the administration and management of all areas in the National Wildlife Refuge System. It states that national wildlife refuges must be protected from incompatible or harmful human activities to ensure that Americans can enjoy Refuge System lands and waters. Before activities or uses are allowed on a national wildlife refuge, the uses must be found to be compatible. A compatible use “will not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuges.”

This EA was prepared by the Service and represents compliance with applicable federal statutes, regulations, executive orders, and other compliance documents, including the following:

- Administrative Procedures Act (5 USC551-559, 701-706, and 801-808), as amended
- American Indian Religious Freedom Act of 1978 (42 USC1996)
- Antiquities Act of 1906 (16 USC431-433)
- Archaeological Resources Protection Act of 1979 (16 USC470)
- Bald Eagle Protection Act (16 USC 668-668d), as amended
- Clean Air Act of 1972, as amended (42 USC 7401 *et seq.*)
- Clean Water Act of 1972, as amended (33 USC 1251 *et seq.*)
- Endangered Species Act of 1973 (ESA), as amended (16 USC 1531 *et seq.*)
- Executive Order 12898, Federal Action Alternatives to Address Environmental Justice in Minority Populations and Low Income Populations, 1994.
- Executive Order 13112, Invasive Species (issued in February 1999)
- Fish and Wildlife Coordination Act of 1958 (16 USC 661 *et seq.*), as amended
- Fish and Wildlife Improvement Act of 1978 (16 USC 7421)
- Floodplain Management (Executive Order 11988)
- Migratory Bird Treaty Act (16 USC 703-712), as amended
- National Refuge System Administration Act of 1966 (16 USC 668dd-668ee), as amended
- National Environmental Policy Act (NEPA) of 1969 (42 USC 4321 *et seq.*), as amended
- Regulations for Implementing the Procedural Provisions of NEPA (40 CFR 1500 *et seq.*)
- National Historic Preservation Act of 1966 (16 USC 470 *et seq.*), as amended
- Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001 *et seq.*)
- Protection and Enhancement of the Cultural Environment (Executive Order 11593)
- Protection of Wetlands (Executive Order 11990)
- National Pollutant Discharge Elimination System(33 USC 1251 *et seq.*), as amended
- Soil and Water Conservation Act of 1977 (16 USC 2001-2009), as amended

Further, this EA reflects compliance with applicable state of Alaska and local regulations, statutes, policies, and standards for conserving the environment and environmental resources such as water and air quality, endangered plants and animals, and cultural resources.

1.11 Climate Change

The DOI issued an order in January 2001, requiring federal agencies under its direction, that have land management responsibilities, to consider potential climate change effects as part of long-range planning endeavors.

Climate change has begun to influence the severity, frequency, and magnitude of wildfires in many regions of the United States. Records of wildfire show increasing area burned in Canada (Stocks et al. 2002; Gillett et al. 2004; Kasischke and Turetsky 2006); Alaska (Kasischke and Turetsky 2006); and the western United States (Westerling et al. 2006) over the past few decades. In the western United States, the annual area burned by large forest wildfires greater than 990 acres during the period from 1987 to 2003 was more than six times than that during the period from 1970 to 1986 (Westerling et al. 2006). Wildfire behavior is modified by climate, forest management, and fire suppression (Allen et al. 2002; Noss et al. 2006), and understanding the reasons for changing wildfire behavior is further complicated by changes in fire reporting over the period of record. However, recent changes in climate were likely the main drivers for increases in area burned in both the western United States (Westerling et al. 2006) and Canada (Gillett et al. 2004; Kasischke and Turetsky 2006; Girardin 2007).

The fire management program at Kenai NWR follows Service guidance on climate change. Adaptive management will be increasingly more important to assess climate change effects on management activity outcomes. Due to climate change, fire management treatments must be designed to anticipate where the biota will be in the future with or without the treatments. There is no reasonable expectation that communities of species will remain intact with changes in their environment due to changes in climatic conditions. Historical conditions and treatments must be considered, but only after considering the future trajectory of species composition. Monitoring of fire management treatments and scientific investigation must be part of management to assess the need to adapt or maintain treatments that are currently being used. Fire management must be agile and adept to anticipate and respond to changes in conditions as changes in climate occur.

Scientific efforts are underway in Alaska to monitor climate change and its effects and to model/predict future impacts on biotic communities and physiographic features. Some of the more obvious and well-documented effects of climate change in southcentral Alaska include receding glaciers, drying wetlands, the upward movement of tree line, the spruce bark beetle epidemic, and expanding grasslands. Less obvious and/or less-documented effects include changes to fire regimes, lightning occurrence, and the spread of invasive species. One example of the climate research and monitoring, specific to the Refuge is included in “Appendix A: Executive Summary for the Kenai National Wildlife Refuge: Projected Vegetation and Fire Regime Response to Future Climate Change in Alaska, June 2009.”

The climate in boreal and arctic Alaska is changing (Hinzman et al. 2005). Mean annual air temperature in interior Alaska has increased by 1.3 degrees Celsius (°C) (34.3°Fahrenheit (F) in the last 50 years and is expected to increase another 3°C – 7°C (37.4°F – 44.6°F) by the end of the 21st century (Chapin et al. 2010). The snow-free period has increased, up to 10 days in some areas, largely due to earlier spring snowmelt (Hinzman et al. 2005; Euskirchen et al. 2006). These changes will have numerous effects on vegetation, hydrology, insect occurrence, and wildlife that could fundamentally change boreal forest and tundra ecosystems. Effects include

- melting permafrost;
- melting sea ice, which has implications for marine mammals and regional weather patterns (Hu et al. 2010);
- drying wetlands (Riordan et al. 2006);

- Changing fire regimes (Kasischke et al. 2011), including changes in the initiation and end of fire season;
- Shifts in distribution of plants and animals (Murphy et al. 2010; Beck et al. 2011);
- Increased likelihood for invasive plant establishment (Villano 2008); and
- Increased possibility of wildlife disease and insect outbreaks.

Research and modeling efforts provide insight on potential future conditions, but specific agency guidance on addressing these changes is limited. The Service has developed a strategic plan for responding to climate change that includes three broad approaches: adaptation, mitigation, and engagement (USFWS 2010b). The core of the Service’s response will be adaptation, defined as “planned, science-based management actions, including regulatory and policy changes, that we take to help reduce the impacts of climate change on fish, wildlife, and their habitats.”

Fire managers are faced with numerous challenges as they consider refuge and other legal mandates as well as safety obligations in the face of changing fire regimes. The primary goal for mitigation in the Service’s strategic plan is to sequester carbon and it is uncertain how sequestration objectives will be applied in Alaska, where numerous species depend on fire and where many naturally occurring, landscape-scale fires are allowed to burn if they do not threaten life or property.

In the absence of specific guidelines regarding fire management and climate change, fire management planning will continue to be based on guidance provided in refuge CCPs and associated step-down plans, the *Alaska National Interest Lands Conservation Act* (ANILCA), and evolving scientific data. Activities will be coordinated with Landscape Conservation Cooperatives and the regional Inventory and Monitoring Program when appropriate. Monitoring of fire effects and participation in research efforts will better inform management decisions in the face of climate change.

1.12 Permit and License Requirements

A prescribed fire plan will be developed and approved prior to implementation of each prescribed fire. The prescribed fires will be carried out in accordance with the requirements detailed in the final Kenai NWR FMP. Smoke generated by prescribed fires must be managed in compliance with the legal requirements of the *Clean Air Act* (42 USC 1857 *et seq.*) and local regulations and will be monitored by Service personnel.

The responsibility for the maintenance of air quality standards and the approval of agricultural type burning in the state rests with the Alaska Department of Environmental Conservation Division of Air Quality (DAQ). Guidelines imposed by the DAQ for smoke abatement on prescribed fires will be strictly followed. The DAQ has the responsibility for issuing permits, defining the conditions when burning will be permitted, and determining what materials may be burned. Permitting procedures require this office to be consulted each and every time prescribed fire is applied in the Refuge. Smoke registration for prescribed fires in a Smoke Management Program (SMP)-II category (greater than 99 acres) is required at a minimum of two weeks before burning, and registration for an SMP-I category (less than 99 acres) burn is required by 10:00 am the day prior to burning. Registration procedures are completed by accessing the

following website: http://dec.alaska.gov/air/OpenBurn/Burn_infor.htm. A Simple Approach Smoke Estimation Model or analysis may be conducted for all prescribed burns to occur in the Refuge. Given the proximity of the Refuge to rural communities, it must be assumed that all fires have the potential to adversely affect public interests and/or “critical targets.”

For additional information, refer to the following:

- Interagency Standards for Fire and Fire Aviation Operations (aka the “Red Book”) (USDA/USDI 2013) http://www.nifc.gov/policies/pol_ref_redbook_2013.html
- Smoke Management Guide for Prescribed and Wildland Fire (NWCG 2001) <http://www.nwcg.gov/pms/pubs/SMG/SMG-72.pdf>
- Alaska Enhanced Smoke Management Plan for Planned Fire Procedures Manual, June 3, 2009 (ADEC 2009) http://fire.ak.blm.gov/content/admin/awfcg_committees/Air%20Quality%20and%20Smoke%20Management/2_ESMP_Planned%20Fires%20Procedures%20062009.pdf

Chapter 2. Alternatives

2.1 Current Fire Treatment/Management Methods _____

The following types of treatment methods are currently used and would continue to be used to reduce hazardous fuels, regardless of the alternative chosen to become the new fire management plan (FMP) for Kenai National Wildlife Refuge (NWR). Implementation of any treatment is dependent on funding.

- **Prescribed fire** is a management tool used to manipulate vegetation. Prescribed fires may be loosely classified as broadcast, in which fire is applied across the landscape, or as debris burning as with pile or ditch burning.
- **Natural ignitions** are typically caused by lightning. Natural ignitions may be managed for resource benefit in wilderness and other areas where there is little to no threat of loss to structures or developed assets on and off public lands.
- **Mechanical treatments** are implemented using hand-held tools, chain saws, bulldozers, tractors, masticators, excavators, forestry cutters, chippers, and other specialty equipment. Mechanical treatments may also be used in conjunction with prescribed fire treatments as part of the overall treatment process to meet specific objectives and attain desired conditions.
- **Suppression** actions may include the construction of firelines by firefighters using hand tools, engines, heavy equipment (such as dozers), and aircraft (using water, retardant, and other water applicable chemicals to retard fire spread). Some suppression actions may be limited in wilderness areas, and in other areas suppression actions using heavy equipment or aircraft may be restricted based on the presence of cultural sites, riparian habitat, waterways, and critical habitat.

2.2 Fire Management Units _____

The National Wildfire Coordinating Group (NWCG 2013) defines a fire management unit (FMU) as a land management area definable by objectives, management constraints, topographic features, access, values to be protected, political boundaries, fuel types, and major fire regime groups that set it apart from the characteristics of an adjacent FMU. The FMU may have dominant management objectives and pre-selected strategies assigned to accomplish these objectives.

The Kenai NWR Comprehensive Conservation Plan (CCP) (USFWS 2010a) describes the Refuge's management categories. The CCP explains that a management category is used to define the level of human activity appropriate to a specific area of the Refuge. It is a set of Refuge management directions applied to an area in light of its resources and existing and potential uses to facilitate management and the accomplishment of Refuge purposes and goals. The four Refuge FMUs — wilderness, minimal, moderate, and intensive — correspond with the CCP's management category areas, with corresponding management direction and allowable human activities. The CCP has undergone thorough environmental

analysis and public input; thus the four FMUs, by association, have been publically vetted and approved. The four FMUs, which are the same for both alternatives proposed in this environmental assessment (EA), are described in detail in Appendix B.

There is another set of management directions that are applied to the FMUs (same for both alternatives) — the Alaska Interagency Wildland Fire Management Plan (AIWFMP) — which has been incorporated into the CCP, by reference. The AIWFMP is a statewide wildfire response plan. A summary of the AIWFMP is also included in Appendix B, along with a description of how the AIWFMP guidance is applied to each Refuge FMU.

The following guidance can be found in the CCP in the sections titled “Fire Management Program” and “Use of Fire as a Management Tool.” Management direction will allow prescribed fire, wildfire, and mechanical treatments as the principle tools to improve wildlife habitats, reduce hazardous accumulations of wildland fuels, and maintain or restore natural fire regimes.

- Prescribed fire will be allowed in the Intensive, Moderate, Minimal, and Wilderness management categories (approximately 1,938,000 acres or 97.5% of the Refuge), though its use in the Wilderness management category could only occur under specific conditions defined in national Wilderness and Fire Management policies.
- Use of wildland fire will be allowed in the Intensive, Moderate, Minimal, and Wilderness management categories (1,938,000 acres or 97.5% of the Refuge), but use will be the default management action in the Minimal and Wilderness management categories (approximately 1,883,500 acres or 95% of the Refuge).
- Undesirable wildfires (that is, those not contributing to Refuge management goals or threatening human health and safety) will be suppressed through the use of a pre-identified management response.

General management direction from the Refuge CCP, regardless of FMU, is that the management of wildland fire for the benefit of Refuge ecosystems should be the guiding principle while taking measures to protect human life, property, and/or areas of special concern. The CCP can be accessed at the following website: <http://alaska.fws.gov/nwr/planning/kenpol.htm>.

2.3 Proposed Alternatives

2.3.1 Alternative A: No-Action Alternative, Continue Current Level of Management

Current management direction would continue under the no-action alternative. The Refuge would manage fire on the landscape in accordance with the Refuge CCP and with the AIWFMP. The proposed FMP follows the outline of the April 2009 interagency FMP format (USDA/USDI 2009b) and incorporates current policy and terminology relating to interagency and Service fire management programs. As a step-down plan from the CCP, the FMP describes actions to prepare for and respond to unplanned wildfire ignitions, to plan and conduct hazard fuels mitigation projects and prescribed fires, and to complete other fire management business.

The Kenai NWR uses prescribed fire as a tool in two management areas: hazardous fuels reduction and habitat management. This EA does not propose using prescribed fire for habitat management but only for hazard fuel reduction in or near Refuge developments, sensitive resources, and WUI or intermix areas to reduce or mitigate the risk of wildfire.

The Refuge would continue to treat hazardous fuels such as black spruce, white spruce, beetle-killed spruce, flammable brush species such as rusty menziesia (*Menziesia ferruginea*) and Labrador Tea (*Ledum palustre*), and grasses such as Bluejoint Reedgrass (*Calamagrostis canadensis*), or any combination of these fuels.

2.3.1.1 Wilderness FMU

The Wilderness FMU comprises 1,320,550 acres or 66.4% of Kenai NWR's total 1.98 million acres. Neither broadcast burning nor mechanical treatments have occurred in this FMU. During the 10-year period from 2003 to 2012, there were eight large wildfires (greater than 100 acres): six naturally ignited (lightning) fires, one human-caused fire, and one fire of unknown origin that burned a total of about 50,000 acres in this FMU. Four of the naturally ignited fires were managed for resource benefits, but two were suppressed.

2.3.1.2 Minimal FMU

The Minimal FMU comprises 703,550 acres or 35.5% of Kenai NWR's total 1.98 million acres. The following actions and level of fire management treatments would continue:

- There has been no past broadcast burning in this FMU.
- The current number of acres treated mechanically each year ranges from 0 to 216 acres.
- The current number of acres in WUI areas treated mechanically each year ranges from 0 to 216 acres.

During the 10-year period from 2003 to 2012, there were two large wildfires (one naturally ignited and one human-caused) that burned approximately 16,490 acres. The naturally ignited fire was managed for resource benefits.

2.3.1.3 Moderate FMU

The Moderate FMU comprises 179,000 acres or 9% of Kenai NWR's total 1.98 million acres. The following actions and level of fire management treatments would continue:

- The current number of acres treated annually with broadcast burning in this FMU ranges from 0 to 1,100 acres, which equates to approximately 0% to 0.6% of the FMU acres.
- The current number of acres treated mechanically each year ranges from 0 to 184 acres.
- The current number of acres in WUI areas treated mechanically each year ranges from 0 to 184 acres.

During the 10-year period from 2003 to 2012, there were no large wildfires in this FMU.

2.3.1.4 Intensive FMU

The Intensive FMU comprises 54,000 acres or 2.7% of Kenai NWR's total 1.98 million acres. The following actions and level of fire management treatments would continue:

- There has been no past broadcast burning in this FMU.
- The current number of acres treated mechanically each year ranges from 0 to 214 acres.
- The current number of acres in WUI areas treated mechanically each year ranges from 0 to 214 acres.

During the 10-year period from 2003 to 2012, there were no large wildfires in this FMU.

2.3.2 Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation

Alternative B is essentially identical to Alternative A (no action) in every fire management program element (including the FMUs and fire management options), except hazardous fuels and wildfire mitigation. Wildfire mitigation includes measures to decrease the likelihood of property damage and injury due to human caused or naturally ignited fires and involves efforts such as the reduction or removal of hazardous fuels, wildfire preparedness, fire prevention, and FIREWISE activities.

Alternative B proposes to treat more acres (as funding is available) because it includes fuel reduction activities in Community Wildfire Protection Plan (CWPP) and community of interest (COI) areas (see section 2.4.1.4 below). The program elements described for Alternative A that would be the same for Alternative B are not repeated here. Instead, the descriptions presented in the following sections deal exclusively with hazardous fuels and wildfire mitigation.

While the CWPP and COI areas are included in both alternatives, Alternative A would not implement a collaborative strategic program of hazardous fuels and wildfire mitigation for those areas. Conversely, Alternative B is a proposal to collectively or holistically analyze wildfire and fuels hazards and risks and develop a program of strategic mitigation for the Refuge FMP.

2.3.2.1 Vision of the Wildland Fire Management Program

The Service's vision for wildland fire management on the Kenai NWR is to design and implement a program of work in alignment with the mission of the Service and the National Wildlife Refuge System, and in concert with the establishing purposes of the Refuge and its wilderness that promotes the following:

- Naturally ignited fire is accepted and valued as an ecosystem process and healthy fire adapted ecosystems are maintained;
- Wildfires are managed both to protect human life, private property and other values at risk, and to accomplish identified resource management objectives; and

- Communities of the Kenai Peninsula are resistant to wildfire damage, and biologically diverse landscapes of the Refuge are resilient to the effects of fire.

To realize this vision, the Refuge Fire Management Program must work cooperatively and collaboratively with Refuge Managers, other Refuge Staff, the Regional Fire Management Branch, Refuge cooperators and partners, and with the public. The Service must help its neighbors—the residents of the Kenai Peninsula—adopt FireWise practices and promote FireWise Communities. The Service needs to use the best available science to analyze landscapes, identify hazards and assess risks, and develop a strategic hazardous fuels treatment plan for the Refuge, especially where WUI and intermix areas adjoin Refuge lands. The Service also needs to explore new ways to reach area residents and Refuge visitors with fire safety and fire prevention information, thereby reducing the number of abandoned, unattended, and escaped campfires.

2.3.2.2 Coordination, Outreach, and Education

As recognized in current wildland fire policy, effective fire management requires close coordination between local communities and other government agencies, particularly those communities that experience high wildland fire risk in the WUI, and partner agencies that share fire prevention concerns for those communities. As the management of private lands has become an increasingly important factor in the fire risk equation, the Service has recognized the importance of providing outreach, education, and support to local communities to reduce wildland fire hazards in and near those communities. The State of Alaska Department of Natural Resources, Division of Forestry Kenai-Kodiak Area Office (KKAO) provides fire protection and suppression services to the local communities and surrounding wildlands of the Kenai Peninsula and the Kodiak archipelago. KKAO partners with the Kenai NWR fire management program for numerous activities, including the following:

- Preparedness and suppression
- Fire prevention, outreach, and education programs
- Wildfire risk mitigation, including hazardous fuels management

2.3.2.3 Purpose of Community Wildfire Protection Plans

The *Healthy Forests Restoration Act of 2003* (Public Law [PL] 108-148) encourages the development of CWPPs, and communities (or counties) may at their option develop a plan. A CWPP enables local communities to improve their wildfire mitigation capacity and work with government agencies to identify high fire risk areas and prioritize areas for mitigation, fire suppression, and emergency preparedness. The minimum requirements for CWPPs are as follows (SAF 2004):

1. **Collaboration:** Local and state government representatives, in consultation with federal agencies or other interested groups, must collaboratively develop a CWPP.
2. **Prioritized Fuel Reduction:** A CWPP must identify and prioritize areas for hazardous fuels reduction and treatments. Furthermore, the plan must recommend the types and methods of treatment that will protect at-risk communities and their essential infrastructures.

3. **Treatments of Structural Ignitability:** A CWPP must recommend measures that communities and homeowners can take to reduce the ignitability of structures throughout the area addressed by the plan.

At the local level, successful implementation of fuel treatments must include community decision makers collaborating with federal, state, and local governments; Alaska Native Corporations; community-based groups; landowners; and other interested persons. Collaboration is used to establish priorities, cooperate on activities, and increase public awareness and participation to reduce the risks to communities and surrounding lands. While land management agencies make the decisions on matters affecting public lands, these collaborative efforts will produce programs that can be supported broadly and implemented successfully.

In the CWPP areas, these plans provide a seamless guide for fuel reduction across ownerships, identifying those treatments to be completed by public agencies and those to be completed by private landowners. The CWPP is composed of both WUI and intermix communities and is defined as areas where human habitation and development meet or intermix with wildland fuels (USDA/USDI 2001b:752–753). Human encroachment upon wildland ecosystems within recent decades is increasing the extent of the WUI and is therefore having a significant influence on wildland fire management practices.

Within the Kenai Peninsula Borough, the nine CWPP areas (see Figure 2-3) listed below are adjacent to the Kenai NWR, have been identified as being at high risk from wildland fires originating on or adjacent to federal lands, and have developed CWPPs. The maps for the individual CWPP areas are presented in the following appendices:

- Appendix C: Cooper Landing
- Appendix D: Diamond Ridge / Fritz Creek / Fox River
- Appendix E: Funny River
- Appendix F: Kalifornsky / Kasilof / Coho / Clam Gulch
- Appendix G: Kenai
- Appendix H: Nikiski / Salamatof / Grey Cliffs
- Appendix I: Ninilchik / Ninilchik Forties
- Appendix J: Soldotna / Ridgeway
- Appendix K: Sterling

In addition to the nine CWPP areas, there are three COIs within the boundaries of the Refuge.

- Appendix L: Swanson River Oil Field
- Appendix M: Beaver Creek Oil Field
- Appendix N: Moose Research Center

These three COIs include year-round residents, structures, equipment, infrastructure, and other valuable assets identified as being at high risk from wildfires originating on or off the Refuge.

Figure 2-3. Kenai Peninsula CWPP areas



The CWPPs are collaborative, living documents that are reviewed and updated on a regular basis by an interagency committee (the Kenai Peninsula Borough's All Lands All Hands Committee), in consultation with members of the respective communities. The All Lands All Hands Committee, also known as the Kenai Forest, Wildland Fire and Fuels Management Coordinating Committee, was established by an interagency Memorandum of Understanding in 2004 and again in 2010. The committee prepared the original five-year All Lands All Hands Action Plan in 2004 and revised it in 2011. Committee members participated in the completion of 20 CWPPs for the Borough, including the nine listed above. The committee meets at least twice each year to collaborate and plan management activities.

The CWPPs provide a wealth of information to Refuge land and fire managers and their cooperators, including wildfire hazard and risk information, location of assets/values to be protected and planned mitigation activities.

Using the CWPPs and spatial modeling tools, Refuge fire managers propose to develop spatially strategic hazardous fuels and wildfire mitigation projects and treatments that will help the Refuge and its adjacent communities accomplish their mutual goals and objectives.

2.3.2.4 Summaries of the CWPPs

Cooper Landing CWPP

The Cooper Landing CWPP area is adjacent to the eastern boundary of the Refuge within the Kenai River Valley. Although about 43 acres of the CWPP area lies inside the Refuge, the Refuge acres are within designated Wilderness areas: Mystery Creek Wilderness north of the Sterling Highway and Andrew Simons Wilderness south of the Kenai River. At this time, the Refuge is not proposing hazardous fuels treatments in the Cooper Landing CWPP area because the area is designated wilderness.

Diamond Ridge / Fritz Creek / Fox River CWPP

The Diamond Ridge / Fritz Creek / Fox River CWPP area is adjacent to the southern boundary of the Refuge, north and west of Kachemak Bay. About 203 acres of the Refuge lie in this CWPP Area. However, these Refuge acres are within the Andrew Simons Wilderness Area, and there is no known fire history at that location due to the elevation and local climate. The Refuge has no plans for hazardous fuels treatments in this area.

Funny River CWPP

The Funny River CWPP area contains almost 28,000 acres of the Refuge, south of the Kenai River and from the west end of Skilak Lake to the Refuge Headquarters, just south of Soldotna. The community of Funny River and its interagency cooperators have been very active in the implementation of the Funny River CWPP (see Table 2-1 for the CWPP project lists). This community activism is due in part to the active fire history of the area, which includes, most recently, the 2009 Shanta Creek Fire (13,000+ acres) and the 2005 King County Creek Fire (10,000+ acres). Both of these fires were ignited by lightning in or near the Andrew Simons Wilderness Area, and both had the potential to threaten Funny River residents. The northern boundary of the Andrew Simons Wilderness abuts the private lands of the Funny River community between the Killey and Funny rivers. Lands in the community and its surroundings are dominated by large continuous stands of black spruce. This hazardous fuel type covers about one-third (9,325) of the Refuge acres in the CWPP area. While the Refuge has actively treated hazardous fuels along much of its boundary in this CWPP area (Funny River Road fuelbreak and Slikok treatments, and contingency fire lines established during the Shanta Creek Fire), the risk of wildfire damage to communities remains high.

Table 2-1. KPB Spruce Bark Beetle Mitigation Program: Project Status of CWPPs Areas of Concern

CWPP Area	Project Name	Fuel Treatment	WUI Acres	Ownership	Treatment Type	Estimated Cost Assuming No Value Of Wood Material	Treatment Status
COMPLETED PROJECTS							
Kasilof	North Cohoe Loop Beach Access Road	Removal of SBB ¹ trees and treatment of slash to eliminate fuel continuity around community and public recreation area	~45 acres	Alaska DNR/Private	Hand felling: Could be contract bid or assigned to DOF/Chugachmiut hazard crew. Slash to be treated.		Completed 1/2012
Kenai	Float Plane Road	Removal of SBB trees and treatment of slash to eliminate fuel continuity around community and Kenai Airport	~80 Acres	City of Kenai/Private	Contract Bid: Hand or Mechanical Treatment		Completed 2009
Nikiski	KPB Nikiski Poolside parcels	Removal of SBB trees and treatment of slash to eliminate fuel continuity around community and public recreation area	~95 Acres	KPB	Timber Sale: Mechanical Treatment		Completed 2010: 93 acres
Moose Pass	Trail Lakes Fish Hatchery	Removal of SBB trees and treatment of slash to eliminate fuel continuity around infrastructure and enhance safety zone area	~15 Acres	Alaska DNR	Contract Bid: Hand or Mechanical Treatment		Completed 2009
Funny River	Funny River Road	Removal of SBB trees and treatment of slash to eliminate fuel continuity around or into community	8 miles	Public and Private	Contract Bid: Hand or Mechanical Treatment		Completed 2009
Soldotna	Kenai River & Campgrounds	Removal of SBB trees and treatment of slash to eliminate fuel continuity around community and public recreation area	45 acres	Public and Private	Hand felling:assigned to DOF hazard crew. Slash to be treated.		Completed KPB DOF 2010
Soldotna	Sport Lake Public Access Area	Removal of SBB trees and treatment of slash to eliminate fuel continuity around community and public recreation area	1 acre	Public and Private	Hand felling:assigned to DOF hazard crew. Slash to be treated.		Completed City of Soldotna
Soldotna	Main Road Buffers	Hazard Trees along road corridors	5 miles	Public and Private	Contract Bid: Hand or Mechanical Treatment		Completed 2010/11
Ninilchik	Continued SBB ROW Work	Continued effort to get landowners to allow SBB projects to remove hazard trees		Mixed	Contract Bid: Hand or Mechanical Treatment		Continued through 2011
Clam Gulch	Clam Gulch State Parks Parcel	Removal of SBB trees and treatment of slash to eliminate fuel continuity around community and public recreation area	~150 Acres	Alaska DNR	Contract Bid: Mechanical Treatment		Completed 2010/2011: 119 acres
COMPLETED PROJECTS (CONTINUED)							
Homer	Baycrest Ski Trail	Create 100 foot fuel break along 20 miles of trails by removing hazard trees and treating slash	~250 Acres	Mixed: KPB, City of Homer, Private	Timber Sale on KPB: Could be contract bid or assigned to DOF/Chugachmiut hazard crew. Slash to be treated.		Completed 2010/2011: 80 acres
Homer	Paul Banks School	Remove ~110 slash piles from previous project crew work	~20 Acres	KPB	Contract bid to remove using 4 wheeler/trailer in frozen conditions		Completed 2009

Table 2-1. KPB spruce bark beetle mitigation program: Project status of CWPPs areas of concern, 1/12/2012 (continued)

CWPP Area	Project Name	Fuel Treatment	WUI Acres	Ownership	Treatment Type	Estimated Cost Assuming No Value Of Wood Material	Treatment Status
Homer	Bridge Creek Reservoir	Reduce fuels surrounding City of Homer water reservoir	210 Acres	City of Homer/KPB	Contract Bid: Mechanical and Hand Treatment		Completed 2011: 80 acres
Homer	Diamond Creek State Park Lands	Removal of SBB trees and treatment of slash to eliminate fuel continuity around community and public recreation area	~90 Acres	Alaska DNR	Hand felling: Could be contract bid or assigned to DOF/Chugachmiut hazard crew. Slash to be treated.		Completed 8/2012: 105 acres
Ninilchik	Garrison Ridge F&G Parcel	Removal of SBB trees and treatment of slash to eliminate fuel continuity around or into community	~20 acres	Alaska DNR	Contract Bid: Hand or Mechanical Treatment		Completed spring 2012: 20 acres
City of Kenai	KPB Slash Disposal Sites	Provide/Maintain public slash disposal sites to promote Defensible Space Projects	4 sites borough wide: Kenai, Funny River, Kasilof, Hope		Contract Bids	\$40,000.00/per year	Completed 8/2013
ONGOING PROJECTS							
Kenai	Beach Gullies	Removal of SBB trees and treatment of slash to eliminate fuel in gulches leading into the community from the beaches from the Senior Center to Forest	~40 Acres	City of Kenai/Private	Hand felling: Could be contract bid or assigned to DOF/Chugachmiut hazard crew. Slash to be treated.		Ongoing
Soldotna	Tsalshe Trails						DOF 2010 & 2011: Ongoing
UNCOMPLETED PROJECTS							
Clam Gulch	Marathon Gas Pad	Removal of SBB trees and treatment of slash to reduce chance of ignition and protect community and infrastructure	~10 Acres	Private	Contract Bid: Mechanical Treatment	\$10,000.00	
Funny River	Utility Corridors	Removal of SBB trees and treatment of slash to remove hazards to community electrical service		Private	Contract Bid: Mechanical Treatment	\$25,000.00	
Nikiski	Captain Cook State Park	Removal of SBB trees and treatment of slash to eliminate fuel continuity around public recreation area	100 acres, 6 miles of ROW work		Contract Bid: Mechanical Treatment	\$45,000.00	
Total Estimated Cost of Unfinished Projects						\$80,000.00	

Note:

1. SBB = spruce bark beetle

The Refuge is collaborating with the Alaska Division of Forestry and the Kenai Peninsula Borough to assess the hazards and reduce the risk of unwanted wildfires in this area. Using the best available fire behavior modeling tools, the Refuge and its cooperators will strategically select and treat black spruce stands and other hazardous fuels in the CWPP area on both sides of the Refuge boundary. Any hazardous fuels mitigation treatments proposed for the wilderness portion of the CWPP area must undergo a Minimum Requirements Analysis and must meet the provisions of the *Wilderness Act of 1964*.

Two new wildfire mitigation treatments that are being implemented by Refuge cooperators in 2013 include (1) an Alaska Division of Forestry project (funded by Service WUI grant) to construct a 60- to 80-acre fuelbreak on private lands along the Refuge boundary west from the Funny River; and (2) a Natural Resource Conservation Service (NRCS) funded project to develop a fire break on private lands just east of the Funny River.

Kalifornsky / Kasilof / Cohoe / Clam Gulch CWPP

The Kalifornsky / Kasilof / Cohoe / Clam Gulch CWPP area encompasses about 18,874 acres along the western boundary of the Refuge. This CWPP Area borders the western shoreline of Tustumena Lake and includes the Kasilof River Valley and the four communities for which it is named. About two-thirds of the Refuge acres in this CWPP (12,646) are covered by hazardous fuel types including black spruce, white spruce, beetle-killed white spruce, and mixed spruce/hardwood forests. The Refuge is collaborating with the Alaska Division of Forestry and the Kenai Peninsula Borough to assess the hazards and reduce the risk of unwanted wildfires in this area. Using the best available fire behavior modeling tools, the Refuge and its cooperators will strategically select and treat black spruce stands and other hazardous fuels in the CWPP area on both sides of the Refuge boundary.

Kenai CWPP

The Refuge is immediately adjacent to the northeast corner of the Kenai CWPP area. That area of the Refuge is dominated by wetlands (muskegs/bogs), and while there are isolated stringers of black spruce in the area, the Refuge is proposing no hazardous fuels treatments at this time.

Nikiski / Salamatof / Grey Cliffs CWPP

The Nikiski / Salamatof / Grey Cliffs CWPP area lies to the north of Kenai, between the Refuge and Cook Inlet, and includes about 23, 649 acres of the Refuge. North of the community of Nikiski and the end of the Spur Highway at Captain Cook State Park, this CWPP area is roadless and accessible only by all-terrain vehicle, snowmobile, or boat. There are dozens of remote cabins and home sites along the Refuge boundary in this area. While hazardous fuels mitigation work is ongoing in and around Nikiski and Salamatof and within Captain Cook State Park, the Refuge has not yet addressed fuels hazards in this area due to its inaccessibility. The unincorporated community of Grey Cliffs has been identified as a community-at-risk (extreme) on the Alaska State list. A wildfire in that area of the Refuge would likely threaten numerous homes in the Grey Cliffs community and would be extremely difficult to suppress due to the lack of access. There are about 7,800 acres of treatable hazardous fuels within the Refuge portion of this CWPP area.

Ninilchik / Ninilchik Forties CWPP

The Ninilchik / Ninilchik Forties CWPP area lies along the western border of the Refuge south of Tustumena Lake and includes about 415 acres of the Refuge. While there are hundreds of remote recreational cabins, residences, and outbuildings in the Ninilchik Forties community, immediately adjacent to the Refuge boundary, Refuge lands in this CWPP area are within the Andrew Simons

Wilderness. The area has an active fire history, which includes the 1995 Crooked Creek Fire (17,000+ acres); the 2005 Fox Creek Fire (26,000+ acres); and the 2007 Caribou Hills Fire (63,000+ acres). The effects of those fires (consumption of hazardous fuels), when coupled with the protection of wilderness values, has led the Refuge to decide not to develop plans for hazardous fuels mitigation on its lands in this CWPP area.

Soldotna / Ridgeway CWPP

The Soldotna / Ridgeway CWPP area is surrounded by the Sterling, Funny River, Kalifornsky, and Kenai CWPP areas to the east, south, and west and by the Refuge to the north. It encompasses about 4,816 acres of the Refuge, of which about 25% or 1,204 acres are treatable hazardous fuel types. The Refuge is collaborating with the Alaska Division of Forestry, the Kenai Peninsula Borough, and the Alaska Department of Fish & Game (ADF&G) to assess hazards and reduce the risk of unwanted wildfires in this area. Using the best available fire behavior modeling tools, the Refuge and its cooperators will strategically select and treat black spruce stands and other hazardous fuels in the CWPP area on both sides of the Refuge boundary.

Sterling CWPP

The Sterling CWPP area borders the Soldotna / Ridgeway CWPP area to the east and the Funny River CWPP area to the north, and it includes the Sterling Highway access/egress corridor from the community of Sterling east to the Cooper Landing CWPP area. The Sterling CWPP area is bordered to the north and south by the Refuge and includes about 36,691 acres of Refuge lands. About one-half of the Refuge acres in the CWPP area (18,346 acres) are treatable hazardous fuel types (black spruce, white spruce, white spruce beetle-kill, and mixed spruce/hardwood forest). The Refuge has actively implemented hazardous fuels mitigation treatments (Lily Lake and Skilak Loop) in this CWPP area in the past and proposes to continue these activities and others over the next planning period.

Swanson River Oil Field COI

The Swanson River Oil Field COI area lies completely within the boundaries of the Kenai NWR to the north of Sterling and encompasses about 7,887 acres of the Refuge, one-half of which (3,943 acres) are covered by treatable hazardous fuel types. This oil field includes the first producing oil well in Alaska's history (the Discovery Well) and more than 50 other wells with hundreds of buildings, storage tanks, pipelines, roads, telecommunication towers, power lines, other infrastructure, equipment, and full-time year-round occupancy by more than 100 workers and managers (currently). The only road access/egress is via the Swanson River Road south to the Sterling Highway. Hazardous fuels (including large dense stands of black spruce, white spruce, beetle-killed white spruce, and mixed spruce/hardwood forests) surround this producing oil and gas field. The Refuge is proposing to strategically select and implement hazardous fuels mitigation treatments in and around the oil field and along the Swanson River Road to protect lives and valuable infrastructure.

Beaver Creek Oil Field COI

The Beaver Creek Oil Field COI area lies completely within the boundaries of the Refuge, just north of the communities of Kenai and Soldotna. It encompasses about 4,098 acres of the Refuge, one-quarter of which (1,024 acres) are covered by treatable hazardous fuel types. While it is a much smaller development than the Swanson River Oil Field, it also contains several wells, buildings, tanks, pipelines, power lines, and other infrastructure with equipment and full-time year-round occupancy by workers and managers. The only road access/egress is via the Marathon Road south to the Spur Highway in Kenai.

The Refuge is proposing to strategically select and implement hazardous fuels mitigation treatments in and around the oil field and along the Marathon Road to protect lives and valuable infrastructure.

Moose Research Center COI

The Moose Research Center (MRC) COI area lies completely within the boundaries of the Refuge, northeast of Sterling, Alaska. This one-of-a-kind wildlife research facility and its interface area cover about 11,375 acres of the Refuge. The MRC is surrounded on three sides (north, east, and south) by the Dave Spencer Wilderness Area, which includes the world-class Swanson River and Swan Lake Canoe Trails. The MRC is owned by the Refuge but operated through an interagency agreement by the ADF&G. Assets at the MRC include residential cabins, barns, storage buildings, a laboratory, propane tanks, fences, corrals, and other infrastructure. ADF&G employees and managers occupy the MRC year-round. The only access/egress route is via the Swan Lake Road west to the Swanson River Road, then south to the Sterling Highway in Sterling, Alaska. The Refuge has worked cooperatively with the ADF&G to treat hazardous fuels at the MRC over the last 10 years and proposes to continue that program of work. In collaboration with the Refuge, the ADF&G has prepared the 2013 Moose Research Center Habitat Enhancement Plan (see Appendix O). While the planned treatments in the MRC Habitat Enhancement Plan are designed to regenerate moose browse for the captive animals, the treatments also strategically cut and remove black and white spruce and other trees, thereby mitigating hazardous fuels in the complex.

2.3.2.5 Proposed Treatments under Alternative B

The types of treatments that may be used to remove or reduce hazardous fuels and mitigate wildfire risks under Alternative B include mechanical treatments (clearing, thinning, pruning, cutting and piling, mastication) and prescribed fire treatments (pile burning, broadcast burning), and post-treatment seeding and tree/shrub planting, using less flammable native species such as willow (*Salix* spp.), alder (*Alnus* spp.), birch (*Betula neoalaskana*, *B. glandulosa*), or aspen (*Populus tremuloides*), especially where the desire is to replace bluejoint reedgrass.

Mechanical treatments may be accomplished by hand crews with chain saws and hand tools, by public biomass removal (firewood permit), or by tracked equipment such as dozers, excavators and skid-steers with various cutting, shearing, grappling or masticating attachments (shearing blades, tree shears, mowers, roller-choppers, feller-bunchers, grinders and masticating rollers), or by rubber-tired equipment such as hydro-axes and mowers.

Prescribed fires are accomplished by the Refuge Fire Management Program, at times with assistance from its cooperators. The Refuge maintains a staff of qualified firefighters with the necessary skills and prescribed fire qualifications to accomplish its prescribed fire program.

The hazardous fuels to be treated include black spruce, white spruce, beetle-killed spruce, mixed spruce/hardwood forests, flammable brush species such as rusty menziesia, Labrador tea, and bluejoint reedgrass, or fuels complexes where multiple types of hazardous fuels are combined.

An effective hazardous fuels treatment program on the Refuge, when coupled with communities and neighborhoods where fuel hazards and fire risk are mitigated, would provide the best management environment for Refuge managers to be able to manage natural fires for resource benefits.

2.3.2.6 Collaborative Management of Strategically Planned Fuels Treatments

In planning hazardous fuels projects for the Refuge, fire managers locate proposed treatments based upon road access, values at risk, fuel type, fuel hazard, relative risk from wildfire, and/or desired vegetation changes. The overarching goal of the fuels program is to allow fire to play its natural role in the ecosystem while providing for the safety of surrounding communities. Maintaining the largely natural and intact fire regimes in the undeveloped wildlands of the Refuge into the future will be at least partially dependent upon the strategic placement and effectiveness of hazardous fuels treatments within the Refuge.

The CWPPs identify the areas of highest concern. Most of the CWPPs have identified significant areas of risk from fires moving off the Refuge and into communities. Both the relative risk and the public concern associated with natural fires managed for resource benefit can be reduced or mitigated with an active and successful hazardous fuels mitigation program. The majority of hazardous fuels reduction projects should address a strategic mix of on- and off-Refuge treatments in the highest risk areas (see Table 2-2).

Table 2-2. Fire risk ratings for CWPP and COI lands

CWPP / Community of Interest (COI)	Risk Rating	CWPP Total Acres	Refuge Acres
Cooper Landing	High	32,600.00	42.70
Diamond Ridge / Fritz Creek / Fox River	Extreme	159,400.00	203.10
Ninilchik / Ninilchik Forties	Extreme	172,600.00	415.10
Sterling	High	86,600.00	36,691.50
Funny River	High	43,500.00	27,976.40
Soldotna / Ridgeway	High	21,200.00	4,816.30
Kenai	Extreme	20,800.00	0.02
Nikiski / Salamatof / Grey Cliffs	Extreme	102,000.00	23,648.70
Kalifornsky / Kasilof / Cohoe / Clam Gulch	Extreme	117,400.00	18,873.80
Beaver Creek Oil Field (COI)	High	N/A	4,098.00
Swanson River Oil Field (COI)	Extreme	N/A	7,887.00
Moose Research Center COI	Extreme	N/A	11,375.00

While it is possible that Refuge habitat management goals and objectives might also be addressed through careful planning of hazardous fuels mitigation projects, the proposed FMP will only address fire management goals and objectives. Habitat treatment plans for the Refuge would require new site-specific or area analyses and would need to relate directly to the goals and objectives identified in the Kenai NWR's revised CCP (USFWS 2010a). Future habitat management plans and CWPPs will overlap, allowing land managers to comprehensively leverage hazardous fuels and habitat treatment benefits. In general, allowing natural fire on the greater Refuge landscape provides the best opportunity for landscape-level disturbance that can benefit wildlife. In areas at risk from wildfire, more intensive project design will be necessary to accomplish both hazardous fuels and habitat maintenance or enhancement objectives.

2.3.3 Comparison of Alternatives

While both alternatives are founded upon the same Refuge and fire management goals and objectives, they differ in scope. In Alternative A (No Action, Continue Current Level of Management), the actions proposed under the hazardous fuels mitigation program are limited to projects and treatments already planned and approved through other step-down plans and previous NEPA analyses (such as the 2006 Skilak Wildlife Recreation Area Management Plan and 1996 Moose Management Plan). Examples of ongoing hazardous fuels mitigation projects and treatments that would continue to be implemented (dependent upon funding) under Alternative A include Skilak Loop, Lily Lake, Slikok and the Funny River Road fuelbreak projects.

Under Alternative B (the preferred alternative), the scope of the Refuge hazardous fuels and fire mitigation program would be expanded to include the nine CWPP areas, the Swanson River and Beaver Creek Oil and Gas Fields, and the Moose Research Center. Using state of the art spatial modeling tools such as FSPRO, FARSITE, the Interagency Fuels Treatment Decision Support System, and others, the Refuge would collaborate with its cooperators and at risk communities to strategically plan and locate hazardous fuel reduction treatments to mitigate the risk of wildfire.

A potential constraint for implementing treatments under Alternatives A and B is adequate funding. While the Refuge and its cooperators look for new sources of funding and compete regionally and nationally through federal channels for conventional hazardous fuels mitigation funding, the reality of the federal hazardous fuels mitigation budget process is that this alternative may not be fully implemented.

Table 2-3 below provides a comparison of the fire management treatments and range of acres proposed to be treated annually under each alternative. The acreages listed in the prescribed fire and mechanical treatment columns under Alternative B are estimates of the maximum potential acreage of the treatable vegetation types (black spruce, white spruce, beetle-killed white spruce, and mixed spruce/hardwood forest). Specific treatment sites would be selected through spatial fire behavior modeling/analyses to identify key areas where hazardous fuels mitigation would produce the most benefit. Selected treatment sites would be subjected to environmental, biological, and cultural/historical assessments before approval. Implementation would depend on available funding. That is, given limited hazardous fuels mitigation funding, the Refuge could select specific treatments based upon cost. The successful implementation of prescribed fire treatments may also be limited by adverse weather and fuel moisture conditions, and/or a lack of available resources (such as firefighters, equipment, helicopters).

2.4 Alternatives Considered But Dismissed From Detailed Analysis _____

No other alternatives were considered for detailed analysis.

2.5 Mitigation Measures _____

Mitigation measures and constraints would be implemented to avoid or substantially reduce a treatment's adverse environmental effects. The FMU discussions in Appendix B include mitigation measures. Table 2-4 below lists additional measures that will be implemented in all fuel and fire management actions.

Table 2-3. Comparison of alternatives

Map Item ¹	Refuge / WUI Location	Alternative A: No Action - Continue Current Management (Acres)		Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation (Acres) ⁸	
		Prescribed Fire ²	Mechanical Treatments ³	Prescribed Fire ⁴	Mechanical Treatments ⁵
Kenai NWR Fuel Reduction Treatments					
1.	Sterling WUI / Lily Lake	16	184	415	0
2.	Sterling WUI / Skilak Loop	21	123	102	0
3.	Funny River WUI / Funny River Road Fuelbreak ⁶	184	216	50	50
4.	Funny River WUI / Slikok	0	55	199	0
5.	Moose Research Center ⁷	42	72	390	1,635
6.	Swanson River Oil Field	0	0	3,943	3,943
7.	Beaver Creek Oil Field	0	0	1,024	1,024
CWPP (WUI) Area Fuel Reduction Treatments⁹					
a.	Cooper Landing CWPP	0	0	0	0
b.	Diamond Ridge / Fritz Creek / Fox River CWPP	0	0	0	0
c.	Funny River CWPP	0	0	9,325	9,325
d.	Kalifornsky / Kasilof / Cohoe / Clam Gulch CWPP	0	0	12,646	12,646
e.	Kenai CWPP	0	0	0	0
f.	Nikiski/Salamatof / Grey Cliffs CWPP	0	0	7,800	7,800
g.	Ninilchik / Ninilchik Forties CWPP	0	0	0	0
h.	Sterling CWPP	0	0	18,346	18,346
i.	Soldotna / Ridgeway CWPP	0	0	1,204	1,204
Total Treatment Acres		263	650	54,240	54,769
Average Annual Treatment Acres		17.5	43.3	3,616	3,651

Notes:

1. Refer to the maps in Appendices C through N.
2. Acres of prescribed fire completed over the past 15 years
3. Acres of mechanical treatments completed over the past 15 years
4. Proposed acres of prescribed fire to be completed over the next 15 years (funding-dependent)
5. Proposed acres of mechanical treatments to be completed over the next 15 years (funding-dependent)
6. This access/egress fuelbreak has been treated and maintained in multiple entries since 1999
7. See the ADF&G 2013 Moose Research Center Habitat Enhancement Plan in Appendix O
8. Proposed treatment acres in Alternative B are estimates of treatable vegetation/fuel types (black spruce, white spruce, beetle-killed white spruce, and mixed spruce/hardwood forest). Specific treatment sites would be selected through spatial fire behavior modeling/analyses to identify key hazardous fuels for mitigation. Selected treatment sites would be subject to environmental, biological, and cultural/historical assessments before approval. Implementation would depend on funding.
9. The acreages listed under Alternative B for the Funny River and Sterling CWPPs include the acres listed in Alternative B in Map Items 1-4.

Table 2-4. Mitigation measures

Resource	Mitigation Measure
Human Health and Safety	
Prescribed Fire	<ul style="list-style-type: none"> ● Each prescribed fire will require a detailed and comprehensive prescribed fire plan that has been reviewed by a technical specialist and approved by the Refuge Manager and Refuge archaeologist. ● The prescribed fire plans, which will include smoke management plans, will be prepared by the Land Manager and Service Region 7 Fire District staff prior to implementing prescribed fires. ● Prescribed fires will comply with applicable regulations of the Alaska State Forestry Division and Alaska Air Quality Division and will be carried out in accordance with the constraints identified on each refuge's spatial FMP maps. ● Agency or local law enforcement may be requested for traffic control if smoke impacts visibility on roads or highways. ● Warning signs will be posted to advise motorists of a prescribed burn in progress and the potential for reduced visibility on roads that may be impacted by a prescribed burn. ● Ample notification will be given to landowners in WUI areas. Notices may also be posted to inform other adjacent landowners or nearby communities of prescribed fires. ● Press releases will be provided to the local media to inform the public in advance of a prescribed fire. ● The Alaska State Forestry Division, the local fire departments, county sheriffs' offices, and other parties as identified within the individual burn plan will be notified prior to prescribed burns. ● Prescribed fires will not be started until all contingency forces are confirmed to be on-site or in standby status, as specified in the prescribed fire plan.
Invasive/Exotic Plants	
Prevention	<ul style="list-style-type: none"> ● Vehicles will minimize driving in areas infested with invasive/exotic plants at a time when movement of seeds is likely, and when this is not possible, vehicles and equipment will be cleaned after leaving an infested area. Vehicles and equipment will be considered clean when a visual inspection does not disclose seeds, soil, vegetative matter, and other debris that could contain or hold seeds. ● A designated location will be identified for the cleaning described above. This will be in a spot not conducive to exotic weed establishment and will be monitored for incipient weed populations.
Water Resources	
	<ul style="list-style-type: none"> ● Minimize soil disturbance and thus potential for sediment delivery to streams and ponds during prescribed fire by using previously prepared vegetated firebreaks or existing barriers such as roads and trails, even if this results in a slight increase in burned area. ● Prevent or minimize soil erosion and thus potential for sediment delivery to streams and ponds by retaining a high proportion (80% or more) of surface cover in vegetation, litter (dead leaves, grass, and other dead plant parts), and fibrous root systems. ● Heavy equipment will be closely monitored in designated areas to minimize adverse effects on wetlands and other resources at risk. ● Retardants and foams will not be used within 300 feet of any waterway.
Soils	
	<ul style="list-style-type: none"> ● Prevent or minimize soil erosion by retaining a high proportion (80% or more) of surface cover in vegetation, litter (dead leaves, grass, and other dead plant parts), and fibrous root systems. ● Minimize soil disturbance for fire lines in prescribed fire and for wildfires by using previously prepared vegetated fire breaks or existing barriers such as roads, trails, and streams, even if this results in a slight increase in burned area. ● Prevent or minimize soil compaction by limiting vehicles to designated roads. ● Heavy equipment use will require approval from refuge manager or designee for each incident. ● Ground disturbed by suppression activities will be rehabilitated.

Table 2-3. Mitigation measures (continued)

Resource	Mitigation Measure
<p>Cultural Resources</p>	<ul style="list-style-type: none"> ● Heavy equipment will avoid known cultural/historic resources adverse effects on cultural resources. ● Cultural resource sites will only be treated, as necessary, if they are at risk of infestation by invasive/exotic plants and if fuel loads on the site would put the resource at increased risk of damage or destruction in the event of a wildfire. ● The refuge manager will be contacted immediately if previously unrecorded cultural resources are discovered during any vegetation treatments. The Refuge archaeologist will record, delineate, and ensure protection of cultural resources. ● Identify all cultural resources within a jurisdiction using archaeological surveys and consultations with cultural specialists, tribal representatives, and other knowledgeable people (identifying sites is often cost prohibitive for many agencies and management priorities are not structured to fund surveys). ● Include resource advisors at all stages of wildfires and prescribed fires (prevention, planning, implementation, restoration). ● Plot firelines/firebreaks to avoid known cultural resources. ● Map, mark, or flag cultural resources during wildfire suppression and rehabilitation and prescribed burn implementation. ● Provide all fire workers with basic training on cultural resources. ● Design plans to protect resource values at risk. ● Where wildfire poses risks to cultural resources, reduce fuels near archaeological and historic sites mechanically or with prescribed fire to reduce damages from future wildfire. ● Determine effects of heat treatment and fire suppression tactics (such as foams, retardants) on cultural resources at risk (exposed resources) ● In instances of wildfire, develop a post-fire data recovery and/or restoration program that is sensitive to cultural resource concerns.

Chapter 3. Affected Environment and Environmental Consequences

3.1 Introduction

This chapter describes current conditions (affected environment) and the potential beneficial and adverse effects (environmental consequences) that could result from implementation of either of the alternatives:

Alternative A: No Action—Continue Current Level of Land Management (Prescribed Fire, Mechanical Treatments, and Fire Suppression)

Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation

3.2 Assessing Resources and Effects

3.2.1 Resources Analyzed in Detail

The affected environment and environmental consequences are described together for each of the following resources analyzed in detail:

- Section 3.3 Fire and Fuels Management
- Section 3.4 Biological Environment
- Section 3.5 Water and Soil Resources
- Section 3.6 Air Quality
- Section 3.7 Cultural Resources
- Section 3.8 Service Values
- Section 3.9 Public Health and Safety

3.2.2 Resources Not Analyzed

The following topics were not analyzed in this environmental assessment (EA) because they would not be affected by either of the alternatives:

- Environmental justice concerns because there would be no disproportionately high or adverse human health or environmental effects on minority populations and low-income populations.
- Social and economic values and conditions
- Recreation
- Transportation systems

3.2.3 Analysis Period (Duration of Effects)

Short-term effects (both beneficial and adverse) are those that would occur during treatment implementation and persist up to one year.

Long-term effects (both beneficial and adverse) are those that would be noticeable for decades after treatment, depending on treatment objective.

3.2.4 Definitions for Evaluating Effects

The “Environmental Consequences” section for each resource describes the types of effects that would result from taking no action (Alternative A) or implementing Alternative B. Those effects are described according to the definitions in sections 3.2.4.1 and 3.2.4.2.

3.2.4.1 Types of Effects

Beneficial effects are those that would result in a positive change in the condition or nature of the resource, usually with respect to a standard or objective. It is a change that would move a condition or resource toward its desired condition.

Adverse effects are those that would result in a negative change in the condition or nature of the resource, usually with respect to a standard or objective. It is a change that would move a condition or resource away from its desired condition.

Direct effects are caused by the action and would occur at the same place and time as the action.

Indirect effects are also caused by the action, would occur later in time, and are further removed in distance but are still reasonably foreseeable; or the response of the target resource is triggered by the reaction of another resource to the proposed action.

Cumulative effects are those that would result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions.

3.2.4.2 Intensity of Effects

“Intensity” refers to the severity of effects or the degree to which an action may adversely or beneficially affect a resource. The following intensity definitions are used throughout this Chapter 3 to describe effects.

Negligible: An action that would affect very few individuals of species populations or would not affect the existing natural and human environment in the analysis area. The change would be so small or localized that it would have no measurable or perceptible consequence.

Minor: An action that would affect a relatively small number of individuals within species populations or would not affect the existing natural or human environment in the analysis area. The change would require considerable scientific effort to measure, be very localized in area, and have barely perceptible consequences.

Moderate: An action that would cause measurable effects on a relatively moderate number of individuals within a species population and on noticeable areas of the natural and human environment in the analysis area. Species populations of species or natural system function might deviate from normal levels under existing conditions, but all species would remain indefinitely viable in the analysis area.

Major: An action that would have drastic consequences (adverse effects) or a high level of beneficial effects for a species population or the natural and human environment. The change would be readily apparent throughout the analysis area. Major adverse effects could be considered significant.

3.2.5 Indicators

Indicators are measureable factors that are used to describe resource conditions. The indicators used to describe desired and current conditions are the same indicators used to predict the potential effects that could result from implementation of either of the proposed alternatives described in Chapter 2. The focus of this EA is on the analysis of effects from implementing fuel reduction actions. The indicators are therefore only described and used in “Section 3.3. Fire and Fuels Management.”

3.2.6 Analysis of Cumulative Effects

The Council on Environmental Quality (CEQ) regulations (at section 1508.7) define a cumulative impact [effect] as “the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.”

The CEQ provided additional guidance (memorandum prepared by James L. Connaughton, Chairman, White House Council on Environmental Quality, June 24, 2005 [CEQ 2005]) on the extent to which agencies of the federal government are required to analyze the environmental effects of *past actions* when they describe the cumulative environmental effects of a proposed action

CEQ interprets the *National Environmental Policy Act* and its regulations on cumulative effects as requiring analysis and a concise description of the identifiable present effects of past actions to the extent they are relevant and useful in analyzing whether the reasonably foreseeable effects of the agency proposal for action and its alternatives may have a continuing, additive, and significant analysis, agencies should relationship to those effects. In determining what information is necessary for a cumulative effects analysis, determine which information is “relevant to reasonably foreseeable significant adverse impacts, is essential to a reasoned choice among alternatives, and can be obtained without exorbitant cost” (40 CFR 1502.22).

3.2.7 Present and Reasonably Foreseeable Future Actions in the Vicinity of Kenai NWR

Section 2.4.2.3 (Chapter 2) describes the CWPP and COI areas on and adjacent to the Kenai NWR. Treatments in off-refuge areas could contribute to cumulative effects when considered along with the treatments proposed inside the Refuge.

3.3 Fire and Fuels Management

This section summarizes the current fuels conditions and potential fire behavior at the Kenai NWR and the effects from taking no action (Alternative A) or from implementing Alternative B. This section only analyzes the effects of fuels treatments on fuel loads, flame length, rate of spread, fire behavior, and fire risk and hazard. It does not cover the use of fire for vegetation and habitat benefits; this is discussed in the “Biological Environment” section.

3.3.1 Methodology

Landscape level vegetation mapping and analysis are based on LANDFIRE (<http://www.landfire.gov/>), a cooperative project between the US Department of Agriculture–US Forest Service and the US Department of the Interior. LANDFIRE is used to depict major ecosystems, wildlife habitat, vegetation or canopy characteristics, landscape features, and wildland fire behavior, effects, and regimes. However, because the data are created on a coarse scale due to the scope of the nationwide data set, the applicability of data products varies by location and specific use. There is an ongoing interagency effort to update and improve the accuracy of LANDFIRE data by providing vegetation, fuels, and disturbance data and submitting corrections that adjust for errors in cover type to the national database.

The Refuge has a Geographic Information System (GIS) and maintains its own geospatial vegetation database. Refuge data are used for Refuge specific analyses and for comparison with LANDFIRE. The Refuge and its cooperators also collaborate with the Kenai Peninsula Borough to maintain an interagency geospatial vegetation database, which is based upon satellite imagery and field sampling. This database has produced Peninsula-wide wildfire hazard and risk assessments and interagency fuels mitigation maps.

Current vegetation conditions are also established through on-site evaluation of species composition, stand structure, and fuel load. Pre-treatment methods to collect and analyze data may include the establishment of photo points, collecting fuel samples to determine fuel loading and fuel moisture, and/or the establishment of monitoring plots to establish a comprehensive data set of species present within the site. For purposes of developing individual burn plans for a specific treatment, Scott and Burgan’s (2005) 40 fuel models were used to depict general characteristics such as vegetative continuity, height, tons per acre of live/dead fuels, and basic fire behavior characteristics.

3.3.1.1 Scope of the Analysis

Analysis Area. The analysis area for the fire and fuels analysis includes the Kenai NWR and the CWPP and COI areas identified in Chapter 2. The maps are in the following appendices:

- Appendix C: Cooper Landing
- Appendix D: Diamond Ridge / Fritz Creek / Fox River
- Appendix E: Funny River
- Appendix F: Kalifornsky / Kasilof / Cohoe / Clam Gulch
- Appendix G: Kenai
- Appendix H: Nikiski / Salamatof / Grey Cliffs

- Appendix I: Ninilchik / Ninilchik Forties
- Appendix J: Soldotna / Ridgeway
- Appendix K: Sterling
- Appendix L: Swanson River Oil Field
- Appendix M: Beaver Creek Oil Field
- Appendix N: Kenai Moose Research Center

Analysis Period. Fire behavior was modeled for current conditions, immediately after treatment, and at 2-5 years after treatment.

3.3.1.2 Indicators

Predicting the potential behavior and effects of wildland fire is an essential task in fire management. Mathematical surface fire behavior and fire effects models and prediction systems are driven in part by fuelbed inputs such as load, bulk density, fuel particle size, heat content, and moisture of extinction. To facilitate use in models and systems, fuelbed inputs have been formulated into fuel models. A fuel model is a set of fuelbed inputs needed by a particular fire behavior or fire effects model. Scott and Burgan (2005) fuel models were identified in the Refuge and are described below in Section 3.3.3.3.

Indicator: Fuels

Measurement: Fuel Load. The weight of dead and down woody fuel is measured in tons per-acre. The weight of standing brush and foliage can also be predicted if all or a portion is expected to be added to the dead and down fuel loading. Fuel loading is used to predict fire behavior by using the current and expected fuel loading to select the correct fuel model (see the discussion below under “Affected Environment”) to use in fire behavior prediction systems. Components of fuel loading include fuel sizes and their proportion, arrangement, and continuity. *Total fuel* is all fuel, both living and dead, present on a site. *Available fuel* is the amount of fuel that will burn under a specific set of fire conditions.

Measurement: Flame Length. This is the length of flame measured in feet, from the base of the flame to the tip of the flame. Longer flame lengths increase resistance to control and the likelihood of torching events and crown fires in forest areas. Flame length is influenced by fuels, weather, and topography and presence of volatile resins or oils in living vegetation. As illustrated in Table 3-1, increasing flame lengths above 4 feet may present serious control problems to firefighters because they are too dangerous to be directly contained by hand crews (Schlobohm and Brain 2002; Anderson 1982). Flame lengths over 8 feet are generally not controllable by ground-based equipment or aerial retardant and present serious control problems, including torching, crowning, and spotting.

Measurement: Rate of Spread. Rate of spread is the horizontal distance that the flame zone moves per unit of time (feet per minute) and usually refers to the head fire segment of the fire perimeter. It is directly related to the amount of heat received by the fuels ahead of the flaming zone. Rate of spread is strongly influenced by fuels, winds, and topography—it generally increases with increasing wind speed, slope, and amount of fine fuels.

Table 3-1. Relationship between flame length and potential for success of active suppression.

Flame Length	Description
Less than 4 feet	Fires can generally be attacked at the head or flanks by firefighters using hand tools. A hand line should hold the fire.
4–8 feet	Fires are too intense for direct attack at the head with hand tools. A hand line cannot be relied on to hold the fire. Bulldozers, engines, and retardant drops can be effective.
8–11 feet	Fire may present serious control problems, such as torching, crowning, and spotting. Control efforts at the head will probably be ineffective.
Greater than 11 feet	Crowning, spotting, and major fire runs are probable. Control efforts at the head of the fire are ineffective.

Source: NWCG 2004.

3.3.1.3 Fire Risk and Fire Hazard

The likelihood of future fires causing unacceptable resource damage is influenced by two factors: fire risk and fire hazard. Fire risk is the probability of a fire occurring in the Refuge and is based on historic fire records. Fire hazard, on the other hand, is dependent upon fuel conditions, including the accumulation of dead and living vegetation and fire weather. Under historic fire return intervals, fuel accumulation would be considerably less than current levels. A particular area may have a low historic risk of fire occurrence, but the fuel hazard, and thus fire severity, may be high enough to result in unacceptable lethal levels of vegetation mortality (lethal effects are those where fires result in greater than 70% mortality of vegetation) (USFS 2000).

3.3.1.4 Fire Behavior, General Discussion

Fire behavior describes how a fire burns, where it burns, how fast it travels, how much heat it releases, and how much fuel it consumes. It is important to understand what controls fire behavior and how to predict it because this knowledge helps predict wildfire risk and fire effects, control wildfires, and to conduct prescribed fires.

Fire behavior is controlled by *three interacting components: fuels, weather, and topography*. Fuels provide the energy source for fire. Fuel availability, which depends on both fuel arrangement and fuel moisture, determines if fires will burn as surface or crown fires. Weather elements, such as temperature, relative humidity, wind, precipitation, and atmospheric stability, also combine to influence fire behavior by regulating fuel moisture and rate of spread. Topography can influence fire indirectly, by mediating wind patterns, or directly—fires burning upslope spread faster than fire burning on flat land.

Component: Fuels

Fuel is all living and dead plant material that can be ignited by a fire. Fuel characteristics strongly influence fire behavior and the resulting fire effects on ecosystems. Fires vary widely in the kind of fuels that burn (for example, live vs. dead fuels, surface vs. ground fuels), the total amount of fuels that burn, and the rate or intensity at which these fuels burn. These characteristics of fuel consumption, in turn, determine peak temperatures reached, the duration of heat, and the stratification of heat above and below the soil surface (NWCG 2001).

Predicting the potential behavior and effects of wildland fire is an essential task in fire management. Mathematical surface fire behavior and fire effects models and prediction systems are

driven in part by fuelbed inputs such as load, bulk density, fuel particle size, heat content, and moisture of extinction. Fuelbeds are classified in six strata or layers: (1) tree canopy; (2) shrubs/small trees; (3) low vegetation; (4) woody fuels; (5) moss, lichens, and litter; and (6) ground fuels (duff). Each of these strata can be divided into separate categories based on specific characteristics and relative abundance. Modification of any fuel stratum has implications for fire behavior, fire suppression, and fire severity (Graham et al. 2004).

Component: Weather

Of the three fire behavior components, weather is the most likely to fluctuate. Accurately predicting fire weather remains a challenge for forecasters, particularly during drought conditions. As spring and summer winds and rising temperatures dry fuels, particularly on south-facing slopes, conditions can deteriorate rapidly, creating an environment that is susceptible to wildland fire. Fine fuels (grass and leaf litter) can cure rapidly, making them highly flammable in as little as one hour following light precipitation. Low live fuel moistures of shrubs and trees can significantly contribute to fire behavior in the form of crowning and torching.

Component: Topography

Topography is the third component and is important in determining fire behavior. Steepness of slope, aspect (direction the slope faces), elevation, and landscape features can all affect fuels, local weather (by channeling winds and affecting local temperatures), and rate of spread of wildfire.

3.3.1.5 Components That Influence Fire Behavior at Kenai NWR

Some of the topographic and climatic features of the western Kenai Peninsula can have a major influence on fire behavior on the Refuge. Cold air drainage from the Harding ice field and associated large glaciers produce localized turbulence and downslope winds that can be extreme and can arise suddenly, producing dramatic changes in fire behavior. The Skilak glacier and the downslope winds it produces on Skilak Lake is one example. Severe turbulence and downslope foehn or east winds can occur anywhere along the west slope of the Kenai Mountains when conditions are right.

During the late spring and early summer fire season, moist ocean breezes from the southwest are the norm. These diurnal or daily sea breezes tend to have a dampening effect on fire behavior as relative humidity is increased. However, when temperatures are high, these moist winds can produce thunderstorms and lightning along the foothills of the Kenai Mountains. Occasionally, cool, dry north winds occur on the refuge, which have been known to cause severe fire behavior with relative humidity in the 20% range.

Due to the rain shadow effect of the Kenai Mountains to the east and the Alaska Range to the west, annual precipitation on the Kenai lowlands, ranges from 25 inches at Homer and 19 inches at Kenai to 17 inches at Sterling. About half of this annual precipitation falls as light rain or drizzle, between early August and November. Soil and duff moistures during this period are generally high, and fire severity or depth of burn is correspondingly low and spotty. From mid-April to July, the refuge experiences its longest days (up to 20 hours of daylight) and lowest relative humidity. These factors, in addition to the typical lack of precipitation in early summer, can contribute to extreme fire weather and fire behavior on the Kenai. Running crown fires and long-range spotting are possible during these times.

The lowland areas of the western Kenai Peninsula are populated by large stands of black spruce. Fires characteristically burn with fairly high intensity and slow, predictable rates of spread. Surface fuels of shrubs, feather mosses and lichens are the primary carrier of fire in these areas. Ignition of the tree crowns will occur just behind the flaming front if flame lengths are sufficient to ignite the lower lichen-covered branches. Very low relative humidity and high wind can produce sudden, extreme fire behavior in these stands.

3.3.2 Desired Conditions

The desired conditions are that fire risk and fire hazard at Kenai NWR are low because treatments have been implemented to remove or minimize the amount of total fuels (through prescribed fire and/or other treatment methods). The potential for a wildfire to result in a loss of life or damage to infrastructure and other values is reduced at the Refuge. When identified, fuels are treated to reduce fire behavior (low rate of spread and short [less than 4 feet] flame lengths) and resistance to control.

Generally, the following will help achieve desired conditions for fire behavior:

- Large prescribed fire projects and other fuel treatments have modified natural stand structure to alter fire behavior.
- Strategically located fuelbreaks are present, where fuel accumulations have reduced fire behavior potential. This will provide safe areas for suppression crews to work and anchor control lines, thereby reducing the probability of fires spreading to adjacent properties and allowing safe use of roads that are key access routes for firefighters and escape routes for residents and other publics.

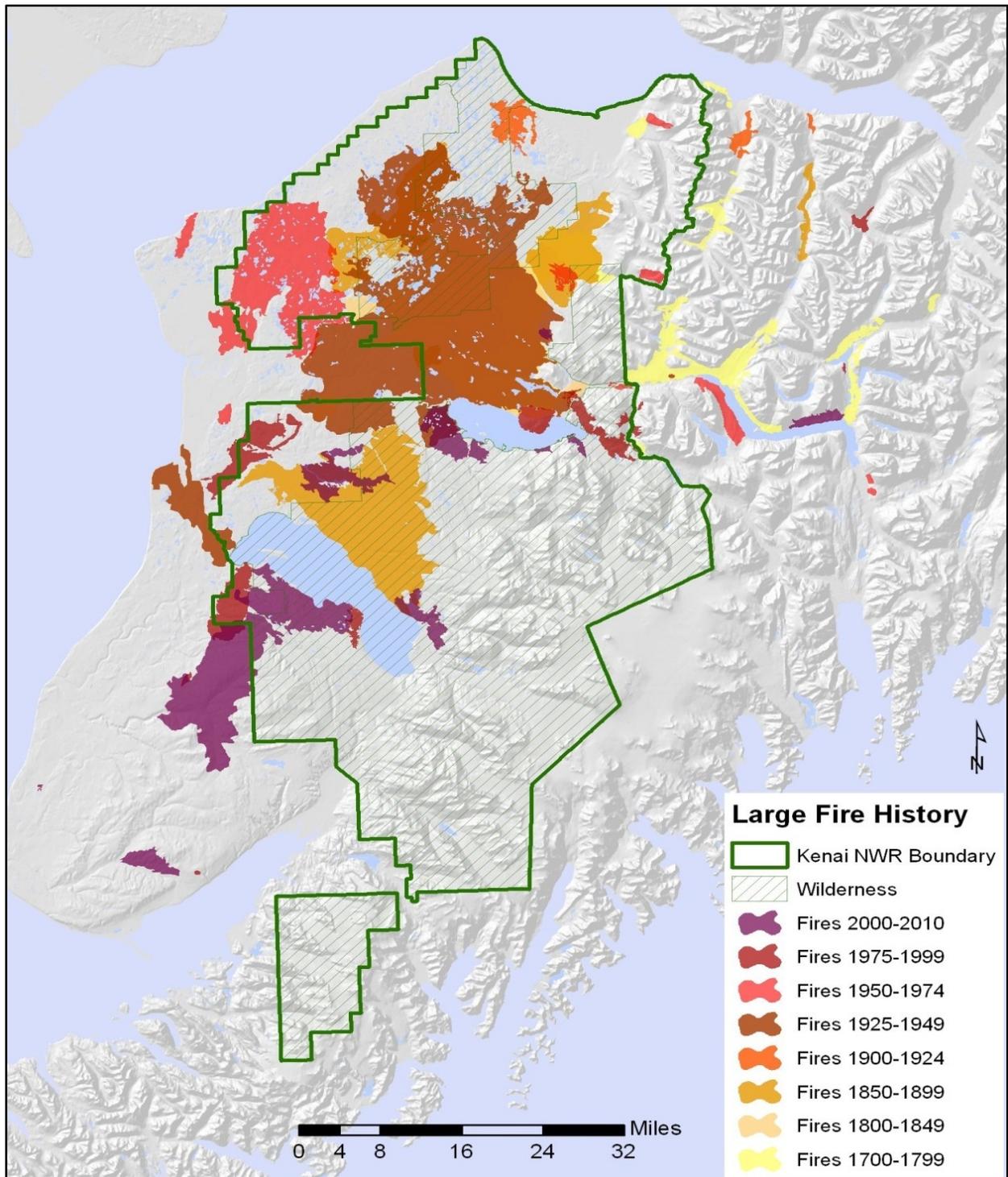
3.3.3 Affected Environment

3.3.3.1 Fire History at Kenai NWR

An aerial view of the Kenai NWR reveals a mosaic pattern of spruce and mixed hardwood stands in every stage of post-fire forest succession. Historical records of past fire activity are somewhat lacking compared with other regions of the United States, but a number of studies of fire frequency on the Kenai Peninsula have been completed (Lutz 1960; DeVolder et al. 1999) or are in progress. Several studies have documented large fires back to 1708. These studies included the collection of lake sediment and soil charcoal samples and the dendro-chronological dating of fire-scarred and fire-killed trees. Annual narratives prepared by refuge managers record fire data beginning in 1941. From 1974 to the present, official fire records and State Forestry Fire Reports complete the extent of Refuge fire data. The known large fire history of the Kenai Peninsula is shown in Figure 3-1.

According to data from 1974 to 2005, the average number of wildfires (both naturally ignited and human caused) on the Refuge is 7.75 fires per year. These fires burn an average of 2,080 acres per year. These averages were influenced by several large fires in 2004 and 2005. The fires from those two years increased the average number of fires by 0.41 fire per year and the average annual acres burned by 1,286 acres per year. Wet fire seasons generally experience fewer fire starts and lower acreage burned, while dry years see a higher frequency of ignitions, greater fire severity and larger wildland fires. Over the years 2002-2011, 70 Refuge fires burned 68,832.3 acres. The 10-year averages are 7 fires per year and 6,883 acres per fire.

Figure 3-1. History of large fires at Kenai NWR



Climate change may be affecting the frequency and sources of ignition on the Kenai Peninsula and the Refuge. In the absence of reliable weather and fire information prior to 1947, anecdotal information is that lightning and lightning-caused fires are not a typical occurrence on the Peninsula. This is supported by the number of fires started by humans (1,149) and the number started by lightning (50) in the years 1990 to 2005. While less than 5% of the Peninsula's fires were started by lightning, almost 25% of these 50 lightning fires were in 2005 alone.

3.3.3.2 Summary of Kenai Peninsula Fire History Studies Conducted at the Kenai NWR 1997-2004

White/Lutz Forests

The mean fire return interval (MFRI) for the past 2,500 years was estimated as 515 ± 355 (1 standard deviation [SD]) years (range 105–1,642 years). This estimate is based on a sample size of $n = 112$ radiocarbon dates of soil charcoal at 22 sites from Anchor Point to Nikiski. Dates older than 2,500 years were omitted from the MFRI calculation because of the possibility that soil charcoal has degraded after this period of time, thus censoring the available sample pool.

The mean time-since-fire was estimated at 605 ± 413 years (median 444 years, range 90–1,518 years) for all sites (Bert and Anderson 2006).

Black Spruce Forests

The MFRI for the entire study area for the past 300 years was estimated as 89 ± 43 years (1 SD) years (range 25-185 years). This estimate was based on 1,022 basal cross-sections and 771 increment cores of lowland black spruce. Twelve fires were dated as occurring in 1708, 1762, 1801, 1828, 1883, 1834, 1849, 1867, 1874, 1884, 1888, and 1898.

The primary study area was in the 110,000-hectare (271,816 acres) 1947 Burn. A secondary study area of 10,000 hectare (24,710 acres) was located in the Pipeline Road area, northeast of the 1947 Burn (DeVolder et al. 2000).

Mixed White and Black Spruce and Hardwoods Forests

The MFRI for the Paradox Lake area (about 6 miles north of Sterling) was estimated at 130 ± 66 years (1 SD) years with 35 fires separated by intervals of 40 to 270 years occurring during the last 4,600 years since the arrival of black spruce on the landscape.

This estimate is based on sedimentary charcoal in a 30-foot core taken from Paradox Lake (informal name) at a depth of 52 feet, supplemented with a 28-inch short core of near-surface sediments. The total charcoal fire history record spanned about 13,000 calendar years; MFRI's were longest during the shrub-herb tundra phase (138 ± 65 years); decreased after expansion of birch, willow, and aspen (77 ± 49 years) and white spruce (*Picea glauca*) (81 ± 41 years); and increased again with the arrival of black spruce (*P. mariana*) (130 ± 66 years) (Anderson et al. 2006).

3.3.3.3 Current Fuels and Expected Fire Behavior

Fire behavior varies with habitat. Large areas of the Refuge include stands of mixed spruce/hardwoods, white spruce, shrublands, and grasslands. Mixed spruce/hardwood stands generally burn with less intensity than black spruce, having less ladder fuel and more canopy shading. Pockets of

hardwoods provide a natural barrier to fire spread; crowning spruce fires will normally drop to the ground when encountering a hardwood stand, in all but the most extreme conditions. Fires also do not carry as well in the brush and shrubland found on the Refuge, especially where sparse. Labrador tea, however, can be a primary carrier of fire. Dead or cured stands of bluejoint reedgrass can produce rapid rates of spread and high intensity, especially when cured.

Refuge lands, other than those covered by glaciers or water, are covered by a diverse mix of forest types and vegetation communities, which are represented by a variety of fuel types and complexes, and their corresponding fire behavior characteristics. The *Fuel Model Guide to Alaska Vegetation* (Cella et al. 2008) and its associated *Fuel Model Crosswalk* (Scott 2008) describe the fuel models of Alaska and the Kenai Peninsula and a comparison of the three fuel model guides used for various applications in Alaska; those three guides are the Northern Forest Fire Laboratory's 13 Fuel Models (Anderson 1982); Scott and Bergen 40 Fuel Models (2005); and Canadian Forest Fire Danger Rating System (CFFDRS) (Alexander et al. 1996). The Refuge uses all three fuel model guides at different times for different applications. The CFFDRS is the primary system used to predict fire danger and fire behavior in Alaska.

Using the 40 Standard Fire Behavior Fuel Models (Scott and Burgan 2005), the Refuge is represented by the fuel models and their corresponding fire behavior characteristics, which are described in Table 3-2 below. It is important that fire and fuel managers apply the fuel models in order to predict the current and projected fuel hazard and fire severity. Fuel refers to all living and dead plant material that can be ignited by a fire. Fuel characteristics strongly influence fire behavior and the resulting fire effects on ecosystems. The fuel models listed here are distributed throughout the four FMUs described in Chapter 2 and in Appendix B.

3.3.4 Environmental Consequences

3.3.4.1 Alternatives A and B

Hazardous fuels reduction is the most frequently cited example of pre-suppression activities that are nearly unanimously favored over the reactive system of suppression. Active management can improve the health and resiliency of the land, which contributes to reduced fire hazard (WFLC 2010). The use of prescribed fire and wildfire is, overall, the most cost-effective long-term fire management strategy for restoring and maintaining lands in a desirable condition. All fuel-reduction actions under both alternatives would help reduce fire risk to maximize long-term protection to communities and natural and cultural resources, while minimizing the costs of fire suppression and emergency rehabilitation of lands or structures damaged by wildfire and maximizing available resources for fire suppression on lands adjacent to the Refuge.

The purpose of all treatment methods in each fuel model is to affect current and future predicted fire behavior, and this can be done by reducing or removing ground, ladder, and crown fuels in order to maintain desirable fuel models or to change a fuel model to alter fire behavior and reduce fire hazard.

The majority of Service lands have evolved with fire. The wildlife and plants supported by grasslands, shrublands, riparian/wetland areas, and woodlands/forests depend on fire for their survival. The lack of periodic fire in these wildlands (due to fire suppression or fragmentation of landscapes from human development) has actually increased the risk of wildfire.

Table 3-2. Current fuel models for Kenai NWR

Fuel Model Fuel Type	Fuel Model Code (Number)	Summary Characteristics	Adjective Class for Predicted Fire Behavior ¹
ROS = rate of spread; FL = flame length			
GR Grass	GR1 (101)	Short, Sparse Dry Climate Grass (Dynamic) The primary carrier of fire is sparse grass, though small amounts of fine dead fuel may be present. The grass in GR1 is generally short, either naturally or by grazing, and may be sparse or discontinuous. The moisture of extinction of GR1 is indicative of a dry climate fuelbed, but GR1 may also be applied in high-extinction moisture fuelbeds because, in both cases, predicted spread rate and flame length are low compared to other GR models.	ROS: moderate FL: low
	GR2 (102)	Low Load, Dry Climate Grass (Dynamic) The primary carrier of fire is grass, though small amounts of fine dead fuel may be present. Load is greater than GR1, and fuelbed may be more continuous. Shrubs, if present, do not affect fire behavior.	ROS: high FL: moderate
	GR3 (103)	Low Load, Very Coarse, Humid Climate Grass (Dynamic) The primary carrier of fire is continuous, coarse, humid-climate grass. Grass and herb fuel load is relatively light; fuelbed depth is about 2 feet. Shrubs are not present in significant quantity to affect fire behavior.	ROS: high FL: moderate
	GR4 (104)	Moderate Load, Dry Climate Grass (Dynamic) The primary carrier of fire in GR4 is moderately coarse continuous grass. Load and depth are greater than GR2; fuelbed depth is about 2 feet. (Note: bulleted text in the draft FMP says "tall grass.")	ROS: very high FL: high
GS	GS1 (121)	Low Load, Dry Climate Grass-Shrub (Dynamic) The primary carrier of fire is grass and shrubs combined. Shrubs are about 1 foot high, grass load is low. Moisture of extinction is low.	ROS: moderate FL: low
SH Shrub	SH1 (141)	Low Load Dry Climate Shrub (Dynamic) The primary carrier of fire is woody shrubs and shrub litter. Low shrub fuel load, fuelbed depth about 1 foot; some grass may be present.	ROS: very low FL: very low
	SH2 (142)	Moderate Load Dry Climate Shrub Shrubs cover at least 50% of the site. The primary carrier of fire is woody shrubs and shrub litter. Moderate fuel load, depth about 1 foot. Grass is sparse or not present.	ROS: low FL: low
	SH3 (143)	Moderate Load, Humid Climate Shrub Shrubs cover at least 50% of the site. The primary carrier of fire in SH3 is woody shrubs and shrub litter. Moderate shrub load, possibly with pine overstory or herbaceous fuels; fuel bed depth 2 to 3 feet.	ROS: low FL: low
	SH4 (144)	Low Load, Humid Climate Timber-Shrub The primary carrier of fire in SH4 is woody shrubs and shrub litter. Low to moderate shrub and litter load, possibly with pine overstory, fuel bed depth about 3 feet.	ROS: high FL: moderate
TU Timber- Understory	TU1 (161)	Low Load Dry Climate Timber-Grass-Shrub (Dynamic) The primary carrier of fire is low load of grass and/or shrub with litter.	ROS: low FL: low
	TU3 (163)	Moderate Load, Humid Climate Timber-Grass-Shrub (Dynamic) The primary carrier of fire in TU3 is a moderate litter load from the forest canopy mixed with grass and shrub components. Extinction moisture is high.	ROS: high FL: moderate
	TU4 (164)	Dwarf Conifer With Understory The primary carrier of fire in TU4 is short conifer trees mixed with grass or moss understory.	ROS: moderate FL: moderate
	TU5 (165)	Very High Load, Dry Climate Timber-Shrub The primary carrier of fire is heavy forest litter with a shrub or small tree understory.	ROS: moderate FL: moderate

Table 3-2. Current fuel models for Kenai NWR (continued)

Fuel Model Fuel Type	Fuel Model Code (Number)	Summary Characteristics	Adjective Class for Predicted Fire Behavior ¹
TL Timber-Litter	TL1 (181)	Low Load Compact Conifer Litter The primary carrier of fire is compact dead and down woody fuel (forest litter) beneath a forest canopy and with a fuelbed that has recently burned but is able to carry wildland fire. Light to moderate load, fuels 1 to 2 inches deep. May be used to represent a recently burned forest.	ROS: very low FL: very low
	TL2 (182)	Low Load Broadleaf Litter The primary carrier of fire is dead and down woody fuel (litter) beneath a forest canopy, where the fuelbed has not recently burned, and the fuelbed is composed of broadleaf (hardwood) litter. Low load, compact broadleaf litter.	ROS: very low FL: very low
	TL6 (186)	Moderate Load Broadleaf Litter The primary carrier of fire is moderate load broadleaf litter, less compact than TL2.	ROS: moderate FL: low
SB Slash/ Blowdown	SB1 (201)	Low Load Activity Fuel The primary carrier of fire in SB1 is light dead and down activity fuels (slash) and debris from wind damage (blowdown). Forested areas with heavy mortality may be modeled with SB fuel models. Fine fuel load is 10 to 20 tons per acres, weighted toward fuels 1 to 3 inches diameter class, depth is less than 1 foot.	ROS: moderate FL: low
NB Nonburnable	NB1 (91)	Urban/Developed Consists of land covered by urban and suburban development. To be called NB1, the area under consideration must not support wildland fire spread. In some cases, areas mapped as NB1 may experience structural fire losses during a wildland fire incident; however, structure ignition in those cases is either house-to-house or by firebrands, neither of which is directly modeled using fire behavior fuel models. If sufficient fuel vegetation surrounds structures such that wildland fire spread is possible, then choose a fuel model appropriate for the wildland vegetation rather than NB1.	ROS: none FL: none
	NB2 (92)	Snow/Ice Land covered by permanent snow or ice is included in NB2. Areas covered by seasonal snow can be mapped to two different fuel models: NB2 for use when snow-covered and another for use in the fire season.	ROS: none FL: none
	NB6	This fuel model is a custom model for wet vegetated areas that typically do not burn.	ROS: none FL: none
	NB7	This fuel model is a custom model for drier vegetated areas that typically do not burn.	ROS: none FL: none
	NB8 (98)	Open Water Land covered by open bodies of water such as lakes, rivers and oceans.	ROS: none FL: none
	NB9 (99)	Bare Ground Land devoid of enough fuel to support wildland fire spread. Such areas may include gravel pits, arid deserts with little vegetation, sand dunes, rock outcroppings, beaches, and so forth.	ROS: none FL: none

Source: Scott and Burgan (2005)

Note 1. for Table 3-2: Adjective class definitions for predicted fire behavior

Adjective Class	Rate of Spread (chains/hour*)	Flame Length (feet)
Very low	0-2	0-1
Low	2-5	1-4
Moderate	5-20	4-8
High	20-50	8-12
Very high	50-150	12-25
Extreme	>150	>25

*one chain = 66.0001 feet

The dangers of excluding natural fire include large and damaging fires resulting from the accumulation of flammable vegetation above historic levels; loss of life or serious injury to firefighters and the public; property loss and damage; adverse health effects and impaired visibility from intense or extended periods of unmanageable smoke; loss of plant and animal species and their habitats; and damage to soils, watersheds, and water quality.

Table 3-3 presents the potential direct and indirect effects on each fuel model from actions proposed under each alternative. The biggest change between Alternatives A and B would be the number of acres in each fuel model — Alternative B would result in slightly more acres treated in a fuel model.

Adverse cumulative effects could occur from the continued presence of hazardous fuels from black spruce, white spruce, and beetle-killed spruce, and from changes/increases in the flashy fuels – the flammable grasses and shrubs that can build up in the absence of fire or treatment and in the ever-expanding wildland urban interface (WUI) areas as a result of eliminating fire from those areas. As increasing community development expands the WUI along the Refuge boundary, the incidence of human-caused fire is likely to increase, as will the need to suppress wildfires in the WUI and on Refuge lands adjacent to the WUI. This will increase the need for hazardous fuels mitigation within and adjacent to the WUI as wildfire is aggressively suppressed to protect communities. The lack of fire as an agent of change in the ecosystem, demands an alternative: intensive management of hazardous fuels, if a goal of land management is to protect communities from damaging wildfires.

Under Alternative B, all treatments conducted by the Service, in combination with treatments conducted by other organizations and agencies, would result in temporary to short-term negligible to minor adverse cumulative effects on the fuel models. However, short- to long-term minor to major beneficial cumulative effects would result when fuel models are improved, and the hazards and risks of damaging wildfires are reduced as a result of fuel-reduction treatments both on and off the Refuge. Adverse cumulative effects resulting from fuel reduction treatments under Alternative B could include short- to long-term minor to moderate adverse effects from the increased motorized access to the Refuge (forest thinning, pruning, and prescribed fires can open new pathways for all-terrain vehicles, snowmachines, and other motorized equipment); compacted soils and/or soil erosion from increased motorized use; the spread of invasive species due to increased human activity; and increased human-caused wildfires.

Table 3-3 Direct and indirect effects on each fuel model at Kenai NWR

Fuel Model	Fuel Model Title	Alternative A: No Action, Continue Current Management	Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation
GR1 (101)	Short, Sparse Dry Climate Grass (Dynamic) ROS: moderate FL: low	The goal of any treatments in this fuel model would be to reduce the potential ROS from moderate to low. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects on predicted fire risk and fire hazard. If a wildfire were to occur, there could be short-term negligible to moderate adverse effects, depending on fire risk and fire hazard in the area of the fire and the Service resources and values damaged or destroyed	The goal of any treatments in this fuel model would be to reduce the potential ROS from moderate to low. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects on predicted fire risk and fire hazard. With fuel treatments being conducted in CWPP and COI areas, there would be a greater reduction in hazardous fuels, thus resulting in both short- and long-term moderate to major long-term beneficial effects on resources and values inside and outside the Refuge boundary. If a wildfire were to occur, there could be short-term minor to moderate adverse effects, depending on fire risk and fire hazard in the area of the fire and the resources and values (Service and private) damaged or destroyed.
GR2 (102)	Low Load, Dry Climate Grass ROS: high FL: moderate	The concern here is high ROS, even with the moderate FL. This fuel model would likely remain the same or improve to GR1 because all fuel reduction treatments would be used, where needed, thus providing long-term minor to moderate beneficial effects on predicted fire risk and fire hazard. If a wildfire were to occur, there could be short-term minor to major adverse effects, depending on fire risk and fire hazard in the area of the fire and the resources and values (Service and private) damaged or destroyed.	The concern here is high ROS, even with the moderate FL. With fuel treatments being conducted in CWPP and COI areas, there would be a greater reduction in hazardous fuels, thus resulting in both short- and long-term moderate to major long-term beneficial effects on resources and values inside and outside the Refuge boundary. If a wildfire were to occur, there could be short-term minor to major adverse effects, depending on fire risk and fire hazard in the area of the fire and the resources and values (Service and private) damaged or destroyed.
GR3 (103)	Low Load, Very Coarse, Humid Climate Grass ROS: high FL: moderate	Same effects as described for GR2.	Same effects as described for GR2.
GR4 (104)	Moderate Load, Dry Climate Grass (Dynamic) ROS: very high FL: high	The concern here is the predicted very high ROS and high FL. This fuel model would be a high priority for fuel reduction treatments. Improving the fuel model would provide long-term minor to moderate beneficial effects on predicted fire risk and fire hazard. If a wildfire were to occur in areas with this fuel model, there could potentially be both short- and long-term minor to moderate adverse effects, depending on the particular location and fuel load.	The concern here is the predicted very high ROS and high FL. Fuel reduction treatments would be a high priority, particularly on Service lands and in CWPP and COI areas. Improving the fuel model would provide long-term minor to moderate beneficial effects. If a wildfire were to occur in areas with this fuel model, there could potentially be both short- and long-term minor to moderate adverse effects, depending on the particular location and fuel load.
GS1 (121)	Low Load, Dry Climate Grass-Shrub ROS: moderate FL: low	Same effects as described for GR1.	Same effects as described for GR1.

Table 3-3. Direct and indirect effects on each fuel model at Kenai NWR (continued)

Fuel Model	Fuel Model Title	Alternative A: No Action, Continue Current Management	Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation
SH1 (141)	Low Load Dry Climate Shrub ROS: very low FL: very low	<p>This fuel model would likely remain the same because all fuel reduction treatments would be used, if needed, but this fuel model is not a priority for treatment due to the already predicted low ROS and FL. Maintaining the fuel model would provide long-term negligible to minor beneficial effects on fire risk and fire hazard.</p> <p>If a wildfire were to occur in areas with this fuel model, there could potentially be short-term negligible to minor adverse effects, depending on fire risk and fire hazard in the area of the fire and the Service resources and values damaged or destroyed.</p>	<p>This fuel model would likely remain the same because all fuel reduction treatments would be used, if needed, but this fuel model is not a priority for treatment due to the already predicted low ROS and FL. Maintaining the fuel model would provide long-term negligible to moderate beneficial effects on fire risk and fire hazard on Service lands and in CWPP and COI areas.</p> <p>If a wildfire were to occur in areas with this fuel model, there could potentially be short-term negligible to minor adverse effects, depending on fire risk and fire hazard in the location (on Service land or in CWPP and COI areas) of the fire and the resources and values damaged or destroyed.</p>
SH2 (142)	Moderate Load Dry Climate Shrub ROS: low FL: low	<p>This fuel model would likely remain the same because fuel reduction treatments would only be implemented, as needed, but with the already low ROS and FL, this fuel model is not a priority for treatment. Maintaining the fuel model would provide long-term negligible to minor beneficial effects.</p> <p>If a wildfire were to occur, there could be short-term negligible to minor adverse effects, depending on fire risk and fire hazard in the area of the fire and the Service resources and values damaged or destroyed.</p>	<p>This fuel model would likely remain the same because fuel reduction treatments would only be implemented, as needed, but with the already low ROS and FL, this fuel model is not a priority for treatment. Maintaining the fuel model would provide long-term negligible to moderate beneficial effects on fire risk and fire hazard on Service lands and in CWPP and COI areas.</p> <p>If a wildfire were to occur, short-term negligible to minor adverse effects, depending on the particular location (on Service land or in CWPP and COI areas) and fuel load.</p>
SH3 (143)	Moderate Load, Humid Climate Shrub ROS: low FL: low	<p>This fuel model would likely remain the same. This fuel model is not a priority for treatment. Maintaining the fuel model would provide long-term negligible to moderate beneficial effects.</p> <p>If a wildfire were to occur, there could be short-term negligible to minor adverse effects, depending on fire risk and fire hazard in the area of the fire and the Service resources and values damaged or destroyed.</p>	<p>This fuel model would likely remain the same. This fuel model is not a priority for treatment. Maintaining the fuel model would provide long-term negligible to moderate beneficial effects.</p> <p>If a wildfire were to occur, short-term negligible to minor adverse effects, depending on the particular location (on Service land or in CWPP and COI areas) and predicted fire risk and fire hazard in areas with this fuel model.</p>
SH4 (144)	Low Load, Humid Climate Timber-Shrub ROS: high FL: moderate	<p>The concern here is high ROS, even with the moderate FL.</p> <p>This fuel model would likely remain the same or improve because all fuel reduction treatments would be used, where needed, thus providing long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard on Service lands.</p> <p>If a wildfire were to occur, there could be short-term negligible to moderate adverse effects, depending on fire risk and fire hazard in the area of the fire and the Service resources and values damaged or destroyed.</p>	<p>The concern here is high ROS, even with the moderate FL.</p> <p>This fuel model would likely remain the same or improve because all fuel reduction treatments would be used, where needed, thus providing long-term minor to moderate beneficial effects by reducing predicted fire risk and fire hazard on Service lands and in CWPP and COI areas.</p> <p>If a wildfire were to occur, there could be short-term negligible to moderate adverse effects, depending on fire risk and fire hazard in the area of the fire and the Service resources and values damaged or destroyed.</p>

Table 3-3. Direct and indirect effects on each fuel model at Kenai NWR (continued)

Fuel Model	Fuel Model Title	Alternative A: No Action, Continue Current Management	Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation
TU1 (161)	Low Load Dry Climate Timber-Grass-Shrub ROS: low FL: low	<p>This fuel model would likely remain the same because all fuel reduction treatments would be used, if needed, but this fuel model is not a priority for treatment due to the already predicted low ROS and FL. Maintaining the fuel model would provide long-term minor to moderate beneficial effects by reducing predicted fire risk and fire hazard on Service lands.</p> <p>If a wildfire were to occur, there could be short-term negligible to minor adverse effects, depending on fire risk and fire hazard in the area of the fire and the Service resources and values damaged or destroyed.</p>	<p>This fuel model would likely remain the same because all fuel reduction treatments would be used, if needed, but this fuel model is not a priority for treatment due to the already predicted low ROS and FL. Maintaining the fuel model would provide long-term minor to moderate beneficial effects by reducing predicted fire risk and fire hazard on Service lands and in CWPP and COI areas.</p> <p>If a wildfire were to occur, there could be short-term negligible to minor adverse effects, depending on fire risk and fire hazard on Service lands and in CWPP and COI areas and the resources and values damaged or destroyed.</p>
TU3 (163)	Moderate Load, Humid Climate Timber-Grass-Shrub ROS: high FL: moderate	<p>The concern here is high ROS, even with the moderate FL.</p> <p>This fuel model would likely remain the same or improve because all fuel reduction treatments would be used, where needed, thus providing long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard.</p> <p>If a wildfire were to occur, there could potentially be short-term minor to moderate adverse effects, depending on fire risk and fire hazard on Service lands and in CWPP and COI areas and the resources and values damaged or destroyed.</p>	<p>The concern here is high ROS, even with the moderate FL.</p> <p>Fuel reduction treatments would be a priority, particularly in the CWPP and COI areas. This fuel model would likely remain the same or improve because all fuel reduction treatments would be used, where needed, thus providing long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard.</p> <p>If a wildfire were to occur, there could potentially be short-term minor to moderate adverse effects, depending on fire risk and fire hazard on Service lands and in CWPP and COI areas and the resources and values damaged or destroyed.</p>
TU4 (164)	Dwarf Conifer with Understory ROS: moderate FL: moderate	<p>The goal of any treatments in this fuel model would be to reduce the ROS and FL from moderate to low, resulting in a potential fire behavior similar to TU1. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard on Service lands.</p> <p>If a wildfire were to occur, there could potentially be short-term negligible to moderate adverse effects, depending on the particular location and fuel load on Service lands with this fuel model and the resources and values damaged or destroyed.</p>	<p>The goal of any treatments in this fuel model would be to reduce the ROS and FL from moderate to low, resulting in a potential fire behavior similar to TU1. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard on Service lands and in CWPP and COI areas.</p> <p>If a wildfire were to occur, there could potentially be short-term negligible to moderate adverse effects, depending on the particular location and fuel load in areas with this fuel model and the resources and values damaged or destroyed.</p>
TU5 (165)	Very High Load, Dry Climate Timber-Shrub ROS: moderate FL: moderate	<p>The goal of any treatments in this fuel model would be to reduce the ROS and FL from moderate to low. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard on Service lands.</p>	<p>The goal of any treatments in this fuel model would be to reduce the ROS and FL from moderate to low. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard on Service lands and in CWPP and COI areas.</p>

Table 3-3. Direct and indirect effects on each fuel model at Kenai NWR (continued)

Fuel Model	Fuel Model Title	Alternative A: No Action, Continue Current Management	Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation
		If a wildfire were to occur, there could potentially be short-term negligible to moderate adverse effects, depending on the particular location and fuel load on Service lands with this fuel model and the resources and values damaged or destroyed.	If a wildfire were to occur, there could potentially be short-term negligible to moderate adverse effects, depending on the particular location and fuel load in areas with this fuel model and the resources and values damaged or destroyed.
TL1 (181)	Low Load Compact Conifer Litter ROS: very low FL: very low	This fuel model would likely remain the same. This fuel model is not a priority for treatment due to the current very low ROS and FL. Maintaining the fuel model would provide long-term negligible to minor beneficial effects by maintaining the current low predicted fire risk and fire hazard. If a wildfire were to occur, there could potentially be short-term negligible to minor adverse effects, depending on the particular location and predicted fire risk and fire hazard on Service lands and the resources and values damaged or destroyed.	This fuel model would likely remain the same. This fuel model is not a priority for treatment due to the current very low ROS and FL. Maintaining the fuel model would provide long-term negligible to minor beneficial effects by maintaining the current low predicted fire risk and fire hazard. If a wildfire were to occur, there could potentially be short-term negligible to minor adverse effects, depending on the particular location and predicted fire risk and fire hazard on Service lands and CWPP and COI areas and the resources and values damaged or destroyed.
TL2 (182)	Low Load Broadleaf Litter ROS: very low FL: very low	This fuel model would likely remain the same. This fuel model is not a priority for treatment due to the current very low ROS and FL. Maintaining the fuel model would provide long-term negligible to minor beneficial effects by maintaining the current very low predicted fire risk and fire hazard on Service lands. If a wildfire were to occur, there could potentially be short-term negligible to minor adverse effects, depending on the particular location and predicted fire risk and fire hazard on Service lands and the resources and values damaged or destroyed.	This fuel model would likely remain the same. This fuel model is not a priority for treatment due to the current very low ROS and FL. Maintaining the fuel model would provide long-term negligible to minor beneficial effects by maintaining the current very low predicted fire risk and fire hazard on Service lands and in CWPP and COI areas. If a wildfire were to occur, there could potentially be short-term negligible to minor adverse effects, depending on the predicted fire risk and fire hazard on Service lands and CWPP and COI areas and the resources and values damaged or destroyed.
TL6 (186)	Moderate Load Broadleaf Litter ROS: moderate FL: low	The goal of any treatments in this fuel model would be to reduce the ROS from moderate to low. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard on Service lands. If a wildfire were to occur, there could potentially be short-term negligible to minor adverse effects, depending on the particular location and predicted fire risk and fire hazard on Service lands and the resources and values damaged or destroyed.	The goal of any treatments in this fuel model would be to reduce the ROS from moderate to low. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by reducing the predicted fire risk and fire hazard on Service lands. If a wildfire were to occur, there could potentially be short-term negligible to minor adverse effects, depending on the particular location and predicted fire risk and fire hazard on Service lands and CWPP and COI areas and the resources and values damaged or destroyed.

Table 3-3. Direct and indirect effects on each fuel model at Kenai NWR (continued)

Fuel Model	Fuel Model Title	Alternative A: No Action, Continue Current Management	Alternative B: Strategic and Collaborative Hazardous Fuels and Wildfire Mitigation
SB1 (201)	Low Load Activity Fuel (Slash) or Debris from Wind Damage (Blowdown) ROS: moderate FL: low	The goal of any treatments in this fuel model would be to reduce the potential ROS from moderate to low, resulting in a potential fire behavior similar to TU4 or TU5. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by reducing fire risk and fire hazard on Service lands. If a wildfire were to occur, there could potentially be short-term negligible to moderate adverse effects, depending on the particular location and predicted fire risk and fire hazard on Service lands and the resources and values damaged or destroyed.	The goal of any treatments in this fuel model would be to reduce the potential ROS from moderate to low, resulting in a potential fire behavior similar to TU4 or TU5. Maintaining or improving the fuel model would provide long-term minor to moderate beneficial effects by maintaining the current very low predicted fire risk and fire hazard on Service lands and in CWPP and COI areas. If a wildfire were to occur, there could potentially be short-term negligible to moderate adverse effects, depending on the particular location and predicted fire risk and fire hazard on Service lands and CWPP and COI areas and the resources and values damaged or destroyed.
NB	Nonburnable (insufficient wildland fuel to carry wildland fire under any condition) <ul style="list-style-type: none"> • NB1 (91): Urban/Developed — these areas would not be adversely affected by mechanical treatments or prescribed fire or wildland fire, except for temporary smoke effects. • NB2 (92): Snow/Ice — these areas would not be adversely affected by mechanical treatments or prescribed fire or wildland fire. • NB6 (96): This fuel model is a custom model for wet vegetated areas that typically do not burn. • NB7 (97): This fuel model is a custom model for drier vegetated areas that typically do not burn • NB8 (98): Open Water: these areas would not be adversely affected by mechanical treatments or prescribed fire or wildland fire. • NB9 (99): Bare Ground — these areas would not be adversely affected by mechanical treatments or prescribed fire or wildland fire. 		

3.4 Biological Environment

The vegetation and wildlife on Kenai NWR are unusually diverse for this latitude because of the juxtaposition of two biomes on the Kenai Peninsula: (1) the northern fringe of the Sitka spruce-dominated coastal rainforest on the eastern side of the Kenai Mountains, and (2) the westernmost reach of boreal forest in North America on the western side of the Kenai Mountains. The forests on the Refuge are dominated by white and black spruce with a mixture of aspen and birch. Extensive peatlands are interspersed among spruce in the Kenai Lowlands on the northern part of the Refuge. Lichen-dominated tundra replaces hemlock and subalpine shrub above the tree line in the Kenai Mountains and Caribou Hills. The Refuge has documented 1,086 species of flora and fauna: 151 birds, 20 fish, 30 mammals, 164 arthropods, 484 vascular plants, 97 fungi, 35 lichens, 14 liverworts, 90 mosses, and 1 other invertebrate. Eighteen formations have been classified on the Refuge under the National Vegetation Classification System.

The Comprehensive Conservation Plan (CCP) for the Kenai NWR contains extensive information about the biological environment of the refuge. The CCP and other refuge information are located at the following websites:

Kenai NWR website: <http://www.fws.gov/refuge/kenai/>

Refuge planning website for the 2010 CCP: <http://alaska.fws.gov/nwr/planning/kenpol.htm>

3.4.1 Affected Environment—Vegetation

Eighteen landscape types were classified on the Refuge, including 12 terrestrial vegetation classes, 4 aquatic classes, and 2 abiotic classes (rock and ice). The landscape classes correlate to the fuel models presented in Table 3-2 above. The 18 landscape types in Table 3-4 are grouped in this section according to “Grasslands and Shrubs,” “Forests and Woodlands,” and “Wetlands (Fens and Peatlands) and Riparian Habitats.”

Table 3-4. The 18 landscape types on Kenai NWR

Landscape Type	Percentage	Acres
Hardwood	5.274	99,910
Mixed hardwood-softwood	18.359	347,803
White spruce	9.683	183,439
Black spruce	15.344	290,690
Mountain hemlock	1.613	30,564
Wetland	2.649	50,177
Herbaceous/grass	3.08	58,344
Shrub (alder)	4.315	81,752
Shrub (non-alder)	0.363	6,884
Alpine tundra	6.888	130,491
Alpine shrub	5.413	102,549
Streams (non-anadromous)	0.089	1,693
Streams (anadromous)	0.2	3,798
Lake (rearing)	5.895	111,684
Lake (non-rearing)	1.956	37,063
Estuarine	0.703	13,314
Rock	9.18	173,905
Ice	8.996	170,421

The stream, lake, estuarine, rock, and ice landscape types would not be affected by fuel reduction treatments, so they are not discussed in this document.

3.4.1.1 Grasslands and Shrublands

Grasslands

The grassland areas include several species of grasses, a large variety of sedges (Cyperaceae family), and forbs (refer to Appendix F in the Refuges 2010 CCP, p. 11).

The grassland habitat type is a composite of naturally occurring patches of bluejoint reedgrass, mostly linear features associated with human disturbance such as right-of-ways, pipeline corridors, and roadsides. Bluejoint reedgrass currently represents 3% of the Refuge but will likely increase in the future as it replaces stands of beetle-killed spruce. Although bluejoint reedgrass is native, it can be highly invasive and suppress stand regeneration for many decades (Berg 2005).

Shrublands

Lowland Shrub

This vegetation type occupies 5% of the Refuge and is dominated by permanent shrub communities, primarily willow and alder (particularly *Alnus crispa* subsp. *sinuata*, *A. incana* subsp. *tenuifolia*). These communities are typically on sites disturbed frequently by water, wind, or sliding snow.

Subalpine Shrub

This vegetation type occupies 5% of the Refuge and is dominated by alder thickets in the ecotone between forest (generally mountain hemlock or white spruce) and alpine tundra. An important area for brown bear denning, it provides cover while brown bears feed in adjacent habitats. Some of the plant species that occur frequently in this vegetation type include Barclay's willow (*Salix barclayi*), diamond-leaf willow (*S. pulchra*), under-green willow (*S. commutate*), Richardson's willow (*S. richardsonii*), gray-leaf willow (*S. glauca*), and arctic willow (*S. arctica*) are common willows in these thickets. Boreal sagebrush (*Artemisia arctica*), black crowberry (*Empetrum nigrum*), lingonberry, narcissus-flowered anemone (*Anemone narcissiflora*), cloudberry, starflower, alpine blueberry (*Vaccinium uliginosum*), and monkshood (*Aconitum delphinifolium*).

Alpine Shrub-Lichen Tundra

This vegetation type covers about 7% of the Refuge in the Kenai Mountains. About 87% of this type is composed of dwarf shrub and lichen tundra, and 13% is tall shrub (alder and willow) thickets usually associated with tundra. This is habitat for several wildlife species, including caribou (*Rangifer tarandus*), Dall sheep (*Ovis dalli dalli*), and ptarmigan (*Lagopus lagopus*).

3.4.1.2 Forests and Woodlands

Black Spruce

Black spruce occupies 15% of the Refuge (or 30% of forests on the Refuge). This landscape type is dominated by black spruce, much of which is in the Kenai Lowlands north of the Sterling Highway. Wildfire is frequent, with an MFRI of more than 80 years. Large fires in 1947 and 1969 established much of the age-class distribution in this forest type. More than 45% of black spruce forests are in the 41- to 60-year class, with 5% estimated to be less than 40 years old. Following fire, black spruce is often converted to early successional hardwood species, providing high-quality, abundant moose browse for as long as

35 years post-fire. Vascular flora that occur frequently in this landscape type on the Refuge include dwarf birch (*Betula nana*), paper birch (*Betula neoalaskana*), bluejoint reedgrass, crowberry (*Empetrum nigrum*), field horsetail (*Equisetum arvense*), false toadflax (*Geocaulon lividum*), narrow-leaf labrador tea (*Ledum palustre*), twinflower (*Linnaea borealis*), trembling aspen (*Populus tremuloides*), bog labrador tea (*Rhododendron groenlandicum*), prickly rose (*Rosa acicularis*), arctic blackberry (*Rubus arcticus*), cloudberry (*Rubus chamaemorus*), and lingonberry (*Vaccinium vitis-idaea*).

White Spruce

White spruce represents almost 10% of the Refuge (or 19% of the forests on the Refuge). This vegetation type is dominated by white spruce and Lutz spruce (*Picea X lutzii*), a hybrid between Sitka (*Picea sitchensis*) and white spruce, with occasional scattered paper birch (*Betula papyrifera*) or quaking aspen (*Populus tremuloides*) in the overstory canopy. It occurs mostly in the Kenai Mountains and uplands of the Caribou Hills and Tustumena Benchlands. Since the 1985 CCP was completed, spruce bark beetles have killed most mature white and Lutz spruce south of Tustumena Lake, leaving standing and fallen snags with bluejoint grass in the understory.

As a result of beetle-induced mortality, 50% of the white spruce forest is estimated to be in the early stages of regeneration. Less than 5% of white spruce is old growth (less than 150 years old), suggesting that remnant stands are a rare habitat on the landscape. Other vascular flora that occur frequently in this landscape type on the Refuge include bluejoint grass, field horsetail, false toadflax, twinflower, pink pyrola (*Pyrola asarifolia*), wintergreen (*Pyrola secunda*), prickly rose, arctic raspberry (*Rubus arcticus*), strawberryleaf raspberry (*Rubus pedatus*), marsh fern (*Thelypteris dryopteris*), starflower (*Trientalis europaea*), and lingonberry.

Spruce Bark Beetle in Black and White Spruce Forests

The spruce bark beetle is the dominant agent of disturbance in spruce forests of the Kenai Peninsula. Beetles selectively attack mature spruce trees (more than 6 inches diameter at breast height) because large slow-growing trees are less able to resist the establishment of adult female beetles in the phloem (food-carrying tissue of a plant). Bark beetles are always active somewhere on the Peninsula at low levels; there have been repeated outbreaks over the last 250 years with an average return interval of 52 years (Berg et al. 2006). However, the outbreak of the last 20 years has been of unprecedented size and intensity. Beetles infected 4 million acres of forested land in southcentral Alaska, of which more than 800,000 acres on the Kenai Peninsula experienced 80%–90% spruce mortality. Increasing temperatures and drought stress due to of global warming are likely increasing the rate of spruce bark beetle outbreaks on the Peninsula (Berg et al. 2006).

Mountain Hemlock

Mountain hemlock (*Tsuga mertensiana*) occupies less than 2% of the Refuge (or 3% of forests on the Refuge). It generally grows in a high-elevation band between white and Lutz spruce and alpine shrub-tundra. Almost all (98%) of the hemlocks on the Refuge are estimated to be more than 80 years old, so they represent an important source for old-growth forest for wildlife species, such as marten (*Martes americana*), that depend on these forests.

Hardwoods

This vegetation type occupies 5% of the Refuge (or 10% of the forests on the Refuge). This type is characterized primarily by paper birch and, to a lesser extent, quaking aspen and balsam poplar

(*P. balsamifera*). Although this forest type is fairly well distributed across all age classes, more than 50% is estimated to be less than 60 years old. Early successional and intermediate-stage hardwood, which constitute about 40% of the Refuge, are important habitat for moose and snowshoe hares, birds, and other wildlife.

Mixed Hardwood–Softwood (Conifers)

The mixed hardwood and softwood (or broadleaf and needleleaf [conifers]) vegetation type occupies 18% of the Refuge (or 36% of all forests on the Refuge). Several alliances (Viereck et al. 1992) make up this forest type; the most common are spruce–paper birch–balsam poplar, quaking aspen–spruce, and spruce–paper birch. The mixed hardwood-softwood forests are mostly mature, with 70% of this type estimated to be more than 120 years old. This vegetation type may be a transitional stage from hardwood to softwood.

3.4.1.3 Wetlands (Fens and Peatlands) and Riparian Habitats

Sphagnum moss-dominated fens and peatlands are defined by periodic saturation or coverage of the soil by water. Only 3% of Refuge lands are wetlands, but they are valuable wildlife habitat, contributing to populations of 96 vertebrate species. Due to a warmer and drier climate, black spruce seedlings and shrubs (*Vaccinium* spp., *Betula nana*) have encroached on these wetlands in the past half century (Klein et al. 2005).

Riparian habitats contain various terrestrial plant communities distinguished by their association with lakes, ponds, and streams. Riparian habitat makes up only 5% of the Refuge but it is perhaps the most valuable wildlife habitat. It is essential to 36 species of birds (26% of the species that breed on the Refuge) and is used by every other species occurring on the Refuge). These birds depend on mature cottonwood (*P. balsamifera* subsp. *trichocarpa*) or quaking aspen trees for nest sites.

3.4.2 Environmental Consequences—Vegetation

3.4.2.1 Alternatives A and B

Both alternatives could result in potential beneficial and adverse effects on vegetation. For all vegetation types, a possible adverse effect of prescribed fire is that the fire could escape beyond the boundary of the planned burn and affect desirable grass and shrub species; especially those species not fire adapted or resilient to disturbance. In areas where native plant species might not recover following a fire (includes both prescribed fire and wildfire), adverse effects could be both short and long term if invasive species spread and outcompete the native species for resources (sunlight, moisture, soil nutrients) in the burned areas. Adverse effects would range from minor to major, depending on vegetation type, the extent of the fire and fuel load, and potential for invasive plants to spread into the disturbed areas.

The use of heavy equipment to carry out mechanical treatments will be closely monitored to minimize adverse effects on nontarget vegetation. Any disturbance to surrounding vegetation during mechanical removal of hazardous fuels could result in temporary to short-term minor adverse effects.

The environmental consequences for specific vegetation types are described below.

3.4.2.2 Grasslands and Shrublands

Grasslands

One of the primary management concerns related to grasslands is the invasion of shrubs, trees, invasive plants, and noxious weeds into grasslands. Even some species of native plants can be highly aggressive, moving into disturbed areas and preventing the growth of other species that may be more desirable for a variety of reasons, including fuels characteristics. One such concern is bluejoint reedgrass in WUI areas and beetle-killed areas.

Beneficial Effects

Prescribed fire in grasslands would result in a reduction of fuel loads, thus fire hazard, and beneficial effects would be minor to moderate over both the short and long term.

Fire would result in other long-term beneficial effects because fire kills woody plants, allowing sunlight to reach the soil and changing the soil pH and nutrient availability (NIFC 2010; USFWS 2010a). Native grasses and forbs have greater seed production, germination, and establishment after a fire because burning allows plant nutrients to be returned to the soil and used again. Fire promotes the growth of native grasses and forbs, providing a competitive advantage for the native species. The productivity of native plant species usually increases following a fire, and growth is stimulated by the removal of litter and preparation of the seedbed (mowing is not a good replacement for fire because it does not reduce plant litter).

There would also be long-term minor to moderate beneficial effects from mechanical treatments to remove bluejoint reedgrass and invasive shrubs and trees that have become established on grasslands.

Adverse Effects

Long-term minor to moderate adverse effects could result if fire caused bluejoint reedgrass to spread. Light surface burning tends to increase the abundance of bluejoint reedgrass (Dyrness and Norum 1983; Smith and Janes 1978; Viereck et al. 1992). Fire will kill above-ground vegetation of bluejoint reedgrass. Following low-severity fires, bluejoint reedgrass will typically sprout from on-site surviving rhizomes, but severe fires will also kill belowground rhizomes (Smith and Janes 1978; Sylvester and Wein 1981). Buried or wind-dispersed seeds may be the primary source of plant establishment on severely burned sites (MacDonald and Lieffers 1991; Sylvester and Wein 1981).

Shrublands

Beneficial Effects

As explained in the wildlife section below, some species, such as the moose (*Alces alces*) and snowshoe hare (*Lepus americanus*), inhabit lowland shrubland vegetation, such as willows. Following light fires, most willows (such as feltleaf willow [*Salix alaxensis*]) recover quickly, sending up new shoots from undamaged root crowns. Few, if any, seedlings establish following this type of burn because organic soil layers are only partially consumed, preventing seedling establishment. Severe fires in these vegetation types can kill willows by completely removing soil organic layers and charring the roots (Zasada 1986). Sprouts develop more rapidly than seedlings and can reach heights over 20 inches after the first growing season. The density of Feltleaf willows probably increases or remains constant for up to 30 years after a forest fire, but thereafter declines as young trees overtop it (Foote 1983; Parminter 1984).

In addition, fuel reduction actions using fire and/or mechanical treatments in low shrub areas would result in long-term beneficial effects because fire behavior during any future wildland fires may not be high or extreme and would be easier to suppress.

Adverse Effects

The adverse effects that could result from the use of fire or mechanical treatments in shrublands would be the same or similar to those described above for grasslands.

Subalpine and alpine shrub-lichen tundra areas are not a priority for fuel-reduction treatments because the predicted fire behavior is currently low. However, a naturally occurring wildland fire could result in the same beneficial effects on shrub growth (such as willow) as described above and similar adverse effects.

3.4.2.3 Forests and Woodlands

White and Black Spruce

Beneficial Effects

Fuel reduction treatments would focus on removing the dead standing and downed spruce killed by the spruce bark beetle or other natural disturbances such as wind events. This is cause for concern because wind-thrown spruce provide prime breeding habitat for spruce beetles that can subsequently move into adjacent live standing trees. Another focus of fuel-reduction treatments is to thin, remove, or convert black spruce forests and woodlands to a less flammable condition. Mitigation is critical because hazardous fuels and falling trees can also impact watershed resources and human health and safety. The beneficial effects would range from minor to major over the long term because the fire hazard would be lower when fuel loads are reduced or removed, and potential fire behavior is moderated. The reduction or removal of fuels (such as shrubs, small trees, low vegetation, and dead standing trees) or the thinning of crowns of live trees can create conditions where soils and ground vegetation are exposed to more sunlight.

Adverse Effects

Contrary to the beneficial effects, there could be potential adverse effects when ground vegetation, such as grasses, are exposed to more sunlight, which may dry grasses faster following the reduction or removal of hazardous fuels. Dry fuel is much more combustible, and it is generally the grass fuel, leaf litter, and small twigs that will permit a fire to take hold in the first place since they are able to reach combustion temperature comparatively fast. The adverse effects could be both short and long term and could range from minor to moderate if too much drying occurs, creating more unwanted fuels and increasing the fire hazard.

Mountain Hemlock

Beneficial Effects

As stated earlier, 98% of the hemlocks on the Refuge are more than 80 years old and represent an important source for old-growth forest for species (such as marten) that depend on these forests. Protecting these forests through fuel-reduction treatments would result in long-term beneficial effects as ground fuels (forest litter) and ladder fuels (low-lying branches and shrubs) are removed, thus serving to reduce the behavior (rate of spread and flame length) of any future wildland fire in these areas.

Adverse Effects

The adverse effects would be the same or similar to those described above for black and white spruce.

Hardwoods

Beneficial Effects

The goal of any fuels treatments in these areas would be to keep the fuel load, thus fire hazard, as low as possible and fire behavior that has a low rate of spread and flame length. Fire can promote growth of hardwood through either seeding or resprouting. Severe fires will kill trees rather than stimulating sprouting but may promote seed establishment

Adverse Effects

In terms of hazard fuel, however, most deciduous trees are fire-resistant, and such plants do not readily ignite. They may be damaged or even killed by fire, but their foliage and stems do not significantly contribute to a fire's intensity.

Mixed Hardwood–Softwood (Conifers)

Beneficial Effects

About 70% of this vegetation type is estimated to be more than 120 years old. These stands include both white/Lutz spruce and black spruce mixed with aspen, birch, cottonwood, and poplar and a wide range of stand conditions. In some stands, spruce bark beetles have killed a high percentage of the white/Lutz spruce, leaving mature hardwoods and downed dead spruce with grass, forb, and shrub understories. The beneficial effects would be the same or similar to those described above for black and white spruce, hemlock, and hardwoods.

Adverse Effects

The adverse effects would be the same or similar to those described above for black and white spruce, hemlock, and hardwoods.

3.4.2.4 Wetlands (Fens and Peatlands) and Riparian Habitats

There would be no fuels treatments in wetlands or riparian areas to reduce encroachment of trees (such as black spruce) into these areas. Riparian vegetation often contains mixed spruce/deciduous species, but these areas are not a high priority target for fuel-reduction projects.

3.4.3 Affected Environment—Wildlife

Appendix F of the 2010 CCP for Kenai NWR contains an extensive list of wildlife species identified on the Refuge, including 164 insects, 151 birds, 30 mammals, and 20 fish. The CCP is available at <http://alaska.fws.gov/nwr/planning/kenpol.htm>.

3.4.3.1 Special Status Wildlife Species

There are no federally listed threatened or endangered species known to breed or overwinter on the Refuge, but the following is a candidate species for federal listing:

- The Kittlitz's murrelet (*Brachyramphus brevirostris*) likely nests on the southern unit of the Refuge. Three records of Kittlitz's murrelet nesting on lands adjacent to the Refuge south of Kachemak Bay exist (Piatt et al. 1999). There are also some concentrated feeding areas on Kachemak Bay just below the mountainous alpine habitat on the Refuge that match habitat where previous nests were discovered (Angler et al. 1998). This is very similar to the characteristics described from the two other nests found nearby (Day et al. 1983). During summer, habitats are characterized by close proximity to tidewater glaciers and waters offshore of remnant high-elevation glaciers and deglaciated coastal mountains. Their eggs are typically laid on bare ground in unvegetated scree fields, coastal cliffs, rock ledges, and talus above timberline in coastal mountains. This species would not be affected by prescribed fire or wildland fire.

In April 2006 the Alaska Department of Fish and Game (ADF&G) completed its comprehensive wildlife conservation strategy titled, *Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources* (ADF&G 2006), which is supported through the State Wildlife Grant program. The ADF&G currently uses the comprehensive wildlife conservation strategy to assess the needs of species with conservation concerns and to prioritize conservation actions and research. Appendix 4 of the strategy contains conservation action plans for wildlife species and species groups. The species specifically mentioned in Appendix 4 for the Kenai Peninsula include the following:

- Kenai red squirrel (*Tamiasciurus hudsonicus kenaiensis*), whose range is the forested habitat of the Kenai Peninsula. The greatest concern for the red squirrel and marten is the degraded to very degraded habitat condition as a result of forest loss due to bark beetle infestation on an unprecedented scale and the replacement of standing forests with grasslands (ADF&G 2006). The decline in squirrel populations could adversely affect predators.
- Kenai marten (*Martes americana kenaiensis*). Small isolated populations of marten may be at risk from habitat loss (as described for the red squirrel) and overtrapping.

Several species with conservation concerns identified by the state can be found on the Refuge:

- American peregrine falcon (*Falco peregrinus anatum*)
- Steller's eider (*Polysticta stelleri*)
- Olive-sided flycatcher (*Contopus cooperi*)
- Gray-cheeked thrush (*Catharus minimus*)
- Townsend's warbler (*Dendroica townsendi*)
- Blackpoll warbler (*Dendroica striata*)
- Brown bear (*Ursus arctos horribilis*), Kenai Peninsula population

The following are several local populations of terrestrial wildlife species that have been identified by Refuge staff as *species of special interest*:

- A subspecies of red fox (*Vulpes vulpus kenaiensis*)— very rare; potential candidate for local extirpation; candidate for restoration efforts

- Marten—very low densities on the western portion of the Peninsula; candidate for restoration efforts
- Northern goshawk (*Accipiter gentilis*)—regionally and locally rare
- Wolverine (*Gulo gulo luscus*)—declining harvest and population estimates; apparent decline
- Marbled murrelet (*Brachyramphus marmoratus*)—unknown nesting occurrence

3.4.3.2 Birds

The Refuge provides a mosaic of habitat types and contributes to a very diverse avian population. Habitats where birds are found range from unvegetated rock outcroppings in the middle of the Harding Icefield (at almost 6,000 feet elevation) to estuarine wetlands along Chickaloon Bay at sea level. Of the 192 bird species recorded on or just adjacent to the Refuge, 113 are known to breed in the area.

The categories of bird species on the Refuge include passerines, raptors, waterfowl, marsh and waterbirds, shorebirds, and marine birds.

3.4.3.3 Mammals

Carnivores

Black bears (*Ursus americanus*) are estimated to number 3,000 on the Kenai Peninsula (Suring and Del Frate 2002). They are widely distributed in most forest habitats on the Refuge and also occur above the tree line in the Kenai Mountains. Brown bears (*Ursus arctos*) occur in southeastern Alaska, on Kodiak Island, on the Kenai Peninsula, along the Alaska Peninsula, and in coastal areas. The Kenai Peninsula brown bear population was estimated to be 624 in 2010 (Morton et al. 2013).

Ungulates

Moose are the primary ungulate species on the Refuge and commonly occur on the Kenai Lowlands as well as in the Kenai Mountains. During deep-snow winters, moose tend to move into mountain valleys and onto the Kenai Lowlands.

After being extirpated around 1912, caribou were reintroduced in the mid-1960s and again in the mid-1980s from the Nelchina herd. Since 1985, caribou have increased from less than 400 animals in two herds to more than 1,000 animals in four herds.

Only two complete censuses of Dall sheep were done on the Kenai Peninsula. In 1968, estimates were 2,200–2,500 animals; while in 1992, population size was estimated at 1,508–1,774. There are 12 count areas on the Kenai Peninsula. The count area from Killey Glacier to Tustumena Glacier continues to have the highest numbers of sheep. Data from ADF&G's annual survey and inventory reports suggest that the caribou population may be declining. Severe winter weather, competition with Dall sheep, and overharvesting may be causing a decline.

Small Mammals

Some of the small mammals that can be found on the Refuge include Vagrant shrew (*Sorex vagrans*), masked shrew (*Sorex cinereus*), dusky shrew (*Sorex monticolus*), pygmy shrew (*Sorex hoyi*),

singing vole (*Microtus miurus*), tundra vole (*Microtus oeconomus*), northern red-backed vole (*Clethrionomys rutilus*), and northern bog lemming (*Synaptomys borealis*).

The little brown bat (*Myotis lucifugus*) is found on the Refuge, but little is known about its distribution and movements.

Furbearers

The Refuge's river otter (*Lontra canadensis*) population appears to occur in relatively low numbers. River otters hunt on land and in fresh and salt water. They eat snails, mussels, clams, sea urchins, insects, crabs, shrimp, frogs, a variety of fish, and occasionally birds, mammals, and vegetable matter.

Beaver (*Castor Canadensis*) are most common in the northern region of Kenai Refuge, but observed colony densities are low compared to apparent, available habitat and colony densities reported in similar habitats.

The least weasel (*Mustela rixosa*) and the short-tailed weasel or ermine (*Mustela erminea*) range over North America and are found throughout most of Alaska. The short-tailed weasel is found on the Refuge. There are recent documented reports of least weasel from the southern portion of the Kenai Peninsula and many scattered unconfirmed sightings elsewhere.

Little is known about the status of the Refuge's mink (*Mustela vison*) and muskrat (*Ondatra zibethicus*) populations, which are thought to be largely regulated by habitat conditions.

Other furbearers on the Refuge include wolverine (*Gulo gulo*), lynx (*Lynx canadensis*), coyote (*Canis latrans*), wolf (*Canis Lupis*), red fox, and marten.

3.4.3.4 Herptiles (Reptiles and Amphibians)

The wood frog (*Rana sylvatica*) is the only amphibian known to occur on the Refuge.

3.4.3.5 Fish

Waters within the Refuge support 21 different species of fish that include both anadromous and resident species. Five species of Pacific salmon are native to waters of the Refuge: Chinook (*Oncorhynchus tshawytscha*), sockeye (*Oncorhynchus nerka*), coho (*Oncorhynchus kisutch*), pink (*Oncorhynchus gorbuscha*), and chum salmon (*Oncorhynchus keta*). In addition, rainbow trout (*Oncorhynchus mykiss*), Dolly Varden (*Salvelinus malma*), Arctic char (*Salvelinus alpinus*), and lake trout (*Salvelinus namaycush*) are native to the Refuge. Arctic grayling (*Thymallus arcticus*) and northern pike (*Esox lucius*) are both exotic fish species that occur on the Refuge.

3.4.4 Environmental Consequences—Wildlife

3.4.4.1 Alternatives A and B

The wildlife species summarized above may inhabit, breed, forage in, or migrate through more than one habitat type; that is, grassland, shrubland, forest/woodland, or wetland/riparian areas. The effects discussions are organized according to vegetation community and how wildlife could be affected by fuel reduction treatments and wildland fire suppression in a particular habitat type.

3.4.4.2 Grasslands and Shrublands

The wildlife species that inhabit grassland areas would benefit from a greater abundance of native grass and forb species. Protecting native plant species would help maintain the diverse structure in grass fields that creates cover and nesting sites for an array of grassland-dependent wildlife that already inhabit Refuge lands or more that could in the future. Native grasses provide nesting, brood rearing, escape, and roosting cover. The presence of forbs in managed grasslands is important because they diversify structure and invertebrate resources. Many bird species are most abundant in fields with a strong forb component. Plant diversity increases food sources, such as seeds, in addition to increasing the number of different insects that use a grassland area, and insects are an extremely important food source for young birds as they begin to grow and fledge.

Prescribed Fire

The effects of prescribed fire on wildlife can be both adverse and beneficial. Prescribed fire used to reduce fuel loads can have secondary beneficial effects by improving habitat, which is a value to wildlife. For example, depending on shrub component, fire could stimulate sprouting of willows (refer to the Grasslands discussion above in Section 3.5.1.10), which would benefit moose and snowshoe hares. Berry production can be stimulated by fire, benefitting species (such as birds, small mammals, furbearers, and bears) that feed on berries (for example, squashberry (*Viburnum edule*), lingonberry, blueberry (*Vaccinium uliginosum*), and nagoonberry (*Rubus arcticus*)).

Fire removes dry, dead plant matter that has built up over the years, opening up space for new growth and creating thicker, younger cover and increasing food availability by stimulating seed production (USFWS 2010a). The burned areas provide better nesting cover and attract ground-nesting birds. The burned areas also provides improved brood-rearing habitat by increasing the amount and variety of food available for young birds. Prescribed fire would produce long-term minor to major beneficial effects on grassland wildlife.

Any potential negligible to minor adverse effects on grassland and shrubland wildlife can be minimized by planning spring burns early enough to avoid the breeding and nesting season of most wildlife. Birds and some mammals usually leave the area ahead of the fire (USFS 2012). Few animals are unable to escape prescribed fire, and small mammals that inhabit grasslands find shelter by burrowing under a log or staying in an underground burrow (this is also true of the wood frog). Any nests destroyed by the fire are usually replaced through re-nesting (USFS 2012).

Mechanical Treatments

Wildlife may be displaced during mechanical treatments, which would result in temporary negligible to minor adverse effects, depending on the extent of treatment. Adverse effects would increase to minor or moderate and last longer as a result of fuel break construction or maintenance activities if burrows are covered or ground fuels (such as litter or logs) that provide cover are removed.

Fire Suppression

Suppression actions would result in both adverse and beneficial effects. Adverse effects could be minor to major and long term, depending on the size of the fire, the extent of firelines or fuel breaks (if created), and the location of the wildfire in relation to wildlife habitat threatened (particularly critical habitat). Beneficial effects on wildlife would be realized if suppression efforts protected important habitat

areas or minimized loss of habitat. Beneficial effects would be immediate and long term and range from minor to major.

Fire-fighting foams and retardants are often necessary to contain and extinguish wildfires. The Patuxent Environmental Science Center conducted a study on the impacts of wildfire control chemicals on terrestrial vertebrates and invertebrates. Small mammals were selected for primary focus in the study since they are not highly mobile and were expected to be exposed to the chemical within the treated area. Birds, however, likely foraged outside the study site. Further, the density of small mammals was expected to be greater inside the study area than birds. Eggs and nestlings of birds nesting in the study sites were monitored because they may have been exposed to the chemical via direct contact or ingestion.

Small mammal trapping data indicated the meadow vole (*Microtus pennsylvanicus*) was the most common mammal species. Other species trapped included the thirteen-lined ground squirrel (*Citellus tridecemlineatus*) and field mouse (*Peromyscus* spp.). Only the meadow vole was abundant enough for statistical analysis. Study results indicate that there were no effects on the survival rate or and population size for the meadow vole.

Adams and Simmons (1999) summarized results of studies on the ecological effects of fire fighting foams and retardants. White-footed mouse showed no mortality or signs of sub-acute toxicity for any product tested. However, Silv-Ex foam caused periods of stupor and lack of coordination but no mortality in exposed kestrels, and some mortality of red-winged blackbirds exposed to two retardants was recorded. Exposure to 0.3% Silv-Ex foam produced no effects on the survival rate or population size of meadow mole (*Microtus pennsylvanicus*), and no effects on ants were recorded (Vyas et al. 1996). Although no toxicological studies appear to have been carried out on any native vertebrates, the long-term effects of fire retardants and foams appear to be minimal.

Another study (MTDC 2007) states that “Permanent or persistent exposures through [terrestrial] environmental pathways are not expected, since the application “footprint” of these chemicals is quite limited in terms of foraging areas and species habitat for any individual animal, and the ingredients generally degrade in the environment. Although bioaccumulation was evaluated in simple predator-prey scenarios, the potential for long-term biomagnification in the terrestrial food web was not evaluated for this same reason.”

MTDC (2007) notes that the surfactants in the foams were predicted to pose risks to aquatic species from runoff containing residues of fire-fighting chemicals. The quantitative risk assessment (MTDC 2007) for aquatic species from individual ingredients in the firefighting chemical products predicted the following:

- Runoff: No risks were predicted for survival of populations of non-sensitive species. Risks to survival of individuals of sensitive fish species in small streams in some ecoregions were associated with a surfactant in one foam product. Risks to survival of individuals of sensitive fish and aquatic stages of amphibians in small streams in some ecoregions were predicted from a surfactant in one water enhancer.
- Accidental application across stream: All retardant and foam products present risk to survival of populations or individuals of one or more aquatic species if applied across a

small stream. In a large stream, sufficient dilution was achieved to decrease the risk to negligible.

- Accidental spill: All concentrated and mixed retardant and foam products present risk to one or more aquatic species if spilled into a small stream at the volumes assumed in risk assessment. In a large stream, sufficient dilution was achieved to decrease to the risk to negligible.

The study (MTDC 2007) also explains that because fire-fighting chemicals can be used anywhere that a wildland fire occurs, the physical, chemical, and biological attributes of the natural system in which the chemicals are deposited will have a great impact on the environmental transport and fate of chemicals in that system, including the concentration of chemicals in water, soil, or as residues on terrestrial species diet items.

Mitigation measures, included under each fire management unit (FMU) described in Chapter 2, states that retardants and foams will not be used within 300 feet of any waterway. The reason for this mitigation measure is that study results on fire retardants, such as Phos-Chek D75-F, and foams, such as Silv-Ex, showed that the foams were 10 times more toxic to fish, such as rainbow trout and chinook salmon, and between 10-258 times more toxic for fathead minnow than the fire retardants tested. The toxic component of retardant chemicals in aquatic systems is ammonia (McDonald et al. 1996), and fish are less tolerant than are macroinvertebrates. In contrast, the higher toxicities of foams to aquatic invertebrates, such as *Daphnia* and *Hyaella*, is due to the surfactants they contain, which lower the surface tension of water and decrease the ability of aquatic organisms to obtain oxygen (McDonald et al. 1996).

Adhering to the operational constraints when retardants and foams are used during a wildfire would prevent or reduce the potential for adverse effects on aquatic wildlife in all areas of the refuges.

3.4.4.3 Woodlands and Forests

The woodland and forest areas on the refuges provide feeding, resting, breeding, and wintering habitat for a diversity of native forest-dwelling birds, mammals, reptiles, amphibians, and invertebrates. The actions taken to protect the woodland and forests areas would provide long-term minor to major benefits to wildlife.

Some minor to moderate disturbance to wildlife may occur when conducting fuel reduction and other vegetation treatments. Any adverse effects would be negligible to minor and temporary, lasting only as long as it takes to complete the action. It is unlikely that any wildlife would be permanently displaced. The beneficial effects that would result from increasing the amount of native woodland and forest habitat would be moderate to major over the long term.

Prescribed Fire

As with prescribed fire in grassland habitat (refer to the “Grasslands and Shrublands” section above), the effects on woodland and forest wildlife could be both adverse and beneficial. Fuel reduction using prescribed fire would result in greater protection to residual, unburned woodland/forest habitat, which is a benefit to wildlife.

Mechanical Treatments

The effects on wildlife would be the same as described above for “Grasslands and Shrublands.”

Fire Suppression

Caribou winter in spruce forests and woodlands and in open, windswept bogs where the snow is not too deep for foraging. While fire in lowland forests is considered beneficial to moose winter range, it is considered adverse to caribou winter range. The suppression of fires on caribou winter range that support forage lichens could benefit caribou by protecting winter range. Letting natural fires burn would adversely affect caribou.

3.4.4.4 Wetland, Riparian, and Marsh Wildlife

There would be no fuels treatments in wetlands or riparian areas to reduce encroachment of trees (such as black spruce) into these areas, thus there are no predicted adverse effects on wildlife species that nest, breed, or forage in these areas.

See the discussion above for the potential adverse effects of fire suppression chemicals on aquatic species.

3.5 Water and Soil

3.5.1 Affected Environment

3.5.1.1 Water Resources

The Kenai River, the largest river system on the Peninsula, drains about 2,148 square miles (5,563 square kilometers). Approximately 54% of the watershed is on the Refuge, 37% on the Chugach National Forest, and the remainder on private lands. Ten major tributaries feed the Kenai River system: Beaver Creek, Slikok River, Soldotna Creek, Funny River, Moose River, Killey River, Skilak River, Russian River, Cooper Creek, and Juneau Creek. Other Refuge river and stream systems flowing westward into Cook Inlet include Kasilof River (which drains Tustumena Lake), Deep Creek, and the Swanson, Fox, Ninilchik, and Chickaloon rivers.

There are thousands of lakes on the Kenai Peninsula—nearly all of them are on the Refuge. The largest are two glacial lakes, Tustumena Lake (73,000 acres) and Skilak Lake (25,000 acres). More than 4,600 smaller lakes dot the Refuge, mostly in the Moose, Swanson, and Chickaloon river drainages.

3.5.1.2 Soil

Soils of the Refuge are sedimentary, consisting of glacial deposits from the Alaska Range and alluvial/colluvial deposits from the Kenai Mountains, which are composed of shale. Soils can be sandy, silty, or gravelly and well-drained to poorly-drained. Some soils are sensitive to erosion, especially on slopes, and some soils are susceptible to compaction, especially wetlands and riparian areas. According to a 2008 permafrost map, there are some areas of isolated permafrost on the Kenai Peninsula (Jorgenson et al. 2010).

3.5.2 Environmental Consequences

3.5.2.1 Alternatives A and B

Prescribed Fire

Prescribed fires are usually low-severity fires by design because they are conducted when fuel loads, fuel moisture, and weather conditions are favorable for a low-intensity fire (Neary et al. 2005). Wildfires, on the other hand, are usually high-severity fires because they typically occur when temperature, wind speed, and fuel loading are high, and humidity and fuel moisture are low (Neary et al. 2005). Due to these burning conditions, wildfires often have greater effects on ecosystems than do prescribed fires.

Water. Fire can have either beneficial or adverse effects on the physical, chemical, and biological structure of aquatic systems. The effects of fire on water quality are dependent upon the fire size, intensity, and severity. Low-intensity fires have had little effect on stream water quality (Neary et al. 2005). Even where sedimentation and dissolved nutrients increase in stream water in response to burns, the amounts are often negligible.

Fire effects also depend on the proximity of fires to streams and other water sources as well as the timing of fires in relation to precipitation events. The effects of fire on aquatic ecosystems can be divided into direct and indirect effects. Direct effects may include increases in temperature, ash, nutrients, and

charcoal. The indirect effects of fire may include increases in sediment deposition and turbidity, and alterations channel morphology (Neary et al. 2005).

The main effect that burning can have on water quality is the potential for increased runoff of rainfall. Runoff may carry suspended soil particles, dissolved inorganic nutrients, and other materials into adjacent streams and lakes, reducing water quality and degrading fish habitat (Wade and Lundsford 1988). However, most studies indicate that adverse effects of prescribed fire on water quality are minor and of short duration.

Soils. Prescribed fire, as proposed in this EA, would be used to reduce fuel loads. However, a secondary beneficial effect of prescribed fire, regardless of the management goal, is site preparation to modify existing vegetation or physical site conditions to improve germination, survival, and subsequent growth of desired seedlings. One purpose of site preparation is to cause scarification, which modifies soil surface layers to loosen upper soil, to break up the organic layer, to expose mineral soil by removing undecomposed litter and humus; or to mix surface organic materials with mineral layers. The beneficial effects of scarification are improved seedbed conditions and increased root penetration and infiltration. Mixing organic materials with mineral soil increases decomposition, nutrient release, and moisture-holding capacity (Nyland 1996).

Fire may alter several physical soil properties, such as soil structure, texture, porosity, wettability, infiltration rates, and water holding capacity. The extent of adverse fire effects on these soil physical properties varies considerably, depending on fire intensity (a measure of the rate of heat released by a fire), fire severity, and fire frequency. In general, most fires do not cause enough soil heating to produce significant changes to soil physical properties (Hungerford et al. 1991). This is particularly true for low-intensity prescribed fires. Even where fires do cause direct changes to soil physical properties, their indirect effects on soil hydrology and erosion will vary greatly, depending on the condition of the soil, forest floor, topography, and climate.

The long-term adverse effects of fire on soil physical properties range from a single season to many decades, depending on the fire severity, rate of recovery as influenced by natural conditions, post-fire use, and restoration and rehabilitation actions. Persistent soil degradation following fire is more common in the cold and/or arid climates typical of the western United States.

The use of prescribed fire at the refuges would result in no effect or negligible adverse effects on soil properties but beneficial effects

Mechanical Treatments

Water and Soils. The use of chainsaws and other hand-held equipment to remove fuels, such as dead and downed black and white spruce, would not result in adverse effects on soils or water quality.

Fire breaks are generally created and maintained with mechanical treatments through the use of heavy equipment to remove heavy fuel concentrations, mow “green” firebreaks, grade two-track roads to remove vegetation, and to remove single or small groups of trees by hand. These activities would result in temporary or short-term minor to moderate adverse effects on soils that are directly disturbed but no effects beyond the treated area. There would be no long-term adverse effects on soil compaction. There would be no adverse effects on water quality.

Mechanical treatments are often used prior to or in conjunction with prescribed fire to both remove the cut material and prevent sapling trees from encroaching onto the treated site. These types of treatments would continue in order to prevent the further encroachment of invasive plants (such as black spruce) into grasslands and shrublands. These activities would result in temporary or short-term minor to moderate adverse effects on soils that are directly disturbed but no effects beyond the treated area. There would be no adverse effects on water quality.

Fire Suppression

Water and Soils. The effects on soils and water would be the similar to those described above for mechanical treatments.

Fire retardants and foams will not be used within 300 feet of any waterway, so there is little to no potential for adverse effects on water quality.

The commonly used foams all contain surfactants, foaming, and wetting agents. The foaming agents affect the rate at which water drains from the foam and how well it adheres to the fuel. These retardants lose their effectiveness once the water has evaporated or drained from them (Adams and Simmons 1999), thus there would be no adverse effect on soils.

3.6 Air Quality

In 1970 the Congress of the United States created the U.S. Environmental Protection Agency (EPA) and promulgated the *Clean Air Act* (CAA). Title I of the CAA established National Ambient Air Quality Standards (NAAQS) to protect public health. The NAAQS were developed for six criteria pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide, ozone, and lead.

Subsequent revisions to the particulate matter (PM) standard resulted in two new standards: PM₁₀ and PM_{2.5}. The first revision (1987) reduced the PM size that was considered harmful to humans, measuring for particles less than 10 micrometers (or microns) in diameter (PM₁₀). That standard was later revised (1997) to separate the PM₁₀ size particles into two size fractions: coarse and fine. The coarse PM fraction represents particles between 10 and 2.5 microns and fine PM represents particles 2.5 micron and smaller in diameter (PM_{2.5}). Thresholds limits established under the NAAQS to protect health are known as primary standards. The primary health standards are set to protect the most sensitive of the human population, including those people with existing respiratory or other chronic health conditions, children, and the elderly. Secondary standards established under the NAAQS are set to protect the public welfare and the environment. Table 3-5 lists the NAAQS.

Table 3-5. National Ambient Air Quality Standards

Pollutant	Average Time	Federal Primary Health Standard (NAAQS) Exceedance Level	State Standard Exceedance Level
Carbon monoxide	1-hour	35 ppm ¹	35 ppm
	8-hour	9 ppm	9 ppm
Lead	Calendar Quarter	1.5 µg/m ²	1.5 µg/m
Nitrogen dioxide	Annual	0.053 ppm	0.053 ppm
Ozone	8-hour	0.075 ppm	0.08 ppm
PM _{2.5}	24 hour	35 µg/m	
	Annual Average	15 µg/m	
PM ₁₀	24 hour	150 µg/m	150 µg/m
	24 hour	150 µg/m	150 µg/m
Sulfur dioxide	Annual Arithmetic Mean	0.03 ppm	0.02 ppm
	24 hour	0.14 ppm	0.10 ppm
	3 hour	*0.50 ppm secondary standard	0.50 ppm

Notes:

1. ppm = parts per million
2. µg/m = micrometers

3.6.1 Affected Environment

Air quality has become an increasing concern in recent years. Air quality issues and concerns are discussed in several of the annual narratives in which Refuge personnel specifically note that during clear, cold weather, a brown haze is often seen over Cook Inlet and the northern lowlands of the Refuge. Known sources of significant air pollutants include the Swanson River and Beaver Creek oil and gas fields,

Nikiski industrial complex (Tesoro refinery, Agrium), motorized traffic (snowmachines, automobiles, aircraft, motorboats, ATVs), smog from Anchorage, fires, and volcanoes. The Refuge does not have air-quality or visibility-impairment data.

The Refuge is designated as a Class I air quality area under the CAA because it was established prior to 1977. The CAA amendments clarified that Class II “floor” area boundaries, which include national wildlife refuges and wilderness areas having more than 10,000 acres, are to conform to boundary changes in the underlying park or wilderness area. Policy in the Refuge Manual (dated 28 June 1994, 563 FW 2, Air Quality Protection) states that information on air quality and air quality-related values of a Class II area are important for comprehensive management of these Refuge resources (USFWS Service Manual). Although the United States Environmental Protection Agency (EPA) or delegated state authority is not required to notify the federal land manager of proposed projects that may affect Class II areas, the EPA (or state) is required to evaluate whether such projects may cause the exceeding of the NAAQS or prevention of significant deterioration Class II increments in these areas. Wilderness areas that are Class II air-quality areas receive additional protection under the *Wilderness Act*, which requires the Service to minimize the effect of human use or influence on natural ecological processes and to preserve untrammeled natural conditions within wilderness areas.

The state of Alaska has been conducting air quality monitoring in the Kenai Peninsula Borough at a site in Soldotna since October 2011. Monitoring was initiated in response to staff observations of dust events and summer wildland fires on the Peninsula. The Soldotna location is designated as a special purpose monitoring (SPM) site. The Soldotna monitoring site EPA Air Quality System ID number is 02-0122-0008.

The Soldotna monitoring site shows that the major sources of PM₁₀ impacting this site are wind-blown glacial silt from the Kenai River and other stream beds, open unvegetated ground, and vehicular traffic, especially from unpaved roads. Major sources of PM_{2.5} matter includes wood smoke from residential heating, vehicular exhaust, and especially wildland fires. The Kenai Borough may also be subject to high levels of both PM₁₀ and PM_{2.5} following volcanic eruptions.

3.6.2 Environmental Consequences

3.6.2.1 Alternative A

Prescribed fire conducted at the Refuge would not contribute to nonattainment of the NAAQS. Adverse effects on local air quality and visibility would be negligible to minor and temporary from prescribed fire. The effects from wildfire are generally greater, depending on the type of fuels burning, weather conditions, size of the fire, and location.

Mechanical treatments and fire suppression actions would not contribute to nonattainment of the NAAQS.

There would be no cumulative effects from treatments on the Refuge when considered with present or future fuel reduction treatments that may be conducted on lands adjacent to Service lands.

3.6.2.2 Alternative B

The potential increase in prescribed fire conducted on the Refuge and CWPP and COI areas under this alternative would not contribute to nonattainment of the NAAQS. Adverse effects on local air quality

and visibility would be negligible to minor but temporary from prescribed fire. The effects from wildfire could be greater, depending on the type of fuels burning, weather conditions, size of the fire, and location.

Mechanical treatments and fire suppression actions would not contribute to nonattainment of the NAAQS.

There would be beneficial cumulative effects from treatments on the Refuge when considered with present or future fuel reduction treatments that may be conducted on lands adjacent to the Refuge.

3.7 Cultural Resources

3.7.1 Affected Environment

Archeological studies on the Kenai Peninsula began in the 1930s. Since then, only intermittent and nonsystematic work has been done with no comprehensive or systematic coverage of Refuge lands. Most of the Refuge has never been examined for cultural resources. Survey work has focused on very specific locations and usually as a response to development (such as the Swanson River oil fields and along the Sterling Highway corridor). Surveys along the Kasilof and Kenai rivers have followed development of campgrounds and other recreational facilities.

There are 104 known prehistoric sites on Refuge. All of these sites are reported on the Alaska Heritage Resources Survey. Of the 104 sites, at least 21 are included within the Sqilantnu Archaeological District, which is eligible for designation as an Archaeological District in the National Register of Historic Places. An additional 44 sites below Skilak Lake outlet are included in the Stephanka's Village are also eligible. CIRI, Inc., has applied for five sites on the Refuge under section 14(h)(1) of the 1971 *Alaska Native Claims Settlement Act*.

The Refuge has inventoried over 130 known historic cabins, but other historic resources, including those affiliated with mining, trapping, oil development, and road construction, have not been inventoried. The Refuge's Guide for Managing Cultural Resources (USFWS 1996) assists Refuge staff in meeting legal requirements to protect and manage cultural resources of the Refuge. It contains a list of relevant laws and guidelines and lists projects that are considered priorities for inventory, evaluation, protection, and dissemination of information.

3.7.2 Environmental Consequences

3.7.2.1 Alternatives A and B

Implementing the mitigation measures listed in Section 2.5 and Table 2.4 would serve to protect known cultural resources during fuel reduction activities. The mitigation measures do nothing to prevent damage to unknown resources because there would always be the likelihood of affecting unknown cultural resources, even with careful planning of prescribed burns and mechanical treatments. There could potentially be moderate to major adverse effects on cultural resources during a wildland fire, depending on the cultural resource and fire response. Reducing fuel loads in the vicinity of cultural resources would help protect valuable resources.

3.8 Service Values

3.8.1 Affected Environment

The purpose and need section in Chapter 1 explains that there is a need to protect significant values and assets at Kenai NWR. The estimated replacement cost of government-owned assets is \$102,909,849. The replacement cost includes assets such as administrative buildings (including furnishing and fixtures), public use cabins, government vehicles, heavy equipment, campgrounds, fences, information kiosks, signs, pedestrian boardwalks and bridges, observation decks, parking areas, public use comfort stations, utilities (gas and electric—piping, wiring, poles), and the Moose Research Center. This list is a sampling of the type of Service assets that could be at risk from a devastating wildfire.

3.8.2 Environmental Consequences

3.8.2.1 Alternatives A and B

There would be no adverse effects on Service assets from the proposed fuel-reduction treatments under both alternatives. Prescribe fire and mechanical treatments would result in beneficial effects by reducing fuel loads and creating fuelbreaks and buffers to protect Service assets and the natural and cultural resources on the Refuge. Suppression efforts would be conducted to protect assets, which would result in long-term beneficial effects.

Alternative A would not contribute to cumulative effects. There would be no cumulative adverse effects from treatments under Alternative B when considered with present or future fuel reduction treatments that may be conducted on lands adjacent to the Refuge. There would be beneficial cumulative effects when fuel reduction treatments conducted on and off refuge complement each other to increase effectiveness of all treatments.

3.9 Public Health and Safety

3.9.1 Affected Environment

The Kenai NWR lies within the Kenai Peninsula Borough (Borough), which is comprised of the Kenai Peninsula, Cook Inlet, and a large, mostly unpopulated area on the west side of Cook Inlet and northeast of the Alaska Peninsula. In addition to Kenai NWR, the Borough includes portions of Chugach National Forest and three national parks: Lake Clark, Katmai, and Kenai Fjords.

The total population of the Borough is 55,400 as of the 2010 census (USDC 2010). The twin cities of Kenai and Soldotna, along with nearby Sterling, form the population center of the Borough. The Borough also includes the cities of Homer and Seward, numerous smaller communities along the road system, and several villages accessible only by boat or aircraft.

The Refuge averages more than 300,000 visitors per year. There are approximately 35-40 permanent Service employees at the Refuge, and during the summer, seasonal employees and volunteers can raise the staff total to more than 100. There are approximately 80 guides, outfitters and river guides operating on the Refuge, and one concessionaire that operates the Russian River Ferry on the Kenai River, near Cooper Landing.

Within the boundaries of the Refuge, private lands account for 525 acres. There are 46,041 acres of Alaska Native Corporation Lands and 385 acres of Native allotments. There are hundreds of structures (homes, cabins, and outbuildings) on these privately and Native-owned lands within the Refuge. During the summer fire season, there can be hundreds of visitors recreating in the back-country of the Refuge on the Swanson River and Swan Lake Canoe Trails, the Kenai River, any of the hundreds of lakes in the Refuge, in the Skilak Lake Wildlife Recreation Area, in one of the three Refuge wilderness units, or on any of 110 miles of Refuge trails. Of the more than 1,900 lakes in the Refuge, as many as 580 are potentially accessible by floatplane, though some of the accessible lakes in wilderness are seasonally closed to airplane access to protect nesting swans. Other facilities within the Refuge where people work and reside include the Moose Research Center, the Swanson River Oil Field, and the Beaver Creek Oil Field.

3.9.2 Environmental Consequences

3.9.2.1 Alternatives A and B

Prescribed Fire

There would be no long-term adverse effects on public health and safety under these alternatives. There could be temporary negligible to moderate adverse effects on sensitive individuals from smoke during prescribed fires.

Smoke from fires (particularly wildfires) increases particulate and gaseous emissions, particularly PM₁₀, PM_{2.5}, and carbon monoxide. Prescribed fires could briefly reduce air quality in the immediate vicinity of the Refuge. Any adverse effects from the prescribed fires would be temporary and could range from negligible to minor because the burns would be conducted according to the mitigation measures (Table 2-4) and additional guidance contained in the Fire Management Plan for the Refuge. Off-site adverse effects are expected to be negligible given the relatively small units that would be burned at one time and the relatively isolated location of the Refuge.

Smoke emissions during prescribed fires may temporarily reduce visibility in some locations, but implementation of smoke management practices and plans (such as burning during favorable weather conditions when smoke is carried away from sensitive areas) and using the best available fire and emission control measures would minimize visibility impairments. Thus, emissions can be directed away from sensitive receptors, minimizing health hazards.

The mitigation measures and additional guidance contained in the Fire Management Plan and prescribed fire plans would help ensure that personnel conducting the burns will take all necessary safety precautions to protect themselves, staff, and visitors at the Refuge and CWPP and COI areas. Risks to human safety would be negligible.

The treatments would result in beneficial effects by reducing fuel loads and creating fuel breaks and buffers to protect Service staff, visitors, and communities.

Mechanical Treatments

There would be no adverse effects on public health and safety from implementation of mechanical treatments. There would be long-term minor to major beneficial effects from creation and maintenance of fuel breaks and reduction of hazardous fuels on the Refuge and in the CWPP and COI areas.

Fire Suppression

There would be no adverse effects on public health and safety from fire suppression actions.

3.10 Short-term Uses and Long-term Productivity _____

The *National Environmental Policy Act* requires consideration of “the relationship between short-term uses of man’s environment and the maintenance and enhancement of long-term productivity” (40 CFR 1502.16). As declared by Congress under the Act, this includes using all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare; to create and maintain conditions under which man and nature can exist in productive harmony; and fulfill the social, economic, and other requirements of present and future generations of Americans.

Short-term uses and their effects are those that occur within the first few years of project implementation. Long-term productivity refers to the capability of the land and resources to continue producing goods and services long after the project has been implemented. Long-term productivity would be maintained through the application of the mitigation measures described in Section 2.5 (Chapter 2).

None of the proposed alternatives would affect short-term uses or alter long-term productivity of resources at Kenai NWR.

3.11 Unavoidable Adverse Effects _____

Unavoidable adverse effects would occur during implementation of prescribed fire. Some wildlife species may temporarily be displaced during prescribed fires. There would be some unavoidable temporary negligible adverse effects on staff and visitors and on private landowners from smoke during prescribed fires. These activities are necessary to achieve long-term beneficial effects from the management activities, and although there may be potential adverse effects, they would not be significant. Table 2-4 presents the mitigation measures designed to minimize or eliminate potential adverse effects.

3.12 Irreversible and Irrecoverable Commitment of Resources _____

An *irreversible* commitment of resources is a permanent or essentially permanent loss of nonrenewable resources, such as mineral extraction, heritage (cultural) resources, or to those factors that are renewable only over long time spans or at great expense (for example, soil productivity), or to resources that have been destroyed or removed. No irreversible commitments of resources would result from any of the alternatives.

Irrecoverable commitment applies to losses that are not renewable or recoverable for future use. The loss of production would be irretrievable, but it would not necessarily be irreversible. None of the alternatives constitutes an irretrievable commitment of resources.

3.13 Cumulative Effects _____

Cumulative effects are discussed in the individual resource sections earlier in this chapter.

3.14 Energy Requirements, Conservation Potential, Depletable Resource Requirements _____

Consumption of fossil fuels by vehicles and equipment would occur with the action alternatives during management activities. No unusual energy requirements are included nor do opportunities exist to conserve energy at a large scale.

3.15 Prime Farmland, Rangeland, and Forest Land _____

As designated by the United States Department of Agriculture–National Resource Conservation Service and described in the National Soil Survey Handbook (USDA-NRCS 2010), the Kenai NWR does not contain prime farmlands and rangelands and does not manage for prime forest land.

- Prime forest land is described as a land cover/use that is at least 10% stocked by single stemmed forest trees of any size which will be at least 4 meters (13 feet) tall at maturity. When viewed vertically, canopy cover is 25% or greater. Also included are areas bearing evidence of natural regeneration of tree cover (cutover forest or abandoned farmland) and not currently developed for nonforest use. For classification as forest land, an area must be at least 1 acre and 100 feet wide.
- Prime farmland is defined as a Land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and is also available for these uses. It has the soil quality, growing season, and moisture supply needed to produce economically sustained high yields of crops when treated and managed according to acceptable farming methods, including water management. In general, prime farmlands have an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, and few or no rocks. They are permeable to water and air. Prime farmlands are not excessively erodible or saturated with water for a long period of time, and they either do not flood frequently or are protected from flooding.
- Prime rangeland is defined as a land cover/use category on which the climax or potential plant cover is composed principally of native grasses, grass-like plants, forbs or shrubs suitable for grazing and browsing, and introduced forage species that are managed like rangeland. This would include areas where introduced hardy and persistent grasses, such as crested wheatgrass, are planted and such practices as deferred grazing, burning, chaining, and rotational grazing are used, with little or no chemicals or fertilizer being applied. Grasslands, savannas, many wetlands, some deserts, and tundra are considered to be rangeland. Certain communities of low forbs and shrubs, such as mesquite, chaparral, mountain shrub, and pinyon-juniper, are also included as rangeland.

3.16 Possible Conflicts with Other Land Use Plans _____

The land management actions would take place entirely on Service lands and would not conflict with fuel and fire management actions under any community's CWPP but rather would complement other actions.

3.17 Other Required Disclosures _____

There are no federally listed wildlife species on the Refuge, but there is a federal candidate species (Kittlitz's murrelet) (refer to Section 3.4.4 above for effects on wildlife species on the Refuge). There are no federally listed plant species on the Refuge.

There are no properties on the Refuge that are listed in the National Register of Historic Places. However, the 2010 Comprehensive Conservation Plan for the Refuge (page 2-146, "Objective 8.8: Facilities," states:

Within three years of Plan's approval, complete and submit to the State Historic Preservation Officer the nomination form to have the Stepanka Archaeological District listed on the National Register.

Rationale: The cultural resources sites in the Stepanka Archaeological District are a unique record of Kenai Peninsula Native history dating back 4,000 years. The Service agreed to recognize and manage the archaeological values of the area when the land was purchased to be incorporated into the Kenai Refuge. This recognition was spelled out in the 1997 Omnibus Parks Act, which transferred ownership of the Stepanka district to the Kenai Refuge and required the Service to have the area listed on the National Register of Historic Places.

Chapter 4. Preparers, Coordination, and Distribution of the Draft - Final EA and FONSI

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4.2 Fire Management Coordination

4.2.1 Internal Partnerships

- Kenai NWR Management Team — an interdisciplinary team comprised of the Refuge Manager, the Deputy Refuge Manager, and Refuge Program Managers from Administration, Visitor Services, Biology, Facilities and Maintenance, Law Enforcement and Fire Management
- Service Alaska Region Fire Management Branch
- Service Alaska Region Fire Management Officers

4.2.2 External Partnerships

- Alaska Wildland Fire Coordinating Group
- Kenai Interagency Dispatch Center (KIDC)
- The 02/12/2010 Memorandum of Understanding (MOU) for the Development of a Collaborative Forest, Wildfire Protection and Fuels Treatment Program, among the USDA Forest Service – Alaska Region and the State of Alaska Division of Forestry and the USDI Kenai NWR, the BLM Anchorage Field Office, Kenai Fjords National Park, the BIA, and the Kenai Peninsula Borough, reestablished the Kenai Forest, Wildfire Protection and Fuels Management Coordinating Committee and the All Lands All Hands 5-Year Action Plan.
- Kenai Peninsula Fire Chiefs Association
- Local Emergency Planning Committee

4.2.2.1 Alaska Wildland Fire Coordinating Group

The Alaska Wildland Fire Coordinating Group (AWFCG) group provides coordination and recommendations for all interagency fire management activities in Alaska. Membership, procedures, and guidelines are documented in the AWFCG Memorandum of Understanding and Standard Operating Procedures available at <http://fire.ak.blm.gov/administration/awfcg.php>. The Region 7 Fire Management Coordinator represents the Service on this group.

4.2.2.2 Alaska Multi Agency Coordinating Group

The Alaska Multi-Agency Coordination Group (AMAC) provides a forum to discuss actions to be taken to ensure that an adequate number of resources are available to meet anticipated needs and to allocate those resources most efficiently. When activated and as warranted, the AMAC is tasked with the following: incident prioritization; resource allocation; coordination of state and federal disaster responses; political interfaces; media and agency information; anticipation of future resource needs; and the identification and resolution of issues. The *AMAC Operations Handbook* is available at <http://fire.ak.blm.gov/administration/mac.php>. The Region 7 Fire Management Coordinator represents the Service on this group.

4.2.2.3 Interagency Agreements and Planning Documents

Several important agreements and planning documents include the following:

- Alaska Master Cooperative Wildland Fire Management and Stafford Act Response Agreement 2010 (Alaska Master Agreement)
- Alaska Statewide Annual Operating Plan
- Alaska Interagency Wildland Fire Management Plan 2010

4.3 Availability of the Final Environmental Assessment and Finding of No Significant Impact _____

This Final EA and Finding of No Significant Impact (FONSI) are available on the Kenai NWR website at http://www.fws.gov/refuge/Kenai/what_we_do/resource_management/plans.html. News releases announcing the availability of these two documents were published in local newspapers.

Requests for a hardcopy of the EA and FONSI can be emailed to doug_newbould@fws.gov.

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**Appendix A:
Fire Ecology and Fire
Regime Shift Due to Climate Change**

Appendix A

Fire Ecology and Fire Regime Shift Due to Climate Change

Historic Fire Regime

The historic fire regime has been well studied on the Kenai Peninsula (Berg and Anderson 2006, Anderson et al. 2006). Prior to this past century, major fires of unknown origin took place in 1871, 1883, 1891, and 1910 (Lutz 1960), burning much of the Tustumena Benchlands. In 1947 and 1969, two large human-caused fires burned 310,000 acres and 86,000 acres, respectively, in the Kenai Lowlands, converting much of the mostly mature black spruce forest to birch and aspen. Since the 1990s, ~ 140,000 acres of mature and beetle-killed white and Lutz spruce have burned in several fires around Skilak Lake and south of Tustumena Lake.

Historically, two distinct fire cycles occur in spruce on the Kenai landscapes. Black spruce forests, primarily in the Kenai Lowlands, increase in flammability with age (DeVolder 1999). A revised estimate of the mean fire return interval over the entire study area for the past 300 years is 89 ± 43 years (1 SD) years (range 25-185 years) based on 1,022 basal cross-sections and 771 increment cores of lowland black spruce (Berg, pers. comm.). Twelve fires were dated as occurring in 1708, 1762, 1801, 1828, 1883, 1834, 1849, 1867, 1874, 1884, 1888, and 1898.

In contrast, white, Lutz and Sitka spruce forests on uplands burn on a much longer time interval. In the virtually monospecific stands of Lutz spruce on the southern Kenai Peninsula, the mean fire return interval for the past 2,500 years was estimated to be 515 ± 355 (1 SD) years (range 105–1642 years); the mean time-since-fire was estimated at 605 ± 413 years (median 444 years, range 90–1518 years). These estimates are based on a sample size of 112 radiocarbon dates of soil charcoal at 22 sites from Anchor Point to Nikiski (Berg and Anderson 2006). In the Swanson River Road area, a lake-sediment charcoal study at Paradox Lake estimated the mean fire return interval to be ~200 years, perhaps due to the presence of more black spruce in the valley bottoms. On the south side of Kachemak Bay, there is no charcoal evidence that the old-growth Sitka spruce forests have ever burned in the 2,200 years that Sitka spruce has been in the area. On the Refuge north of Kachemak Bay, there are no spruce forests more than 200 years old, even though some of those forests have not burned for at least 1,500 years. It appears that spruce bark beetle outbreaks recycle these forests much more frequently than does fire (Sherriff et al. 2011). It is rare to find spruce trees more than 300 years old, although these species typically live to be 500 - 600 years in other parts of their range.

In mixed white and black spruce and hardwoods forests, the mean fire return interval for the Paradox Lake area ~10 km north of Sterling was estimated at 130 ± 66 years (1 SD) years with 35 fires separated by intervals of 40 to 270 years occurring during the last 4,600 years since the arrival of black spruce on the landscape. This estimate is based on sedimentary charcoal in a 9m core taken from Paradox Lake (informal name) at a depth of 15.8 m, supplemented with a 70-cm short core of near-surface sediments. The total charcoal fire history record spanned ~13,000 calendar years; mean fire return intervals were longest during the shrub-herb tundra

phase (138 ± 65 yr), decreased after expansion of *Betula kenaica*, *Salix* and *Populus* (77 ± 49 yr) and *Picea glauca* (81 ± 41 yr), and increased again with the arrival of *P. mariana* (130 ± 66 yr)(Anderson et al. 2006).

The presence of almost 1 million acres of beetle-killed spruce forest on the Kenai Peninsula has raised the specter of catastrophic wildfire. However, Berg and Anderson (2006) used 121 radiocarbon-dated soil charcoal samples to reconstruct the regional fire history of the last 2,500 years and found no relation between fire activity and past spruce bark beetle outbreaks. On average, one fire occurred for every 10 spruce bark beetle outbreaks in these forests. Nevertheless, a run of warm summers since 1987 has created a spruce bark beetle outbreak of unprecedented scale, and at least three major fires with high rates of spread in recently beetle-killed timber have occurred. This suggests that, with a future warmer climate and increasing human use of the landscape, fire and beetle kill may be well more closely associated than in the past (Berg and Anderson 2006).

Wildland-Urban Interface

The western and southern boundary of Kenai National Wildlife Refuge is quickly becoming 175 miles of WUI, stretching from the subdivision at Point Possession, past the communities of Nikiski, Kenai-Soldotna, Sterling, Funny River, Kasilof-Clam Gulch, Ninilchik and Anchor Point-Happy Valley, to the cabins in Caribou Hills near the headwaters of Kachemak Bay. Portions of this developing WUI have shared boundaries that both delineate refuge administrative boundaries and Congressionally-designated Wilderness. These areas, in particular, will become increasingly more problematic because of the juxtaposition of lands managed under critical and full fire management options with those that are limited. Additionally, the three wilderness units nested within the administrative boundary of the refuge makes for a strange geometric artifact: there is actually more wilderness boundary (760 km) than refuge administrative boundary (660 km)!

The ecological effects of managing the WUI will almost certainly become more pronounced as lands outside the refuge become developed. Indeed, Dibari and Morton (2006) examined the fire history along the refuge boundary during 1937-2005 and found that a greater area of black spruce and white/Lutz/Sitka spruce burned in the portion of the 2 km buffer inside the refuge than the portion of the 2 km buffer outside the refuge. Additionally, a greater percentage white/Lutz/Sitka spruce burned inside the refuge than would be expected given the percentage of land in that land-cover type, suggesting that increasing parcelization and associated fire suppression outside the refuge may already be creating a discontinuity in vegetation composition on either side of the administrative boundary.

In general, the juxtaposition of wild and urban lands creates an environment in which different values, land management objectives, and public expectations are in conflict. Some of the issues and potential impacts produced by or resulting from this interface condition include:

- the increased threat and potential catastrophic impacts of wildfire, increased public access into and use of the Refuge and its resources;
- a greater probability that exotic and/or invasive plant and animal species will be introduced and become established;
- increased illegal activities such as trespass or wildlife violations; and

- impacts to animal and plant populations due to increased legal and illegal harvest, increased brown bear mortality in defense of life or property (DLP), and increased moose-vehicle collisions.

These Refuge-urban interface issues are described in greater detail in the following sections, WUI Fire and Wildlife, Habitats, and Access.

WUI Fire

Throughout the nation, across Alaska, and here on the Kenai Peninsula, there is an expanding wildland/urban interface where the presence of wildfire is unacceptable due to the threat of catastrophic losses of the values at risk. In many areas on the western Peninsula, communities, subdivisions, individual residences, and/or businesses exist immediately adjacent to the Refuge boundary or are completely surrounded by Refuge lands. In these WUI areas, the risks of wildfire ignition and the hazards associated with wildland fire are increased. The incidence of human-caused fires is much greater in the WUI than in the wildland of the Refuge. The threat of natural and human-caused wildfires ignited on the Refuge, and traveling unchecked through continuous wildland fuels into the WUI is also very real.

In some areas of the Refuge, designated Wilderness interfaces with urban development or private lands. This Refuge Wilderness–urban interface condition occurs near the communities of Sterling, Funny River, Kasilof, and Cooper Landing, and in the remote communities of Bear Creek on Tustumena Lake and the Ninilchik Forties on the north end of the Caribou Hills. In these areas, the conflict between Wilderness values and public values is elevated. Aggressive suppression of both human-caused and natural ignitions is the more likely management response in these interface areas, to protect human life and property. (Several natural fires in Refuge Wilderness areas were suppressed in 2005 to protect communities). Less likely responses include the use of lightning-caused fires for resource benefits or a limited suppression response in Wilderness to minimize risk to firefighters, reduce the costs of suppression, and/or mitigate the impacts of suppression activities to Wilderness values.

In response to the urban interface issues associated with Wilderness and non-Wilderness areas of the Refuge and to mitigate the impacts of catastrophic wildfire, we have planned and completed multiple hazard fuel reduction projects. Some of these projects include a six mile-long fuel break along Funny River Road between the communities of Soldotna and Funny River, mechanical fuel reduction and planned prescribed fires on 300 acres south of the Moose Range Meadows subdivision, mechanical fuel reduction and planned prescribed fire on 500 acres of the Lilly Lake area northeast of Sterling, and mechanical fuel reduction and prescribed fire on several units (over 6,000 acres) north and south of the Sterling Highway between Cooper Landing and Sterling. In 2005, the Refuge successfully managed two lightning-caused wildland fires for resource benefits (Irish Channel and Fox Creek) for a total of more than 27,000 acres of fuel reduction (Morton et al. 2006).

These treatments provide benefits in addition to fuel reduction, including improved access and/or egress safety for local residents and visitors along Funny River Road and the Sterling Highway, forest-type conversion from the more-flammable spruce forests to the less-flammable hardwood forests, and habitat benefits for wildlife that use early post-fire succession plant species. Also, large fire scars and fuel reduction treatment areas provide barriers fire managers use to contain or control wildland fires.

Wildland fire management and disaster mitigation on the Kenai Peninsula is a collaborative interagency process. Refuge managers work closely with other Peninsula land and fire management

agencies, including the Alaska Division of Forestry, the Chugach National Forest, the Kenai Peninsula Borough, and others, to plan, coordinate, prioritize, and implement fire management and mitigation activities and/or projects.

Naturalness and BIDEH

Wildfire is a natural landscape process. In forests of the Kenai Peninsula, historical fire return intervals have averaged 80 years in black spruce and 400–600 years in white and Lutz spruce. Wildfire return intervals are likely changing, although the new trajectory is not apparent. Suppression of wildfire in Wilderness has increased because of concerns about an increasing human population and urban development outside Refuge boundaries. Human-caused ignitions have increased in recent years. Furthermore, increased fuel loads from beetle-killed trees and a drier, warmer landscape due to global climate change suggest that wildfire risk may be increasing.

The policies of all four Federal agencies responsible for managing Wilderness in the United States recognize the importance of fire as a natural ecological process and the desirability of maintaining and/or restoring the historic role of fire to wilderness ecosystems (Parsons and Landres 1998). In 1995, the Department of the Interior and the Department of Agriculture issued *Federal Wildland Fire Management: Policy and Program Review*, which provided policy direction for all Federal wildland fire activities. This document was reviewed and updated in January 2001 by an Interagency Federal Wildland Fire Policy Review Working Group. A guiding principle of this new policy is that “the role of wildland fire as an essential ecological process will be incorporated into the planning process.” This new policy allows fires from natural ignition sources to be managed for resource benefits wherever an approved fire management plan is in place (USDA and USDOJ 1995).

In addition to the policy and administrative constraints that have limited the use of natural fire, a number of other reasons explain why natural fire may not be allowed to burn in some Wilderness units (e.g., the risk of fire escaping onto adjacent lands managed for other purposes, the threat of unnaturally intense fires causing unacceptable resource damage, and the threat of smoke causing unacceptable impacts to surrounding areas). Together, such concerns raise serious questions about the potential for natural fire to ever be able to effectively restore (or sustain) natural fire regimes in the Kenai Wilderness.

Management-ignited prescribed fire has been the tool most advocated for mimicking or restoring natural fire regimes in Wilderness. In the contiguous 48 states, the U.S. Fish and Wildlife Service (Service) has relied almost entirely on prescribed fire to accomplish wilderness management objectives, including the reduction of hazardous fuels, range improvement, wildlife habitat enhancement, and restoration of natural fire regimes (Parsons 2000). In Alaska, four situations have been identified in which prescribed fire could be appropriately used in Wilderness (Morton et al. 2006):

1. to restore or enhance habitats of Federally listed threatened and endangered species;
2. to control or eradicate invasive flora;
3. to increase the likelihood of a naturally ignited fire to burn unimpeded (by reducing hazardous fuels loads around structures and urban interface); and
4. to mimic (long-term) or restore (short-term) a significantly altered natural fire regime.

There continues to be considerable opposition within and outside the Service and other agencies to prescribed fire. Prescribed fire is viewed by many as an inappropriate intervention that detracts from the

wild or untrammeled nature of wilderness and which conflicts with the primary purposes of Wilderness. Locally, reduced air quality from prescribed fires continues to concern the Alaska Department of Environmental Conservation, the fire management community, and local communities. Furthermore, there is community concern about prescribed fire escaping the prescription (a hazardous fuel-reduction burn on the north shore of Kenai Lake in 2002 eventually threatened Crown Point, Lawing, and Moose Pass). Perhaps the greatest concern is that the use of prescribed fire could become an accepted alternative to natural ignitions and, as such, would soon become the dominant Wilderness fire management strategy.

On the other hand, only 28,000 acres have been treated either mechanically or with prescribed fire since the 1960s. This relative lack of success is due in part to lack of access and to the fact that when fire conditions are good for prescribed burns, they are also good for wildfires (and so fire management resources are unavailable). Consequently, we will move away from attempting to use prescribed fire in a landscape context (e.g., enhancing moose habitat), and consider using it for more local-scale issues like reducing WUI in a strategic manner (to create more decision space to allow wildland fire to run), creating vegetative corridors to move wildlife towards highway mitigation structures, or for treating invasive plants (see discussion below).

Invasive Exotic Plants and Fire

Over 110 exotic plant species have been recorded on the Kenai Peninsula (Densmore et al. 2001, DeVelice 2004, Duffy 2003), representing over 60 percent of the known exotic vascular plants in Alaska (Rejmanek and Randall 1994). Although still relatively pristine, Kenai Refuge is one of only two refuges in Alaska on the highway system and hosts more than 300,000 annual visitors. The Peninsula has been the site of commercial oil and gas activities since the early 1960s. With 56 square miles of anthropogenic footprint (the area removed from habitat or ecological productivity by human activities), exotic flora are well established in certain areas of the Refuge. Most locations of the 70+ exotic species that have been documented on the Refuge are associated with roads, trails, seismic lines, utility rights-of-way, oil and gas infrastructure, campgrounds, and cabins. Several of these species are relatively invasive, including scotchbroom (*Cytisus scoparius*), white sweetclover (*Melilotus alba*), bird's vetch (*Vicia cracca*), and reed canary grass (*Phalaris arundinacea*).

Exotic, invasive, and injurious flora will almost certainly continue to spread on the Refuge as more land is developed inside and outside the Refuge, as fire is more aggressively managed because of the expanding urban interface (Hunter et al. 2006), and as global warming moderates the subarctic climate on the Kenai Peninsula (Dukes and Mooney 1999). The concern is that there is a positive feedback between invasive plants and fire: invasive plants can increase and change fire risk, and fire operations can increase the risk of invasive spread, and both are likely to increase along the WUI.

Fire has been demonstrated to contribute to invasive plant population increases in Alaska (Villano and Mulder 2008). Burned areas provide competition-free establishment areas as well as corridors for spread through undisturbed ecosystems (Conn et al. 2003). Increases in air temperature with a warming climate may lengthen the fire season and increase fire probability in Alaska (Randerson et al. 2006). Climate change is also known to increase invasion risk (Bradley et al 2010). Although fire management activities may contribute to spread of invasive populations by creating human and equipment movement vectors, prescribed burning may have positive effects on invasions as a control tool.

Prescribed burning can be used as a tool to control known populations of certain invasive plant species. Invasive control burns must take into account timing, fuel type, fire type, pre-treatments (such as

herbicide application, mastication or thinning), and particular plants targeted (DiTomaso & Johnson 2006). Post-fire native vegetation success in Alaska depends on a variety of conditions, including climate and weather conditions, burn severity, pre-burn vegetation composition, fuel load, and burn season (Boucher 2003).

Late winter and early spring prescribed burns have been most effective in reducing non-native plant populations (Potts & Stephens 2009, Meekins & McCarthy 2001). Species that responded best to prescribed control are those with highest above and belowground mortality, including herbaceous forb species such as garlic mustard (*Alliaria petiolata*). However, most control efforts required post-burn monitoring and may require additional treatments such as herbicide application (DiTomaso & Johnson 2006, Meekins & McCarthy 2001, Nuzzo 1991).

Fire operations as introduction and spread vectors

Invasive plant species populations on the Refuge may increase through fire management activities. Although only four percent of the Refuge contained invasive species in the LTEMP systematic inventory, a focused anthropologically disturbed area invasive inventory revealed that major invasions were located in developed areas (access points, buildings, campgrounds, oil-gas wells, roads, seismic lines, trails, and a transfer station) (Barnett & Simonson 2007). Fire management activities frequently utilize these developed areas to conduct and stage activities and personnel.

Specific Refuge incidences with invasive plant introduction and spread include the 2004 Kings Court Fire. Numerous field crews and aircraft were based in and near the existing campground and parking lots of the upper boat launch on Skilak Lake, as well as in a gravel pit further east along Skilak Lake Road. Following fire operations, new populations of oxeye daisy (*Leucanthemum vulgare*), quackgrass (*Elymus repens*), and tansy ragwort (*Senecio jacobaea*) (previously unrecorded in this region) were observed immediately within the operations area and the gravel pit. Subsequent tracking post-fire revealed a substantial increase in both oxeye daisy and quackgrass along the side access road to the boat launch and along the main road. Another incidence includes the Shanta Creek fire in 2009, on the northern shore of Tustumena Lake. Following fire operations, a half-acre population of orange hawkweed (*Hieracium aurantiacum*) was discovered along a dozer line, though it seemed apparent the infestation existed prior to the fire.

Fires or back fires may create new colonization habitat adjacent to developed sites, including private inholdings, historical cabins, and recreational cabins. While most inventoried non-native species at these sites have a low invasion risk value (Carlson et al. 2008), populations of wind-dispersed species may be undesirable in proximity to sensitive ecological areas such as glacial outwash plains.

Many graminoid species are well adapted to fire (USFS 2012). Species of specific potential concern in post-fire Refuge landscapes include:

meadow foxtail (*Alopecurus pratensis*) - resprouts from rhizomes in low to moderate intensity fires, rapid colonization post-fire

orchardgrass (*Dactylis glomerata*) - resprouts from rhizomes in low to moderate intensity fires, increases or remains stable post-fire

quackgrass (*Elymus repens*) – resprouts from rhizomes in low to moderate intensity fires, can spread quickly by rhizomes in early spring seasonal fires. Late spring fires can reduce populations.

foxtail barley (*Hordeum jubatum*) – rapid sprouting and dominant colonization post-fire

perennial ryegrass (*Lolium perenne*) - resprouts from rhizomes in low to moderate intensity fires, increases post-fire

timothy (*Phleum pratense*) – resprouts from rhizomes in low to moderate intensity fires, rapid colonization post-fire

reed canarygrass (*Phalaris arundinacea*) - resprouts from rhizomes in low to moderate intensity fires, fire-tolerant seed bank, will rapidly germinate and dominant colonization post-fire

Kentucky bluegrass (*Poa pratensis*) – fire intolerant, prescribed burns may be used for control in early spring. Other *Poa* species respond similarly.

Forb species of potential concern include:

garlic mustard (*Alliaria petiolata*) – fire may kill all above and belowground material; potential to control by prescribed burning.

spotted knapweed (*Centaurea stoebe* spp. *micranthos*) – taproot can survive fire, fire tolerant seeds, colonization post-fire with seed source.

orange hawkweed (*Hieracium aurantiacum*), meadow hawkweed (*H. caespitosum*), tall hawkweed (*H. piloselloides*), and narrowleaf hawkweed (*H. umbellatum*) – rhizomes may survive, rapid colonization with seed source (wind dispersal).

Oxeye daisy (*Leucanthemum vulgare*) – rhizomes survive post-fire, can resprout post-fire, neutral colonization ability post-fire.

toadflax, butter-n-eggs (*Linaria vulgaris*) – deep root system survives fire, ready dispersal and colonization post-burn with seed source.

white sweetclover (yellow sweetclover) (*Melilotus alba* or *M. officinalis*) – second-year plants may survive fire, heat tolerant seeds, germination stimulated by fire. increased colonization post-fire with seed source.

tansy ragwort (*Senecio jacobaea*) – fire kills plants and seeds; prescribed fire may be a control tool.

perennial sowthistle (*Sonchus arvensis*) – cans survive and persist in burned areas, establishment and colonization post-fire with seed source, wind-dispersed seeds.

common tansy (*Tanacetum vulgare*) – rhizomes survive post-fire, resprouting post-fire, seedling colonization with seed source.

Some operational changes that we will consider to reduce the likelihood of spreading invasive plants include:

- Prepare and maintain weed-free helicopter staging areas strategically located around the refuge.
- Spray down heavy equipment in advance of a fire; consider purchasing portable washers (<http://s-k-enviro.com/index.htm>) for deployment at helo/staging areas.

- Prepare HACCP plans for general fire operations (Hazard Analysis & Critical Control Point Planning).
- BAER funding for post-fire restoration.

Climate Change

Mean annual temperatures on the Kenai Peninsula have warmed several degrees since 1977. Much of this increase is due to warmer winters, with December and January having warmed by an average 9° and 7° F, respectively. Summers began to warm most noticeably with the drought of 1968–69, with a resultant increased rate of evapotranspiration. Similarly, the annual water balance declined from 5.8 inches per year to 2.7 inches per year after 1968 (Kenai airport data), an almost 60% decline. The following changes on the Kenai landscape appear to be related to an increasingly warmer and dryer climate:

- The Kenai Peninsula was the epicenter of a spruce bark beetle outbreak that lasted over a decade through much of the 1990s and caused high mortality of Sitka, Lutz, and white spruce on four million acres in southcentral Alaska (including 1 million acres on the Kenai Peninsula). In the past, the pronounced El Niño–La Niña cycle of 4–6 years of warm and cold summers helped start and stop bark beetle outbreaks. However, a run of warm summers since 1987 set the stage for an outbreak of unprecedented scale—suggesting that with a future warmer climate, fire and beetle kill may be more closely associated than in the past (Berg et al. 2006). Because many forests on the Refuge are monospecific white spruce stands, there are now hundreds of square miles of standing dead spruce forest.
- With warmer summers, more water is transpired from vegetation and evaporated from the soil and water bodies; consequently, closed-basin lake levels have declined by as much as a meter (approximately three feet), and ponds are drying up. Many ponds shown on the 1950 maps and aerial photos are now grassy pans with various degrees of spruce and hardwood invasion (Klein et al. 2005). Peat soil cores show that wetlands that were pure *Sphagnum* fens for thousands of years have been heavily invaded by ericaceous shrubs and dwarf birch in recent decades (Berg et al. 2009). The drying of wetlands and fens probably started at the end of the Little Ice Age in the 1850s, as shown by the ages of first-time black spruce forests that are spreading over the peatlands. The drying appears to have intensified since the 1970s, with warmer summers and greater evapotranspiration. Furthermore, the long-term colonization of the peatlands by black spruce will provide continuity of fuels across previously wet muskegs that served as firebreaks in fires such as the one in 1947. Furthermore, the long-term colonization of the peatlands by black spruce will provide continuity of fuels across previously wet muskegs that served as firebreaks in fires such as the one in 1947. The expanded fuel bed and drier summers will create conditions for larger and more severe fires in the lowland black spruce forests and will put more fire on the flanks of the upland white and Lutz spruce stands (Anderson et al. 2006).
- Many Kenai Peninsula glaciers began retreating in the 1850s, but their retreat has greatly accelerated in recent years. The rapid retreat of the Skilak and Grewingk glaciers, and of the nearby Portage glacier, in the last 20–30 years is especially striking. The Harding Icefield lost an average of 21m in thickness (Adageirsdottir et al. 1998) and 5% in surface area (Rice 1987) in the latter half of the 20th century. Areas exposed by receding glaciers will not be vegetated for many decades. However, the hydrology of glacially-fed streams will likely change as glacial input in the warming summer increases in the near term.

- During the past five decades, tree line in the Kenai Mountains has risen an average of 1m per year (Dial et al. 2007), approximating a 300,000 acre loss of alpine tundra. For example, mountain hemlock normally forms a distinct zone above white spruce at tree line, but white spruce seedlings are now growing several hundred meters above the hemlock tree line. Furthermore, the growth form of mountain hemlock is changing from a ground-hugging *krummholz* to a more normal upright stance, indicating a general moderation of the climate at higher elevations. Increased fire at higher elevations is one likely outcome of this afforestation of alpine tundra.
- Over 1,000 lightning strikes in 2005 on the Kenai Peninsula, an area of Alaska in which lightning ignitions were once considered unusual, suggest that local meteorological conditions may be changing (Morton et al. 2006).

The effects of climate change on vegetation composition have been modeled for the Kenai Peninsula using two different approaches. Rupp and Mann (2002) simulated fire-induced vegetation change using ALFRESCO and refuge biologists have used a climatic envelope approach with RandomForest™. Although very different assumptions underlie these two approaches, both models suggest the following salient outcomes:

1. conversion of softwood to hardwood presumably due to more frequent and hotter fires;
2. rising treeline (primarily mountain hemlock) with concomitant loss of alpine tundra;
3. increasing herbaceous cover (grasslands) particularly south of Caribou Hills (note: parcelization and the resulting deforestation will also increase grasslands along the WUD); and
4. loss of old growth softwood forests (note: Berg suggests consecutive above-average summer temperatures will keep spruce bark beetles sustained metabolically and thereby Sitka, white and Lutz spruce from maturing in the foreseeable future).

In addition, Global Climate Change (CGM) model projections of future boreal forest climates suggest that fire burn area will increase as fire regimes change (Podur & Wotton 2010, Amiro et al. 2006). Altered fire regimes may cause a synergistic increase in invasion potential. Greater fire frequency may create more habitat for invasions, and invasions in turn can contribute to more frequent fires. Although the interaction of climate, fire regime, and invasions is not well understood in Alaska, there are well-documented examples of established invasive plants increasing fire frequency. Cheatgrass (*Bromus tectorum*) invasions in the western US has resulted in native vegetation loss, less predictable livestock and wildlife forage crops, and higher fire control costs (Epanchin-Neill et al. 2009). Before cheatgrass invasion, shrub-regenerating fire occurred every 60 to 110 years; major fires now occur every three to five years (ELI 2002). Buffelgrass (*Pennisetum ciliare*) causes higher intensity, lower interval fires that decrease native plant richness (McDonald & McPherson 2011).

Although there is no empirical evidence yet to suggest that the historic mean fire return interval in spruce is changing in response to rapid climate change, it is apparent that the fire regime may be altering in unexpected ways. In the aftermath of spruce bark beetle-induced deforestation, grassland (*Calamagrostis canadensis*) fires have burned in April on the southern part of the Peninsula in recent years. Lightning caused the 2005 Irish Channel fire that burned 1,100 acres of mountain hemlock

(Morton et al. 2006), an event so rare in this forest type that charcoal evidence of a historic fire regime has not been detected.

Fire Monitoring

Long-term monitoring of fire activity and its effects on vegetation and fuel loads are supported by both plot-based and remote-sensed approaches.

Plot-based monitoring

Kenai NWR has three long-term plot-based data sets for monitoring the effects of wildfire: NPS Fire Monitoring Handbook (FMH) plots, Hakala plots, and the Forest Inventory & Analysis (FIA) plots. The FMH plots were established in areas where prescribed fires were planned and in areas recently burned by wildfires using established National Park Service FMH protocols (USDI National Park Service, 1992) to quantify the effects of fire on vegetation and fuel loading within the study areas. A report (Bowser & Berg, 2005) and protocol (Bowser, 2010) are available for the Kenai NWR FMH plots.

Most of the 68 FMH plots are located within five study areas: Mystery Creek (42 plots), Lily Lake (4 plots), Windy Point Fire (4 plots), Pothole Lake Fire (6 plots), and Hidden Creek Fire (4 plots). The remaining plots were located at East Road (2 plots) and in the vicinity of moose exclosures (6 plots).
Temporal Distribution

The majority of the plots were installed and simultaneously surveyed between 1994 and 1998 (Figure 2). The Mystery Creek plots burned in 2002 and were resurveyed in 2004. After the Windy Point Fire, the Windy Point plots were sampled in 1997, 1999, and 2004.

Fuel loadings and vegetation data collected as listed below:

- mass per unit area (tons/acre) of woody fuels 0 - ¼ in. diameter (1 hr. fuels)
- mass per unit area (tons/acre) of woody fuels ¼ in. - 1 in. diameter (10 hr. fuels)
- mass per unit area (tons/acre) of woody fuels 1 in. - 3 in. diameter (100 hr. fuels)
- mass per unit area (tons/acre) of live woody fuels > 3 in. diameter (1000 hr. fuels)
- mass per unit area (tons/acre) of dead woody fuels > 3 in. diameter (1000 hr. fuels)
- mass per unit area (tons/acre) of litter
- mass per unit area (tons/acre) of duff
- brush density (individuals/m²) for each shrub species
- herbaceous density (% cover) for each herbaceous species
- herbaceous density (point-intercept density) for each herbaceous species
- seedling tree density (individuals/m²) for each tree species
- seedling tree heights (categorical) for each tree species
- pole-size tree density (individuals/m²) for each tree species
- pole-size tree heights (categorical) for each tree species
- pole-size tree diameter at breast height (DBH) (cm) for each tree species

- burn severity of vegetation (categorical)
- burn severity of litter and duff (categorical)

Figure 1. Kenai NWR FMH plot locations.

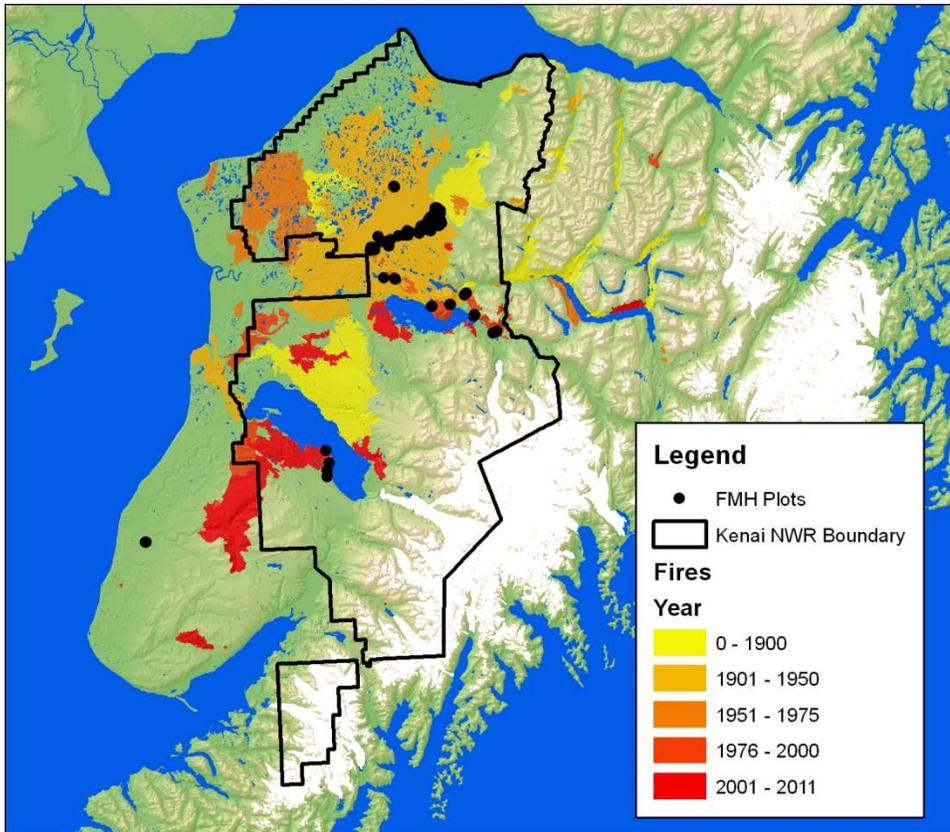
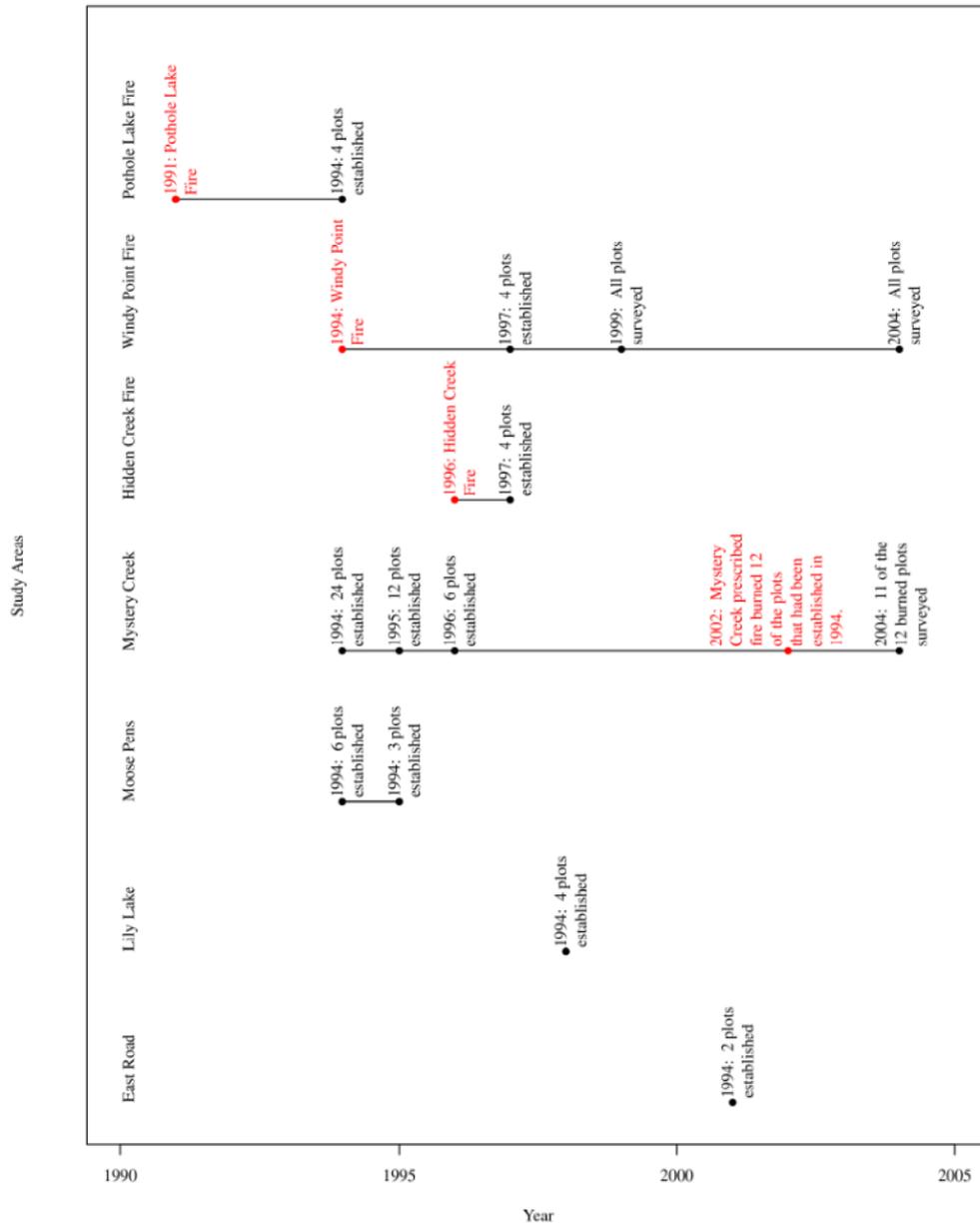


Figure 2. Timeline of establishment and sampling of KNWR FMH plots from Bowser (2010). The Lily Lake plots were established in 1998.

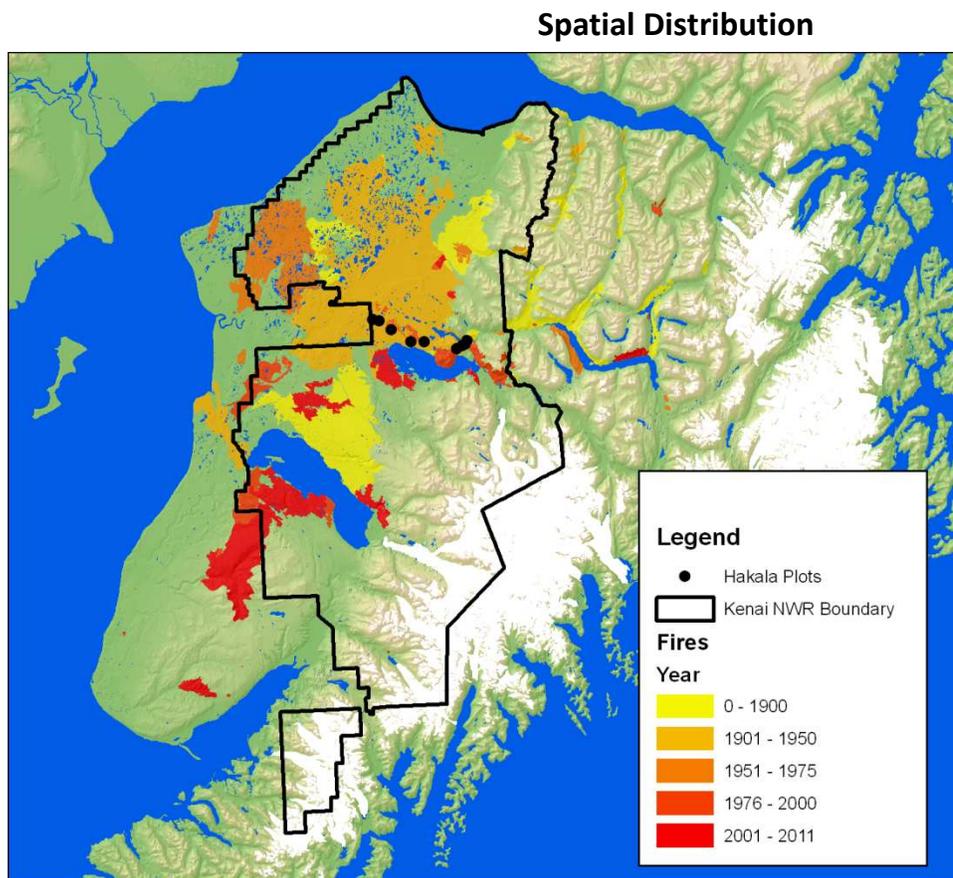


The Hakala plots were established in 1950 within the 1947 burn to monitor the succession of vegetation post-fire. The nine Hakala plots are spread along Skilak Lake Road from its western end to the vicinity of Bear Mountain. The plots were established and surveyed in 1950. They were resurveyed in 1955, 1961, 1965, 1995, 2000, 2005, and 2010. Data collected include the following:

- Basal area of all tree species and larger shrubs (ft²/acre)
- DBH of trees and tall shrubs (cm)
- Heights of trees and tall shrubs (cm)

- Stem (stems/acre) densities of herbaceous plants and small woody plants (stems/unit area)
- Frequencies of occurrence of all non-tree species
- Cover estimates of ground cover classes (% cover)
- Burn severity (categorical)

Figure 3. Hakala Plot locations.



The FIA plots are monitored by the US Forest Service and are considered part of the Refuge’s Long Term Ecological Monitoring Program (LTEMP). Plots were initially established during 1999-2002 and include 215 P2 plots and 21 P3 plots on the refuge; 20% of these plots are resampled on even years every decade. Data collected at the P2 and P3 levels include the following:

P2 plots

Plot/stand level metrics

- Condition class (categorical, related to basal area & stem density)
- Stand age (years)
- Seedling stocking, regeneration, and biomass information for all tree species

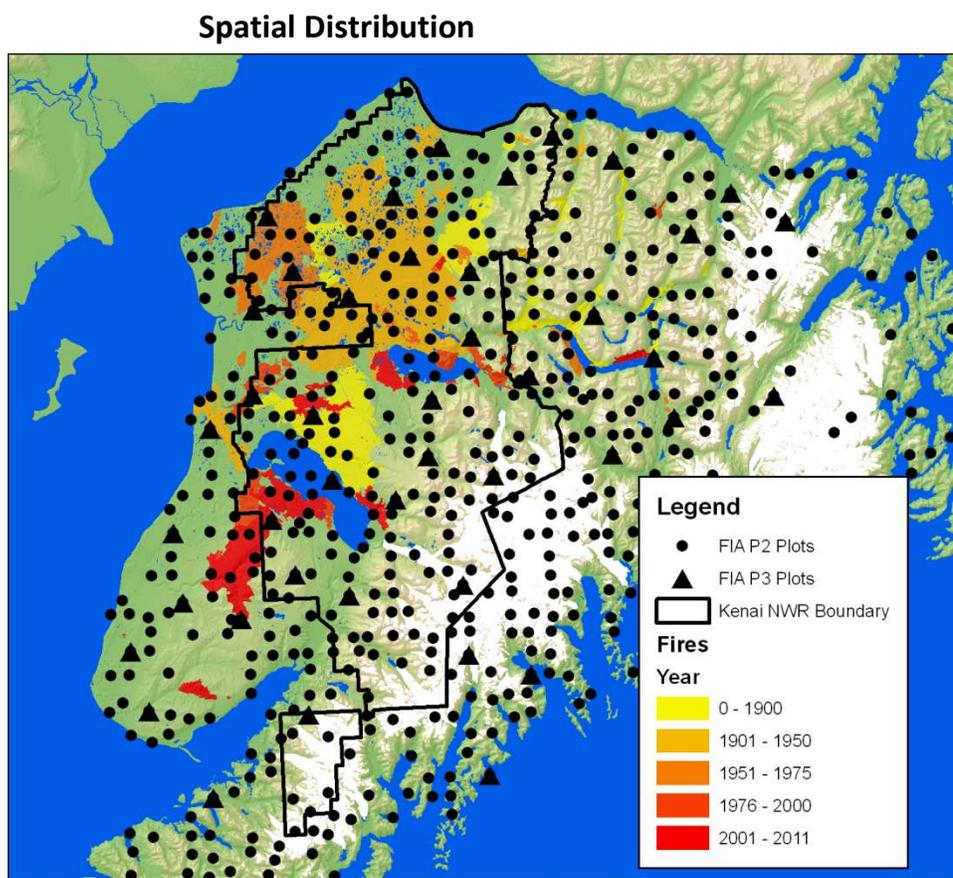
- Seedling condition (categorical)
- Seedling density (seedlings/acre)
- Tree and sapling data for all tree species
- Tree condition (categorical)
- Tree status (categorical)
- Standing dead tree (categorical)
- Tree diameter at breast height (DBH) (in.)
- 10 year growth rate, from core (in.)
- Tree heights (ft.)

P3 plots

Down woody material

Figure 4. Kenai Peninsula FIA plot locations. These are the “fuzzed” coordinates.

Remote sensed



Historic fire perimeters have been reconstructed using natural features (lakes, wetlands, and rivers) and dendrochronology (fire scars, stand-age) from 1708 (De Volder 1999). In Alaska, systematic fire reporting began in the 1940s after the Alaska Fire Control Service was organized (Gabriel and Tande 1983). Fires over 1000 acres from 1940-1987 and fires over 100 acres after 1987 are included in a spatial database hosted by the Alaska Interagency Coordination Center. In 1999, the Moderate Resolution Imaging Spectroradiometer (MODIS) was launched to collect remotely sensed data. MODIS provides daily images used to detect and map the spread of active fires (Justice et al. 2002). Fire perimeters are also documented at field sites using GPS and uploaded into a database at the Alaska Interagency Coordination Center (www.fire.ak.gov). Therefore, the occurrence and extent of future fires on the KENWR will be accurately recorded. The KENWR also maintains a fire history geodatabase for the Kenai Peninsula.

In addition, refuge staff monitor landscape vegetation and land-use with change-detection analysis of classified LANDSAT imagery. The first landcover classification has been completed using 2002 LANDSAT images. Twenty-six land cover classes were identified and mapped across the Kenai Peninsula (O'Brien 2006). Classification and change detection analyses will occur in 10 year intervals as Forest Inventory and Analysis (FIA) data become available for training.

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**Appendix B:
Fire Management Units,
Management of Wildfires, and
Alaska Interagency Wildland
Fire Management Plan**

Appendix B

Section B.1 Fire Management Units at Kenai NWR

Elements Common to All Four FMUs

There are four Fire Management Units (FMUs) at Kenai NWR — these are shown on Figure B-1. The fire management options are depicted on Figure B-2, and the special values to protect at the Refuge are shown on Figure B-3. Each of the FMUs is described in detail below. Some values to protect and fire management and safety considerations are common to all FMUs and are listed below. Concerns and considerations specific to a particular FMU are described in the individual FMU sections.

Values to Protect Common to All FMUs

- Hunting and recreation, subsistence use (notably in Alaska): large and small game and waterfowl hunting, fishing, camping, canoeing and subsistence uses occur in all FMUs
- Historic and Archeological resources (such as structures and sites) and historic and cultural resources are common throughout the Refuge, especially along major waterways where salmon populations occur. To protect known cultural and historical resources the Refuge keeps the locations of known sites secure. The Refuge provides Resource Advisors to fire protecting agencies or incident management teams as necessary to protect known sites from damage due to fire management activities.

Fire Management Considerations Common to All FMUs

- Hazardous fuels projects and treatments will focus on the highest risk areas. Typically these are adjacent to or included in current CWPP areas where FMUs about Refuge boundaries. Collaborative projects including a mix of Refuge, State, and private lands is the optimal desired project design. Treatment types may range from thinning with power tools, mastication, biomass removal, chemical treatments, and landscape-scale prescribed fire treatments. Habitat treatments should occur where altered fire return intervals are occurring or vegetation manipulation using hazardous fuels treatment techniques are desired. All treatment types will minimize effects on Refuge values while reducing risk from Refuge wildfires spreading into adjacent communities. Minimizing the effects on Refuge values can be achieved by:
 - Avoiding hard edging (straightline) treatment areas (a wandering edge with occasional screening strips is desired).
 - Limiting periods of treatment activity to times of least visitor use.
 - Developing standard treatment prescriptions and monitoring outcomes.

Figure B-1. Fire Management Units, Kenai NWR

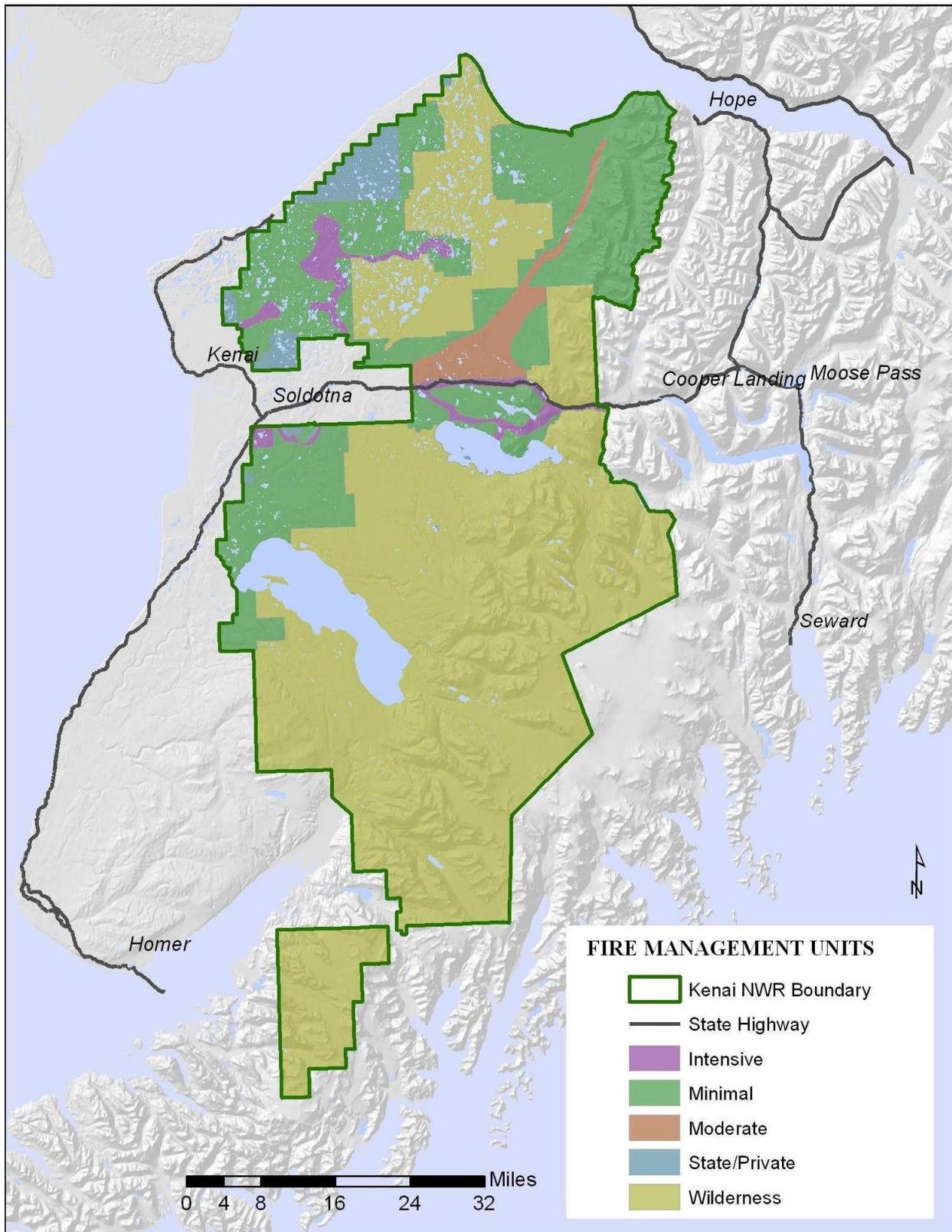


Figure B-2. Fire management options, Kenai NWR

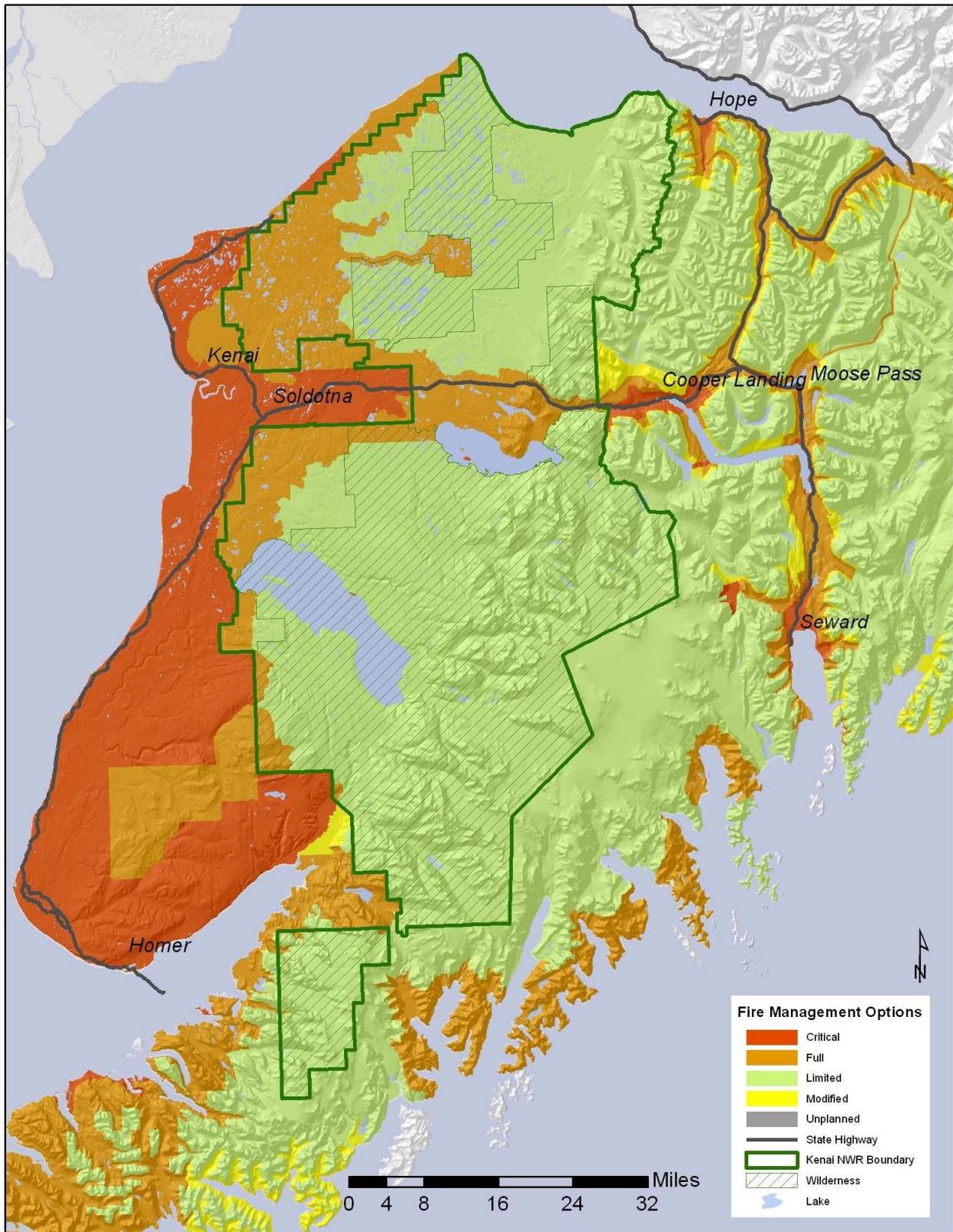
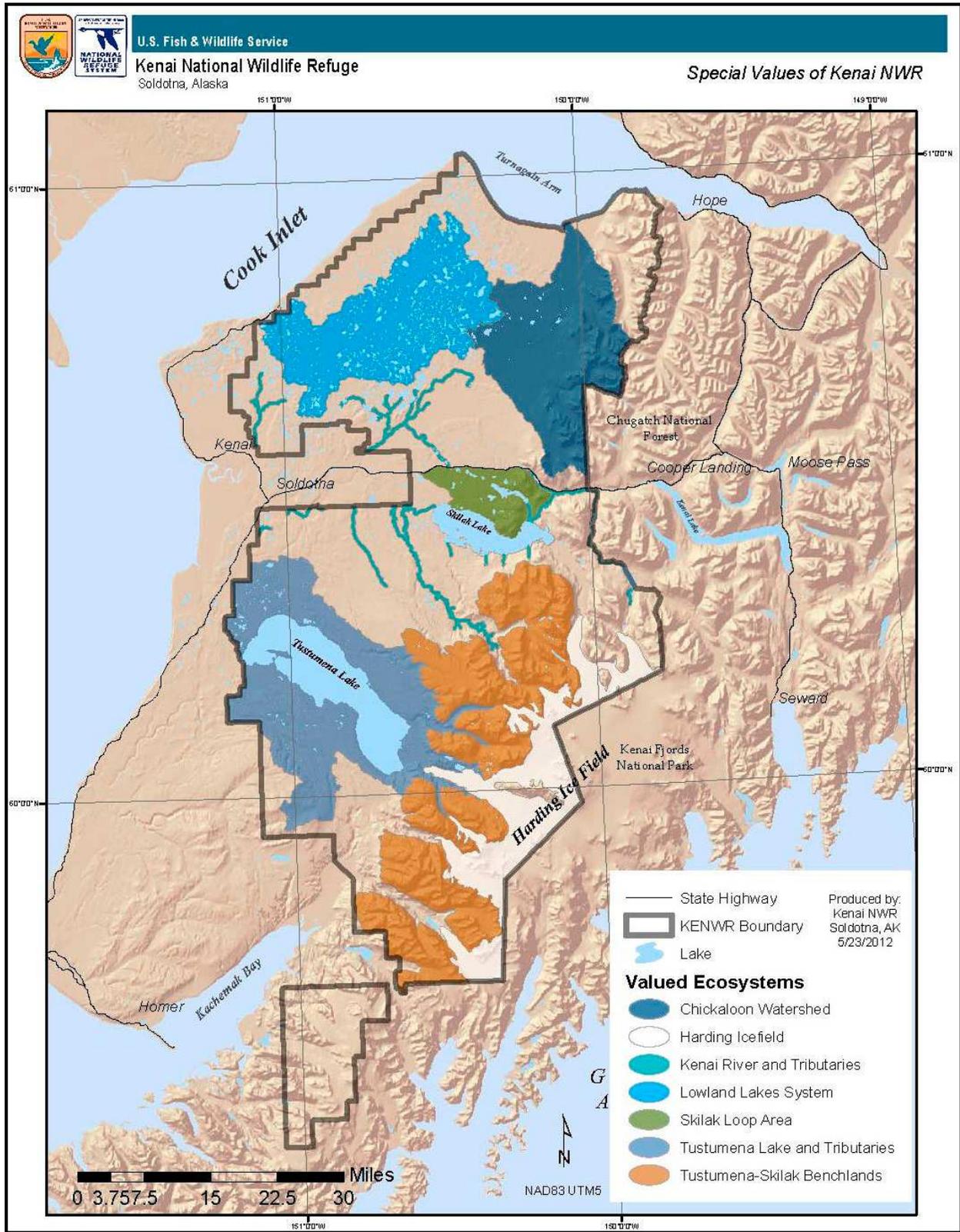


Figure B-3. Special values to protect, Kenai NWR



In addition to informing the Regional Historic Preservation Officer (RHPO) and/or Regional Archaeologist it should be standard procedure to check for the presence of known cultural resources within the unit

- Acreage targets and/or limits by habitats/cover types: There are no specific acreage targets and/or limits by habitats/cover types in any FMU.
- Retardant or foam use restrictions/constraints: The Refuge Manager or designated Agency Administrator must approve retardant or foam use prior to use except in the case of imminent threat to life, safety or loss of homes, facilities, or infrastructure.
- Equipment and aircraft use limitations/application of Minimum Impact Suppression Techniques (MIST):
 - Do not use aerial retardants and foams within 300 feet of waterways or water bodies.
 - Do not allow more than 40 people in a single fire camp in designated Wilderness.
 - Repair ground disturbed by suppression activities to pre-incident condition.
 - The Refuge Manager must approve heavy equipment use (dozers), prior to use.
 - Inform the RHPO / Regional Archeologist of cultural resources or historic properties are discovered during fire operations.
 - Use MIST to the greatest extent possible on all Refuge lands.
- Staff or monitor wildfires during active burning periods until controlled.
- In this FMU, the default management strategy is to monitor wildfires by aircraft (and by ground when needed), until a season-ending event. Management Action Points (MAPs) will be established for incidents with potential to spread to, and impact values to protect and management actions defined and initiated to mitigate fire impacts.
- The FMP and a delegation of authority provide a general strategy to an IC, who has discretion to select and implement appropriate tactics within the limits for the FMU(s), including when and where to use MIST unless otherwise specified.
- Natural recovery is the preferred choice for recovery following wildfires. However, when natural recovery is not likely, Emergency Stabilization (ES) treatments may be needed to prevent further degradation of cultural and natural resources in the burned area. Any seeding will use seeds from natural sources whenever feasible.

Fire Management Guidance Common to All FMUs

- Response to wildfires – preferred strategies and tactics: The default management response to human-caused wildfires is initial attack fire suppression. A human-caused fire that escapes or exceeds the initial attack response will be managed according to an incident management plan prepared by the designated Incident Commander or Incident Management Team, and as documented in the Wildland Fire Decision Support System (WFDSS). The default fire management response to lightning-caused wildfires is to allow them to burn freely until they go out, cross into another FMU with different strategies, or

become a threat to safety or values at risk. Changes in response will be managed according to an incident management plan and documented in WFDSS.

Safety Considerations Common to All FMUs

- Difficulty of movement in marshes/wetlands: marshes, peat bogs, lake and river margins and other riparian/wetland habitats are common throughout the Refuge.
- Entrapment in flashy fuels: *Calamagrostis canadensis* (aka, Canada bluejoint or bluejoint reedgrass) meadows and grasslands are the most common and hazardous flashy fuel type on the Refuge.
- Public evacuation/closures during fire operations: during wildfire or prescribed fire operations, it might be necessary to close affected areas within FMUs and/or evacuate Refuge visitors. During past wildfire incidents, trails, roads or other access points in the Refuge have been temporarily closed in the interest of public safety.
- Smoke impacts on highway safety: smoke from large wildfires or prescribed fires in any FMU could impact local highways, communities and air traffic, depending upon fire location, intensity, wind direction and atmospheric conditions. Smoke management objectives need to be identified in incident management plans and prescribed fire plans and air quality/smoke conditions should be monitored. The Alaska Department of Environmental Conservation is the point of contact for all air quality and smoke-related issues.
- Repeater locations/radio dead spots: The Refuge maintains four radio repeaters, from north to south along the western slope of the Kenai Mountains: the Trapper Joe Repeater on a ridge just east of Trapper Joe Lake; two repeaters on Hideout Hill (the Hideout and Swanson Repeaters), just north of Hidden Lake; and, the Tustumena Repeater on a ridge just south of the southeastern end of Tustumena Lake. All of the repeaters are above the tree-line and powered by batteries with solar panel charging systems. All four provide both narrowband digital and analog radio communications capabilities to the Refuge. The Hideout Repeater is the primary repeater for most Refuge radio communications. The Swanson Repeater is located on the same site to provide redundancy for the Refuge Radio System and an alternate repeater for emergencies. The Tustumena Repeater is the only one located within designated Wilderness (Andrew Simons). Despite this very reliable radio communications infrastructure, there are radio dead spots across the Refuge, especially in deep canyons and depressions or low-lying areas distant from any repeater. There is no Service radio coverage in areas of the Refuge south of Kachemak Bay.
- Unexploded ordnance (UXO): it is possible that unexploded ordnance exists in any FMU, especially discarded small arms ammunition from hunters or UXO left over from previous military exercises and/or seismic exploration activities. While it is also unlikely that UXO would be encountered on any given wildfire or prescribed fire, firefighters and fire managers should always be alert to possible UXO hazards, take steps necessary to control identified hazards and mitigate risks to fire personnel and the public.

- Hazards from poisonous plants, venomous animals, predatory animals, illegal dump sites, and illegal drug operations: while there are no poisonous plants like poison oak or poison ivy on the Refuge, there are poisonous mushrooms and berries that should not be consumed by humans. There are no snakes or other venomous animals but healthy populations of black and brown bear are present throughout the Refuge. Refuge employees are required to carry 12-gauge shotguns with rifled slugs, and other bear deterrents like pepper spray and air horns, while working in bear country. Refuge employees receive bear safety training and firearms training and are annually certified to carry the shotgun. Refuge employees often provide bear guard services to visiting firefighters on large wildfire incidents. Occasionally, illegal dump sites are found along the road system, though the Refuge makes every effort to clean up those sites as soon as possible. Illegal drug operations such as marijuana plantations or Meth labs, though not common, are known to occur on the Refuge.

Wilderness FMU

This category applies only to areas designated by Congress as units of the National Wilderness Preservation System; areas proposed for Wilderness designation will be managed under Minimal management, consistent with section 1317(c) of Alaska National Interest Lands Conservation Act (ANILCA) and U.S. Fish and Wildlife Service (Service) policy. Designated Wilderness will be managed under the *Wilderness Act of 1964* and the exceptions provided by ANILCA. Because Wilderness units are part of a nationwide, multi-agency system, the Service recognizes that responsibilities for managing Refuge Wilderness go beyond the mission of the Service and that the purposes of the *Wilderness Act* are within and supplemental to the other purposes for which individual refuges were established.

The history and intent behind the *Wilderness Act* make Wilderness more than just another category of management. Wilderness encourages a broadened perspective of the Refuge landscape, one that extends beyond managing it solely as wildlife habitat. Wilderness is managed as an area “retaining its primeval character and influence.” In addition, Wilderness provides visitors with opportunities for solitude and a primitive and unconfined type of recreation that allows for discovery, self-reliance, and challenge.

Wilderness areas are managed to preserve their experiential, aesthetic, scientific, and other related values. Research has shown that some values of Wilderness extend beyond their boundaries to people who may never visit but who benefit from the protection of natural ecological processes--- benefits such as clean air and water and the simple knowledge that such places exist. In managing Wilderness, managers are encouraged to consider these off-site and symbolic values as well as tangible resource values.

The Wilderness Act provides a special provision allowing measures to be taken “as may be necessary in the control of fire, insects, and diseases, subject to such conditions as the Secretary deems desirable” [Section 4 (d)(1)] Actions such as prescribed fires or invasive species control may be conducted in wilderness in accordance with Service policy at 610 FW 2.23 and 610 FW 2.19, respectively. Prescribed fire and Non-fire applications such as manual thinning may be desirable options for protecting specific resource values by reducing fuel buildups and modifying forest structure to reduce

fire intensities if ignitions do occur. Management activities in Wilderness must be found to be the minimum requirements for the administration of the area as Wilderness.

Wilderness FMU — Description

With the passage of ANILCA in 1980, Congress designated 1.32 million acres or about two-thirds of the Refuge as Kenai Wilderness. There are three separate and distinct units of designated wilderness on the Refuge: the Dave Spencer Wilderness Area (187,228 acres), which includes the Swanson River and Swan Lake National Recreation Canoe Trails; the Mystery Creek Wilderness Area (46,086 acres), in the Mystery Hills area of the Kenai Mountains north of the Sterling Highway; and, the Andrew Simons Wilderness Area (1,087,094 acres), which covers most of the Refuge lands south of the Kenai River (refer to Figure B-1 above.).

The wildfire season in the Wilderness FMU is typically from the snow-free date in early April or May to the onset of fall rains in August or September, though exceptions exist. Fire intensity, fire size and complexity vary with fire weather and fuel conditions. There is no history of prescribed burning in Kenai Wilderness areas as it was not allowed prior to the CCP revision.

Wilderness FMU — Values to Protect

Dave Spencer Wilderness — Values to Protect

- WUI areas designated in Federal Register as Community at Risk (CAR) or designation as Community of Interest (COI) and key descriptors (location, access, etc.): the community of Sterling, Alaska abuts the southern boundary of the Dave Spencer Wilderness.
- Service structures, infrastructure and private lands (in-holdings): the Moose Research Center (MRC). Established in 1966, the MRC is a world-renowned, one-of-a-kind facility that continues to play a role in the understanding of the nutritional, physiological, and ecological aspects of moose. The Dave Spencer Wilderness encloses the 19,250-acre MRC on three sides. The only access to the MRC is via the Swan Lake Road from the west. There are four one-mile-square fenced moose pens and several buildings at the MRC. Two cabins in the compound house two or more State employees and family members, year-round. There is also a Private Inholding just northeast of Dipper Lake, along the northwest shore of Chickaloon Bay. There are no other structures, infrastructure or private in-holdings in the Dave Spencer Wilderness.
- Adjacent landownership, structure types, and land use: the wilderness area boundary abuts an area of State-selected and private lands at its far northwestern corner – between Point Possession and Miller Creek. There are a number of privately owned recreation cabins within a few miles of the Refuge boundary in this area.
- Threatened and Endangered (T&E) or special status species and habitats, critical habitat for other species of concern: while there are no known T&E or special status species and habitats, there are dozens of lakes in the wilderness that are designated as permanent nesting habitats for trumpeter swans.
- Special designated areas/special values (Wilderness, Wild & Scenic River, etc.): the CCP identifies three special value areas that partially intersect the Dave Spencer Wilderness: the

Chickaloon Watershed and Estuary, the Kenai River and its Tributaries, and the Lowland Lakes System (Figure B-3). The Lowland Lakes System includes the world-class Swanson River and Swan Lake Canoe Trails. Wilderness values include wilderness character where the earth and its community of life are untrammled by man, primeval character and influence, natural and unimpaired conditions, and opportunities for solitude or a primitive and unconfined type of recreation.

- Mining, oil and gas wells and utility right-of-ways: while there are no mining, oil and gas wells or utility rights-of-way within the designated wilderness, the Swanson River Oil & Gas facilities are just west of the southern half of the wilderness area.
- Structures lacking defensible space, water supply issues: while there are no developed firefighting water sources at the MRC, there are accessible lakes near the structures.

Mystery Creek Wilderness — Values to Protect

- Adjacent landownership, structure types, and land use: the eastern boundary of the Mystery Creek Wilderness is shared by the Seward Ranger District of the Chugach National Forest. The southern boundary abuts the Sterling Highway right-of-way.
- Special designated areas/special values (Wilderness, Wild & Scenic River, etc.): Wilderness values include: wilderness character where the earth and its community of life are untrammled by man, primeval character and influence, natural and unimpaired conditions, and opportunities for solitude or a primitive and unconfined type of recreation. The Chickaloon Watershed and Estuary is a special value area identified by the CCP that encompasses a large portion of the Mystery Creek Wilderness.

Andrew Simons Wilderness — Values to Protect

- WUI areas designated in Federal Register as Community at Risk (CAR) or designation as Community of Interest (COI) and key descriptors (location, access, etc.): Communities at Risk include Sterling, Alaska and Funny River, Alaska. Both communities are directly north of the northwest corner of the Andrew Simons Wilderness. Along the southern edges of these communities there are dozens of primary residences and businesses within one mile of the wilderness boundary. Sterling is accessed via the Sterling Highway and secondary roads. The only access into Funny River is via the Funny River Road. There is one Community of Interest: the Ninilchik Forties Subdivision, along the western boundary of the wilderness in the Caribou Hills area south of Tustumena Lake and north of Deep Creek. This community is accessed via Oilwell Road out of Ninilchik, Alaska on the Sterling Highway. There are more than 200 structures in this unincorporated community of residences and recreation cabins.
- Service structures, infrastructure and private lands (in-holdings): There are several Refuge Public Use and Administrative Cabins in the Andrew Simons Wilderness, some of which are also historic resources (see below: Historic and Archeological resources): Doroshin Bay, Emma Lake, Nurses, Pipe Creek, Andrew Berg's, Big Bay and Caribou Island. There is also a Refuge Radio System Repeater (the Tustumena Repeater) just south of the

southern end of Tustumena Lake on a point above the tree line. Private lands (in-holdings) in the Wilderness include:

- Romig Family Trust Parcels (1 modern cabin + historical structures) at the northern end of Upper Russian Lake (46.4 acres)
 - Alaska Wildland Adventures Lodge and cabins at Cottonwood Creek on Skilak Lake (5 acres)
 - Guff Sherman Cabin and other parcels with cabins at Douglas Point on Skilak Lake (5 acres)
 - Dolchok Allotment and Cabins at Harvey Lake on the Tustumena Benchlands (100 acres)
 - Bear Creek Subdivision Parcels on Tustumena Lake (38 acres)
 - Jim Taylor Cabin on Tustumena Lake (4+ acres)
 - Blake Cabin (historic) near Indian Creek on Tustumena Lake [T1S, R8W, Sec 2] (5 acres)
 - Ptarmigan Head Parcel (no structures) north of Caribou Lake [T2S, R11W, Sec 24 & 25] (11.9 acres)
- Adjacent landownership, structure types, and land use: on its eastern side, the Andrew Simons Wilderness shares common boundaries with the Chugach National Forest – Rifle Ranger District and Kenai Fjords National Park. The western boundary abuts State and Private Lands from Crooked Creek south. The southern satellite unit also known as the Glacier Unit of the Andrew Simons Wilderness is surrounded by National Park lands to the east and State and Private Lands to the north and west.
 - Threatened and Endangered (T&E) or special status species and habitats, critical habitat for other species of concern: the Kittlitz’s murrelet (a candidate species for listing), likely nests on the southern unit of the Refuge, which is part of the Andrew Simons Wilderness.
 - Historic and Archeological resources – structures, sites, etc.: historical cabins around Skilak, Emma, and Tustumena Lakes: Doroshin Bay, Emma Lake, Nurses, Pipe Creek, Andrew Berg, Big Bay and Caribou Island. Archeological resources are known to exist around Skilak and Tustumena Lakes and the Kenai and Kasilof Rivers and major tributaries, especially where salmon runs are present.
 - Special designated areas/special values (Wilderness, Wild & Scenic River, etc.): Wilderness values include wilderness character where the earth and its community of life are untrammled by man, primeval character and influence, natural and unimpaired conditions, and opportunities for solitude or a primitive and unconfined type of recreation. Special value areas identified in the CCP that intersect with the Andrew Simons Wilderness include the Skilak Wildlife Recreation Area, the Kenai River and its Tributaries, the Tustumena-Skilak Benchlands, Tustumena Lake and its Watershed, and the Harding Icefield (Figure B-3).

- Structures lacking defensible space, water supply issues: All known structures including private in-holdings have had at least basic defensible space work completed around the structures.

Wilderness FMU — Fire Management Guidance

Firefighter and public safety is always the first priority of fire management. This fire management plan and its activities reflect this commitment. Having provided for safety first, preserving the wilderness character of the three designated Wilderness Areas in the Refuge is the focus of fire management in the Wilderness FMU.

The following fire management guidance applies to all three Wilderness Areas in the Refuge:

- Allowance to manage wildfires to enhance/benefit resources: Naturally ignited wildfires may be managed to maintain/enhance/benefit wilderness resources or wilderness values.
- Actions such as prescribed fires or invasive species control may be conducted in wilderness in accordance with Service policy at 610 FW 2.23 and 610 FW 2.19, respectively. Fire management actions other than emergency response, as well as other administrative activities, must undergo a minimum requirements analysis. This two-step decision process involves determining if an activity should be conducted in the wilderness area and, if so, determining the strategy that would employ the least intrusive tool, equipment, device, force, regulation, or practice required to achieve the management objective.

Wilderness FMU — Safety Considerations

- During wildfire incidents, locating and evacuating Refuge visitors within this FMU could prove especially difficult, due to the remoteness and inaccessibility of the three Wilderness areas.
- Gas lines, power lines, mine shafts: there are no natural gas pipelines, power lines or mine shafts in any of the three Wilderness areas.

Minimal FMU

Minimal management is designed to maintain the natural environment with very little evidence of human-caused change. Habitats should be allowed to change and function through natural processes. Administration will ensure that the resource values and environmental characteristics identified in the CCP are conserved. Public uses, economic activities, and facilities should minimize disturbance to habitats and resources. Ground-disturbing activities are to be avoided whenever possible.

Management actions in this category focus on understanding natural systems and monitoring the health of Refuge resources. Generally, no roads or permanent structures are allowed (except cabins). Temporary structures may be allowed in situations in which removal is planned after the period of authorized use, and the site can be rehabilitated using plants native to the immediate area. Existing cabins may be allowed for administrative, public use, subsistence, or commercial or economic (e.g., guiding) purposes. New subsistence or commercial cabins may be authorized if no reasonable alternatives exist. Public use or administrative cabins may be constructed if necessary for health and safety.

Public use of the Refuge for wildlife-dependent recreation and subsistence activities is encouraged. Public use facilities are not generally provided. Mechanized and motorized equipment may be allowed when the overall impacts are temporary or where its use furthers management goals.

If a transportation or utility system, as defined in section 1102 of ANILCA, is proposed to cross an area in Minimal management, the authorization process would incorporate a corresponding CCP amendment to change the management category in the affected area from Minimal to Moderate or Intensive management, as appropriate.

Compatible economic activities may be allowed where the evidence of those activities does not last past the season of use, except as noted in the preceding discussion of cabins. The primary economic activities are likely to be guiding and outfitting of recreation activities such as hunting, fishing, hiking, river floating, and sightseeing. All economic activities and facilities require authorizations such as special use permits.

Prescribed fire and Non-fire applications such as manual thinning may be desirable options for protecting specific resource values by reducing fuel buildups and modifying forest structure to reduce fire intensities if ignitions do occur.

Minimal FMU — Description

As the second largest of the Refuge FMUs (514,550 acres or 25.9% of the 1.98 million Refuge acres), most of the lands in the Minimal FMU occur north of the Kenai River and are fragmented by lands in the Moderate, Intensive, and Wilderness FMUs (refer to Figure B-1 above). The remainder of the Minimal FMU occurs between the Kenai and Ninilchik rivers and west of the Andrew Simons Wilderness.

Land ownerships adjacent to the Minimal FMU include the Chugach National Forest to the east of the Chickaloon River watershed, and State, Borough, Municipal and Private lands along the western boundaries of the Refuge. Adjacent wildland fire management (Protecting Agency) jurisdictions include the USDA Forest Service and the Alaska Division of Forestry.

Access into the Minimal FMU is better than in Wilderness, but still limited. Road access to Minimal areas or to trails that access Minimal areas includes the Spur Highway, Marathon Road (and associated Beaver Creek Oil and Gas Field roads), the Swanson River Road (and associated Swanson River Oil and Gas Field roads), the Swan Lake Road (and associated Moose Research Center roads), the Mystery Creek Road (and associated pipeline access roads), the Sterling Highway, the Funny River Road and the Tustumena Lake Road. Trail access includes: the Seven Lakes Trail, the Skilak Overlook Trail and several other foot trails within the Skilak Wildlife Recreation Area, the Funny River Horse Trail and the Doc Pollard Trail. Navigable river access is via the Swanson, Kenai and Kasilof Rivers. Aviation access is via floatplane or helicopter.

The wildfire and prescribed fire season in the Minimal FMU is typically from the snow-free date in early April or May to the onset of fall rains in August or September, though exceptions exist. Prescribed fires (especially pile burning) can occur outside of the wildfire season. Fire behavior, fire intensity, fire size and complexity vary with fire weather and fuel conditions, but the threat of wildfires is likely limited to burnable fuels at lower elevations (below 1,000 feet above sea level). Hazardous fuel types or complexes include black spruce types, *Calamagrostis canadensis* grasslands, and areas of beetle-killed

spruce where grasses, forbs and shrubs mix with heavy downed dead fuels to elevate the potential for catastrophic fire behavior, fireline intensity and resistance to control.

Since the Refuge was established in 1943, a number of large fires have impacted portions of what is now the Minimal FMU: the 1947 Skilak Lake Fire (310,000 acres), the 1969 Swanson River Fire (79,000 acres), the 1974 Chickaloon River Fire (3780 acres), two large fires in 1996 – Hidden Creek (5200 acres) and Crooked Creek (11,940 acres), and the 2009 Shanta Creek Fire (13,221 acres). Prior to Refuge establishment, other known large fires in Minimal included one near Point Possession (1915) and another near Slikok Lake (1926).

Minimal FMU — Values to Protect

- WUI areas designated in Federal Register as Community at Risk (CAR) or designation as Community of Interest (COI) and key descriptors (location, access, etc.): From north to south... Gray Cliffs Subdivision (COI) – access via Spur Highway and coastal trail north from Captain Cook State Park; Nikiski (CAR) – access via Spur Highway; Kenai (CAR) – access via Spur Highway and Bridge Access Road/Kalifornsky Beach Road; Sterling (CAR) – access via Sterling Highway; Soldotna (CAR) – access via Sterling Highway, Spur Highway and K-Beach Road; Funny River (CAR) – access via Funny River Road from Sterling Highway; Kasilof (CAR) – access via Sterling Highway; and, Ninilchik Forties Subdivision (COI).
- Service structures, infrastructure and private in-holdings: There are a number of Refuge Public Use Cabins in the Minimal FMU, including cabins at Pincher Creek, Vogel Lake and McLain Lake. Private in-holdings include the Caribou Island Subdivision on Skilak Lake and a small private parcel on the Lower Chickaloon River about 2.5 miles northeast of Lonesome Lake. Refuge infrastructure in the Minimal FMU includes three radio repeaters: one east of Trapper Joe Lake and two on Hideout Hill, north of Hidden Lake.
- Adjacent landownership, structure types, and land use: Minimal FMU areas are adjacent to the Seward Ranger District of the Chugach National Forest, to State, Borough, Municipal and private lands and to ANCSA (22g) parcels owned by the Tyonek and Salamatof Native Village Corporations, along the western boundaries of the Refuge.
- Special designated areas/special values (Wilderness, Wild & Scenic River, etc.): areas of the Minimal FMU abut all three Refuge Wilderness areas so the potential impacts of fire management activities upon adjacent Wilderness values should be considered and mitigated as necessary. Special value areas identified in the CCP that intersect areas of the Minimal FMU include the Lowland Lakes System, the Chickaloon Watershed and Estuary, the Skilak Wildlife Recreation Area, the Kenai River and its Tributaries, and Tustumena Lake and its Watershed (Figure B-3).
- Mining, oil and gas wells, and utility right-of-ways: there are no mines, oil wells, gas wells, pipelines, or utility right-of-ways in the Minimal FMU.

Minimal FMU — Fire Management Guidance

Firefighter and public safety is always the first priority of fire management. All fire management plans and activities must reflect this commitment. Other fire management guidance that is specific to the Minimal FMU includes:

- Allowance to manage wildfires to enhance/benefit resources: Naturally ignited wildfires may be managed to maintain/enhance/benefit natural resources or accomplish Refuge management objectives.
- Allowance for hazardous fuels treatments and treatment types: the full range of hazardous fuels treatments and treatment types are allowed, especially in wildland-urban interface or intermix areas.
- In this FMU, prescribed fires will be used in conjunction with herbicide treatments as specified in other refuge plans to help control invasive species and reduce the build-up of hazardous fuels.

Minimal FMU — Safety Considerations

- Gas lines, power lines, mine shafts: there are no power lines or mine shafts in the Minimal FMU, but there are two natural gas pipe lines: the Enstar line from Chickaloon Bay to Sterling crosses a portion of the FMU along the east side of Chickaloon Bay, and the Wolf Lake to Beaver Creek natural gas pipe line.

Moderate FMU

Moderate management is meant to allow compatible management actions, public uses, commercial uses, and facilities that may result in changes to the natural environment that are temporary or permanent but small in scale and that do not disrupt natural processes. The natural landscape is the dominant feature of Moderate management areas, although signs of human actions may be visible.

Management actions in the Moderate management category will focus on maintaining, restoring, or enhancing habitats to maintain healthy populations of plants and animals where natural processes predominate. For example, large biomass removal and prescribed burning may be used to convert mature forests to earlier native seral stages to enhance browse for moose. In general, management facilities, both temporary and permanent, will be allowed for the purposes of gathering data needed to understand and manage resources and natural systems of the Refuge. Structures will be designed to minimize overall visual impact.

Public facilities provided in Moderate management will, while protecting habitats and resources, allow the public to enjoy and use Refuge resources in low numbers over a large area, or they will encourage the short-term enjoyment of the Refuge in focused areas. The emphasis is on small facilities that encourage outdoor experiences. Facilities such as public use cabins, rustic campgrounds, kiosks, viewing platforms, trails, and toilets may be provided. Facilities will be designed to blend with the surrounding environment.

Compatible economic activities may be allowed where impacts to natural processes and habitats are temporary (e.g., small-scale logging where an earlier seral stage meets management goals; facilities in

support of guiding and outfitting services such as tent platforms or cabins that encourage enhanced public use). All economic activities and facilities require authorizations such as special use permits.

Prescribed fire and non-fire applications such as manual thinning and biomass removal may be desirable options for protecting specific resource values by reducing fuel buildups and modifying forest structure to reduce fire intensities if ignitions do occur.

Moderate FMU — Description

The 49,450-acre Moderate FMU is a long, relatively narrow area of the Refuge north of the Sterling Highway and along the western foothills of the Kenai Mountains (Figure B-1). This FMU was established to encompass the Enstar Natural Gas Pipeline and its associated access roads. The Enstar pipeline connects natural gas facilities in Anchorage and Nikiski Alaska and crosses the Refuge between Chickaloon Bay and Sterling AK. Access into the FMU is from the Sterling Highway, Mystery Creek Road, and along the pipeline right-of-way.

Most of the lands in the FMU slope gently to the northwest, with numerous creeks and rivers crossing the unit. Soils in the unit tend to be well-drained except in the lowland bogs at the southern end of the unit, which drain into the Moose River watershed.

The wildfire and prescribed fire season in the Moderate FMU is typically from the snowfree date in early April or May to the onset of fall rains in August or September, though exceptions exist. Prescribed fires (especially prescribed pile burning) can occur outside of the wildfire season (if piles have been covered). Fire behavior, fire intensity, fire size and complexity vary with fire weather and fuel conditions, but the threat of wildfires is increased by wildlife-oriented recreation activities in the fall when the Mystery Creek Road is opened to the public. Lightning also plays a role in the fire regime of this FMU as thunderstorms typically build up along the western foothills of the Kenai Mountains. Hazardous fuel types or complexes include black spruce, *Calamagrostis canadensis* grasslands, and areas of beetle-killed spruce where grasses, forbs and shrubs mix with heavy downed dead fuels to elevate the potential for catastrophic fire behavior, fireline intensity and resistance to control. Two large fires have crossed this FMU since the Refuge was established; those are the 310,000-acre Skilak Lake Fire (1947) and the 3,780-acre Chickaloon River Fire (1974). Over its history, the Refuge has conducted a number of mechanical treatments and prescribed fires along Mystery Creek Road, to reduce hazardous fuels (black spruce) and improve moose browse.

Moderate FMU — Values to Protect

- WUI areas designated in the *Federal Register* as Community at Risk (CAR) or designation as Community of Interest (COI) and key descriptors (location, access, etc.): the only Community at Risk near the Moderate FMU is Sterling at the western end of the unit.
- Service structures, infrastructure and private in-holdings: there is one public use cabin at Trapper Joe Lake and a couple of remote landing strips along the pipeline corridor. There is a single-lane bridge across the Chickaloon River and a couple of primitive wooden bridges across creeks along the Mystery Creek Road and the pipeline access road. The Refuge owns the Kenai NWR Remote Automated Weather Station (RAWS), on the west side of Mystery Creek Road at Mile 6. There are no private in-holdings in the Moderate FMU.

- Adjacent landownership, structure types, and land use: the Moderate FMU is completely surrounded by Refuge lands and other FMUs, except for its extreme western end, where it interfaces with private lands and the community of Sterling AK. There is a subdivision with numerous private residences and a few businesses along Atkins Road near the Refuge boundary.
- Special designated areas/special values (Wilderness, Wild & Scenic River, etc.): areas of the Moderate FMU abut the Dave Spencer and Mystery Creek Wilderness areas so the potential impacts of fire management activities upon adjacent Wilderness values should be considered and mitigated as necessary. Two special value areas identified in the CCP that intersect with the Moderate FMU include the Chickaloon Watershed and Estuary and the Skilak Wildlife Recreation Area (Figure B-3).
- Mining, oil and gas wells and utility right-of-ways: there are no mines or oil/gas wells in the Moderate FMU. However, the reason for this FMU's establishment is the Enstar natural gas pipeline and associated access road system (Mystery Creek Road). A high-voltage electric transmission line traverses the southern end of this FMU.
- Structures lacking defensible space, water supply issues: there are no structures lacking defensible space in the FMU. Natural water supplies exist at several locations in the FMU, including Mystery Creek and the Chickaloon River and their tributaries. Accessible lakes are limited along the length of this FMU.

Moderate FMU — Fire Management Guidance

Firefighter and public safety is always the first priority of fire management. All fire management plans and activities must reflect this commitment. Other fire management guidance, specific to the Moderate FMU, includes the following:

- Allowance to manage wildfires to enhance/benefit resources: Naturally ignited wildfires may be managed to maintain/enhance/benefit natural resources or accomplish Refuge management objectives.
- Allowance for hazardous fuels treatments and treatment types: the full range of hazardous fuels treatments and treatment types are allowed, especially in wildland-urban interface or intermix areas.
- In this FMU, prescribed fires will be used in conjunction with herbicide treatments as specified in other refuge plans to help control invasive species and reduce the build-up of hazardous fuels.

Moderate FMU — Safety Considerations

- Normally, the Mystery Creek Road and pipeline access roads are closed to motor vehicles – except during moose hunting season. The Refuge usually closes the road when winter weather makes the road impassable. But when the road is open, this FMU is a very popular destination for recreationists. A late season fire in or adjacent to this FMU could result in evacuations and closure of the area.

- Gas lines, power lines, mine shafts: there are no power lines or mineshafts in the Moderate FMU, but there is one natural gas pipeline - the Enstar line between Chickaloon Bay and Sterling. The Enstar pipeline and its access roads are the reason this FMU exists. If/when the pipeline and its access roads are removed and the right-of-way is reclaimed, the Moderate FMU is slated to be reclassified as Minimal.). A high-voltage electric transmission line traverses the southern end of this FMU.

Intensive FMU

This category is designed to allow compatible management actions, public facilities, and economic activities that may result in alterations to the natural environment. In Intensive management areas, the presence of human intervention may be very apparent. Roads, buildings, and other structures are likely to be seen. Intensive management is applied to the smallest area reasonable to accommodate the intended uses. When Intensive management is proposed for an area, the specific purposes for its establishment will be described.

Natural processes or habitats may be modified through human intervention. Habitats may be highly modified to enhance conditions for one or more animal species. For example, water regimes may be artificially controlled to improve habitat for waterfowl.

High levels of public use may be accommodated and encouraged through modifications to the natural environment such as paving, buildings, developed campgrounds, and other facilities that could alter the natural environment in specific areas. Public facilities are designed to provide a safe and enjoyable experience of the natural environment and an increased understanding of Refuge resources for a wide range of visitors. Facilities may accommodate a large number of visitors while protecting refuge resources from damage through overuse.

Compatible economic uses of Refuge resources that result in alterations to the natural environment may be authorized in Intensive management areas. All economic uses are subject to the compatibility standard, must contribute to the purposes of the Refuge, and require official authorizations such as special use permits.

Intensive FMU — Description

There are five distinct, road-accessible administrative units or areas within the 54,500-acre Intensive FMU:

- Swanson River Road/Swan Lake Road (includes the Swanson River Oil and Gas Unit and the Moose Research Center)
- Marathon Road (Beaver Creek Oil and Gas Unit)
- Sterling Highway/Skilak Loop Road (Skilak Wildlife Recreation Area)
- Funny River Road
- Kenai National Wildlife Refuge Headquarters

Each of the areas encompasses one or more primary and secondary roads and all of the intensive management activities associated with access into areas of the Refuge. Wildfires within these areas are almost always aggressively suppressed to protect lives and other values at risk. Intensive hazardous fuels management activities are planned and implemented in this FMU, especially near wildland-urban interface and intermix areas.

The wildfire and prescribed fire season in the Intensive FMU is typically from the snow-free date in early April or May to the onset of fall rains in August or September, though exceptions exist. Prescribed fires (especially slash pile burns) can occur outside of the wildfire season (if piles have been covered). Fire behavior, fire intensity, fire size and complexity vary with fire weather and fuel conditions, but the threat of wildfires is increased by intense uses and human activities. Hazardous fuel types or complexes include black spruce types, *Calamagrostis canadensis* grasslands, and areas of beetle-killed spruce where grasses, forbs and shrubs mix with heavy downed dead fuels to elevate the potential for catastrophic fire behavior, fireline intensity and resistance to control. Large fires including the Skilak Lake Fire in 1947, the Swanson River Fire in 1969, and the Hidden Creek Fire in 1996 have historically impacted portions of this FMU.

Intensive FMU — Values to Protect

- WUI areas designated in the Federal Register as Community at Risk (CAR) or designation as Community of Interest (COI) and key descriptors (location, access, etc.): Communities at Risk adjacent to areas of the Intensive FMU include Kenai AK, Soldotna AK, Sterling AK and Funny River AK. Each of the five Intensive FMU areas involves a primary or secondary road that provides access/egress for Alaska residents, visitors and Refuge employees.
- Service structures, infrastructure and private in-holdings: there are many Service structures and infrastructure within the five areas of the Intensive FMU, including: the Moose Research Center, the Rainbow Lake and Dolly Varden Campgrounds, and the Dolly Varden Public Use Cabin (Swanson River Road/Swan Lake Road area); the Watson Lake, Kelly-Peterson Lakes, Hidden Lake, Upper Skilak, Lower Ohmer Lake, Engineer Lake and Lower Skilak Campgrounds, the Visitor Contact Station (VCS), the Skilak Guard Station, the Skilak GS RAWS (a State-owned weather station on Refuge lands near the Guard Station), the Swanson RAWS in the Swanson River Oil and Gas Unit, and Public Use Cabins at Upper Ohmer Lake and Engineer Lake (Sterling Highway/Skilak Loop Road area); and the Refuge Headquarters Compound with all of its buildings, vehicles and equipment. There are no private in-holdings within the areas of the Intensive FMU.
- Adjacent landownership, structure types, and land use: each of the five Intensive FMU areas abuts State, municipal and/or private lands with homes, businesses and public buildings.
- Special designated areas/special values (Wilderness, Wild & Scenic River, etc.): areas of the Intensive FMU abut all three Refuge Wilderness areas so potential impacts of fire management activities upon adjacent Wilderness values should be considered and mitigated as necessary. Special value areas identified in the CCP that intersect with areas in the

Intensive FMU include the Lowland Lakes System, the Skilak Wildlife Recreation Area, and the Kenai River and its Tributaries (Figure B-3).

- Mining, oil and gas wells and utility right-of-ways: there are no active or historic mining areas within the Intensive FMU, though gravel pits exist at several locations. The Swanson River and Beaver Creek Oil and Gas Units have changed ownership over their history on the Refuge, but both remain active with significant infrastructure and new oil and gas exploration and construction activities. Power lines, oil and natural gas pipelines and communications towers exist throughout the FMU.

Intensive FMU — Fire Management Guidance

Firefighter and public safety is always the first priority of fire management. All fire management plans and activities must reflect this commitment. Other fire management guidance specific to the Intensive FMU includes:

- Allowance to manage wildfires to enhance/benefit resources: while it is possible to manage naturally ignited wildfires to maintain/enhance/benefit natural resources or accomplish Refuge management objectives, the default fire management response within the Intensive FMU is full suppression. Use of wildfire to benefit resource values should only be allowed when life safety, infrastructure and other values can be protected.
- Allowance for hazardous fuels treatments and treatment types: the full range of hazardous fuels treatments and treatment types are allowed, especially in wildland-urban interface or intermix areas.

Intensive FMU — Safety Considerations

- Gas lines, power lines, and mine shafts: there are miles of natural gas and oil pipe lines and power lines within the Swanson River and Beaver Creek Oil/Natural Gas Fields, and there are power lines along the Sterling Highway and Funny River Road, and in the Refuge Headquarters administrative area. There are no mine shafts in the Intensive FMU.

Appendix B

Section B.2 Management of Wildfires

Guidelines for determining a standard wildland fire response are provided in the Alaska Interagency Wildland Fire Management Plan (AIWFMP). That plan provides for a range of fire management responses to wildland fires that protect human life and property and other identified resources and developments, balance fire response costs with values at risk, and are in agreement with Refuge resource management objectives. Initial actions on fires are usually pre-planned per the designated "wildland fire management option" described in the AIWFMP.

Evaluation and selection of a response to a wildfire will include consideration of risks to public and firefighter safety, threats to the assets or values to be protected, costs of various mitigation strategies and tactics, and potential resource benefits.

Protection responses will range from aggressive initial attack to surveillance/monitoring to indirect containment or any combination of the former. The level of suppression action will depend upon the fire management option pre-identified for the FMU, available resources, time of year, fuel type and conditions, cost, terrain and other factors related to the management of a fire.

Managers will use the WFDSS to guide and document wildfire management decisions. The Jurisdictional and Protecting Agencies will work together to develop strategic options to manage a fire, when the fire (1) escapes initial attack, (2) threatens to escape from a Limited fire management option area into a higher management option area, (3) warrants suppression actions but did not receive action due to resource shortages, (4) is beyond the capabilities of initial attack forces, or (5) fire and /or resource management objectives are not being met and a significant change in strategy/action is required.

The FMP and a written delegation of authority can provide a general strategy to an Incident Commander, who has discretion to select and implement appropriate tactics within the limits described for the FMU involved. All resources, including mutual aid resources, will report to the IC (in person or by radio) and receive an assignment prior to tactical deployment.

The default management response to a wildfire occurring in Limited fire management option areas is to place the fire in Surveillance and Monitoring status: AIWFMP protocols will be followed. Within the Limited fire management option areas of the Refuge, a detected ignition will initiate a monitoring response unless the Refuge Manager specifies otherwise. Ignitions within all other fire management option areas (Modified, Full, and Critical) will trigger a protection response as outlined in the AIWFMP. Non-standard responses (management responses other than the designated, pre-planned fire management option response) to wildland fires are also available to the Refuge Manager.

The AIWFMP Fire Management Options occur within each Refuge FMU (refer to Figures B-1 and B-2 above). The options delineate the default fire management (protection) responses. The selection of the appropriate fire management option and its respective response actions, for any given area of the Refuge, is based upon the values at risk, management objectives, and the management strategies selected

for various vegetation communities within the Refuge. Variables (such as time of season, fuel type, fuel loading, fuel moisture, weather and topography) are used to inform the decision-making process on wildfire incidents. However, the predetermined management direction for each FMU will be based on the threat to life, property, and resources of value.

In accordance with CCP direction, wilderness areas in the Refuge are generally designated with the Limited Fire Management Option, although there are exceptions. Where WUI or intermix areas abut Wilderness, a Full Fire Management Option buffer exists between Critical and Limited areas.

Evaluation and selection of a management response to a wildfire will include consideration of risks to public and firefighter safety, threats to the values at risk, costs of various mitigation strategies and tactics, and potential wildfire benefits.

Wildfires will be staffed or monitored during active burning periods as needed to ensure that appropriate mitigation actions are taken to protect threatened values.

Structural fire protection is the responsibility of local governments. Federal agencies may assist with exterior structural protection activities under formal fire protection agreements that specify the mutual responsibilities of the partners, including funding.

All lands within the Kenai NWR are designated by one of the Fire Management Options described below.

Critical Fire Management Option

Description

There are a total of 1,192 acres of land designated as Critical Fire Management Option areas within the Refuge boundaries. Critical areas are found inside or immediately adjacent to all four of the FMUs. These management option areas cover or border sections of land with a high intensity of public uses, management activities and/or communities. Substantial vegetation manipulation is allowed, including prescribed fire and mechanical treatment.

The acres in this fire management option are designated private lands with structures (potentially inhabited) within the Refuge boundaries. A variety of vegetation types and age classes are represented. Age classes vary from early growth (0-20 years) to intermediate growth (41-70 years).

Values to protect

The objective of the Critical Fire Management Option is to protect life and property by prioritizing Protecting Agency suppression actions for wildfires threatening human life, inhabited private property, and designated structures. Firefighter safety is always the first priority and wildfire incidents in Critical receive the highest priority in terms of suppression resource assignments.

Default Management Response

Fires occurring in or immediately threatening lands in Critical will receive the highest priority for protection by immediate and continuing aggressive actions dependent upon the availability of suppression resources.

An Initial Attack response by the Protecting Agency and its cooperators and/or closest Refuge fire-qualified personnel will occur as soon as possible. The Refuge Fire Management Officer (FMO) and Agency Administrator receive immediate notification from the Protecting Agency, upon fire detection. After the initial response, the Refuge and the Protecting Agency may select a response, ranging from full suppression to monitoring fire behavior, depending upon the values at risk and other considerations. These decisions are documented using the interagency WFDSS.

Full Fire Management Option

Description

The Full Fire Management Option covers the second largest area in the Refuge: 363,141 acres. The Full option is found in all four of the FMUs and it typically encompasses development, infrastructure or other areas with high natural resource value. The vegetation is mixed and age classes include areas of wetland, early, intermediate, mature (71-200 years), and sections of old growth (201+ years).

Values to protect

The Full option has high value natural resources, cultural, and historical sites. The protection of uninhabited structures, private property, and valuable natural resources, is addressed in this option. The Skilak Loop Wildlife Recreation Area, the Moose Research Center, the Swanson River Oil & Gas Unit, the Beaver Creek Oil & Gas Unit, and WUI and intermix areas around Peninsula communities are designated Full on the Refuge. Lands and structures in Full receive the second highest priority in terms of suppression resource assignments.

Default Management Response

Wildfires in Full should receive aggressive initial attack to minimize the acres burned. Initial attack suppression response by the Protecting Agency and its cooperators and/or closest Refuge fire-qualified personnel will occur as soon as possible. The Refuge FMO and Agency Administrator should receive immediate notification from the Protecting Agency upon fire detection. After the initial response, the Refuge and Protecting Agency may select a response ranging from full suppression to monitoring fire behavior, depending on the values at risk and other considerations. These decisions are documented using the interagency WFDSS.

Modified Fire Management Option

Description

The Modified Option currently covers the least acreage of all the fire management options on the Refuge — 11.9 acres. These acres are managed the same as the acres in the Full Option until the area converts to Limited after the *conversion date* (the first conversion date is July 10, annually). Before the conversion date, the Protecting Agency and Jurisdictional Agencies jointly decide if the situation warrants conversion from Full to Limited. If the decision is to remain in Full, a later date will be selected to re-assess the situation and decide for or against conversion. Once a Modified area is converted to Limited, it remains in Limited until the end of the fire season. The vegetation is mixed in this unit and age classes are early (0-20 years) and intermediate (21-40 years).

Values to Protect

The only Modified Fire Management Option area on the Refuge encompasses a parcel of land in the southwestern corner of the Andrew Simons Wilderness, in the Caribou Hills area, just north of Caribou Lake. It is known as the Ptarmigan Head In-holding by Refuge staff. Officially, it is designated as Patent #4722 at T2S, R11W, in Sections 24 and 25, Seward Meridian. There are no structures or other values at risk on the parcel. There is no road or trail access to this site. It can be accessed by snow machine in the winter.

Default Management Response

Fires in Modified Option areas receive an initial attack response depending on available resources, unless the Agency Administrator chooses otherwise and documents the decision through the WFDSS process. The Refuge FMO and Agency Administrator should receive immediate notification from the Protecting Agency, upon fire detection. After the initial response, the Refuge and the Protecting Agency may select a response ranging from full suppression to monitoring fire behavior, depending on the values at risk and other considerations. These decisions are documented using the interagency WFDSS.

Limited Fire Management Option

Description

The Limited Fire Management Option is the selected fire management option on about 82 percent (1,622,583 acres) of the Refuge, and 1,281,494 acres of designated Wilderness are in Limited. The Limited Option is found in all of the FMUs except Intensive. The vegetation is mixed, and all age classes are represented in this fire management option area.

Values to Protect

While natural resource values (such as wildlife, habitat, air quality, and water quality) and wilderness values exist in Limited areas of the Refuge, the presence of natural fires in these areas is deemed desirable in order to maintain natural conditions and ecological processes. Where Limited Option areas abut Modified, Full and Critical Option Areas, consideration must be given to the values at risk from wildfire in those areas, when making fire management decisions.

Default Management Response

The default fire management response for fires in Limited, which involves surveillance and monitoring, allowing natural fires to burn within predetermined areas. If this is not possible, a suppression response by the Protecting Agency or closest Refuge fire qualified personnel is initiated as soon as is feasible. The Refuge FMO and Agency Administrator should receive immediate notification from the Protecting Agency, upon fire detection. After the initial response, the Refuge and the Protecting Agency may select a response ranging from full suppression to monitoring fire behavior, depending upon the values at risk and other considerations. These decisions are documented using the interagency WFDSS.

An annual review of fire management options should be completed between September 30 and March 1. All fire management option changes will be coordinated with the Protecting Agency and recorded in the AIWFMP Map Atlas (maintained by the Protecting Agency) by April 1. Fire management option boundary changes are not encouraged during the fire season. However, if a change of the selected

management option is requested and can be accommodated by all affected land manager/owners and by the Protecting Agency, it may be accepted and documented in the Map Atlas.

Each year prior to the active fire season, the Refuge FMO will discuss fire management strategies for the upcoming fire season, with the Refuge Manager, the Deputy Refuge Manager and the Protecting Agency FMO.

The Refuge will adhere to regional and national preparedness levels. A Refuge Preparedness Plan, which would be prepared in collaboration with the Protecting Agency and based upon local fire danger, will be attached to the FMP. It will be updated periodically as historic weather data is accumulated and contact information changes.

Appendix B

Section B.3 Alaska Interagency Wildland Fire Management Plan

The 2010 Alaska Interagency Wildland Fire Management Plan (AIWFMP) provides for a range of suppression responses to wildfire that protects human life and property and other identified resources and developments, balances suppression costs with values at risk and is in agreement with Refuge resource management objectives. The result is that developed areas and other high resource value areas are protected and the natural occurrence of fire in the ecosystem is maintained in remote areas with minimal cost-effective intervention. Currently many special areas of concern (such as archaeological/cultural/historic sites and administrative sites/cabins) have been identified and are protected through the selection/designation of the appropriate fire management option — one that provides for the suppression response necessary to protect the resource(s) at risk. As new values at risk are identified, the jurisdictional agency selects the appropriate fire management option, notifies the protection agency and provides the location and fire management option information to AFS.

Four wildland fire management options are established in the AIWFMP.

- **Critical** is the highest priority area/sites for suppression actions and assignment of available firefighting resources.
- **Full** is the second highest priority area/sites for suppression actions and assignment of available firefighting resources.
- **Modified** is a high priority for surveillance, suppression, and site protection during the peak of the fire season and less priority (often surveillance only) after a designated conversion date in the latter stages of the fire season, normally after July 10.
- **Limited** requires only a surveillance response as long as fires within this designation do not threaten to escape into higher priority areas; if a threat is ascertained, a suppression response may be initiated.

The **Critical** fire management option was specifically created to give the highest priority to suppression action on wildland fires that threaten human life, inhabited property, designated physical developments and to structural resources designated as National Historic Landmarks. Fires that threaten a critical site have priority over all other wildland fires. These areas are the priority for detection coverage. The initial response to wildland fire is to provide protection to the area/sites. Use of wildland fire would only be appropriate in extraordinary circumstances

The **Full** fire management option was established for the protection of cultural and paleontological sites, developed recreational facilities, physical developments, administrative sites and cabins, uninhabited structures, high-value natural resources, and other high-value areas that do not involve the protection of human life and inhabited property. Structures on or eligible for inclusion on the National

Register of Historic Places and non-structural sites on the National Register are placed in this category. Fires occurring within or immediately threatening this designation will be high priority for initial action depending on the availability of firefighting resources but are less priority than wildland fires within or threatening a Critical Management Option area. The intent is to control wildland fires at the smallest acreage reasonably possible.

The **Modified** fire management option is intended to be the most adaptable option available to land managers. Unlike the Full management option, the intent is not to minimize burned acres but to balance acres burned with suppression costs and to accomplish land and resource management objectives. After the conversion date (usually around July 10), the default action for all fires occurring within this option will be surveillance and assessment to ensure that identified values are protected and that adjacent higher priority management areas are not compromised.

In the **Limited** fire management option fire may be allowed to function in its ecological role while providing for the protection of human life and site-specific values. Most natural ignitions will be managed for the purpose of maintaining fire's natural role in the ecosystem. Low impact or indirect suppression methods will be used whenever possible, if suppression action is needed. The intent is to reduce overall suppression costs through minimum resource commitment without compromising firefighter safety.

Through the AIWFMP, the Jurisdictional land manager authorizes the Protecting Agency to provide an increased or decreased level of suppression action for a given wildfire, depending upon the situation (non-standard response). Additionally, the selected fire management option area should be re-evaluated during the next annual review period. The AWFCG may approve departures from the selected management options during periods of "unusual fire conditions" for a specific geographic area(s). These decisions will be based not only on fires and acres burning, but also on anticipated fire behavior and acreage likely to be burned, existing and anticipated smoke problems, probability of success, the experience and judgment of Service and Protecting Agency personnel, and decisions of the Multi-agency Coordinating Group (MAC Group).

The AIWFMP fire management objectives were developed to meet and support agencies' goals and to provide implementation guidance for fire operations. The objectives are:

- Protect human life.
- Prioritize areas for protection actions and allocation of available firefighting resources without compromising firefighter safety.
- Use a full range of fire management activities (fire suppression, monitoring, prescribed fire, thinning and other vegetation treatment projects, prevention and education programs, scientific studies, etc.) to achieve ecosystem sustainability including its interrelated ecological, economic, and social components.
- Use wildland fire to protect, maintain, and enhance natural and cultural resources and, as nearly as possible, enable fire to function in its ecological role and maintain the natural fire regime.

- Manage vegetation through various fuels treatment techniques to reduce and mitigate risks of damage from wildland fire.
- Balance the cost of suppression actions against the value of the resource warranting protection and consider firefighter and public safety, benefits, and resource objectives.
- Consider short and long-term cost effectiveness and efficiencies while maintaining responsiveness to Jurisdictional agency objectives and within the scope of existing legal mandates, policies and regulations.
- Minimize adverse environmental impact of fire suppression activities.
- Maintain each Jurisdictional agency's responsibility and authority for the selection and annual review of fire management options for the lands that they administer.
- Adhere to State and Federal laws and regulations.

Appendix C: Cooper Landing

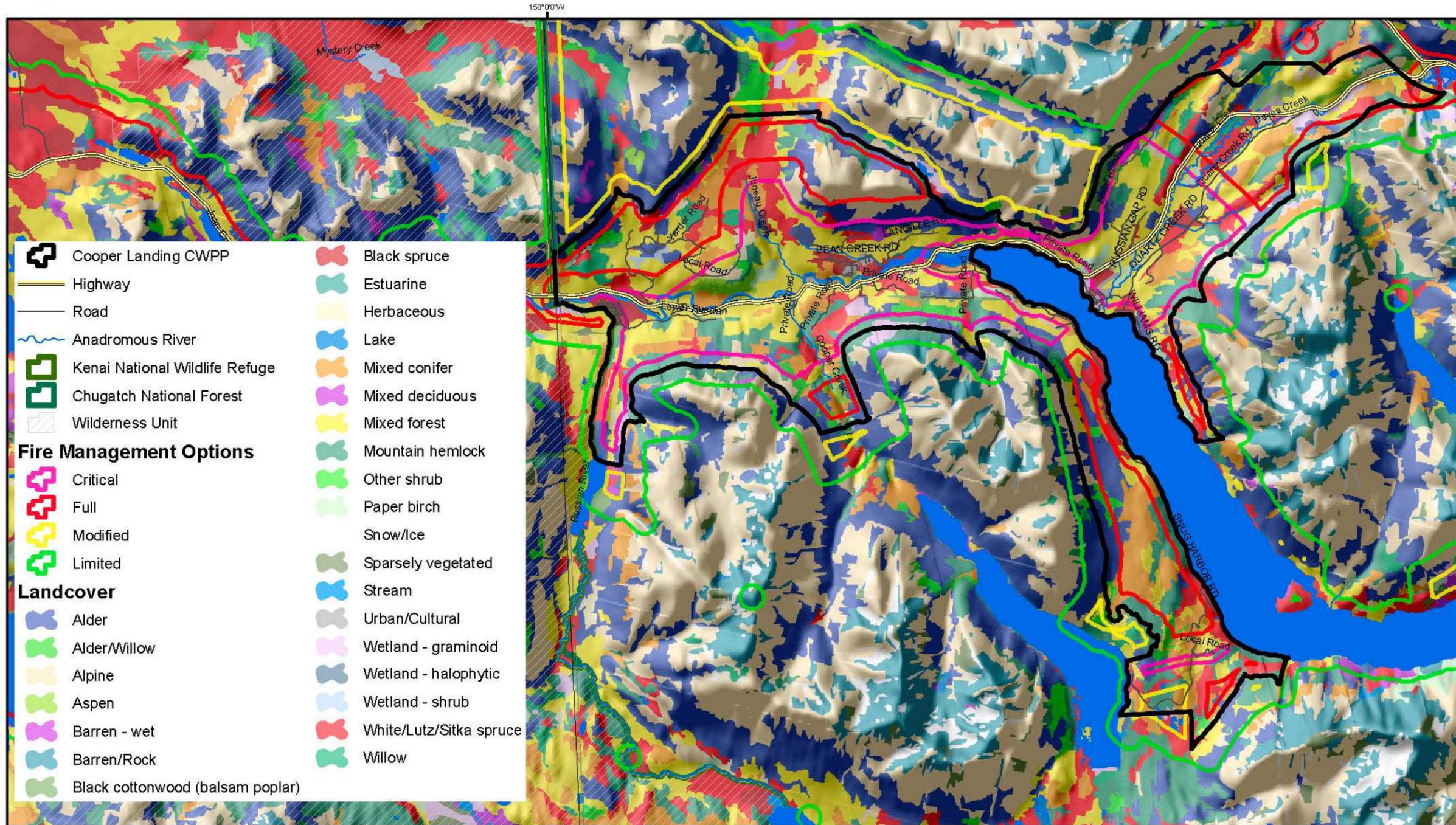


U.S. Fish & Wildlife Service

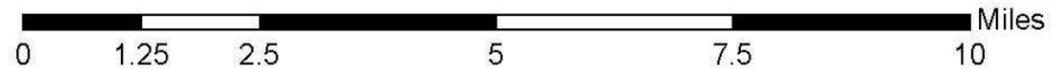
Kenai National Wildlife Refuge

Soldotna, Alaska

Cooper Landing CWPP Landcover



Produced By: Dawn Magness
11/28/2012

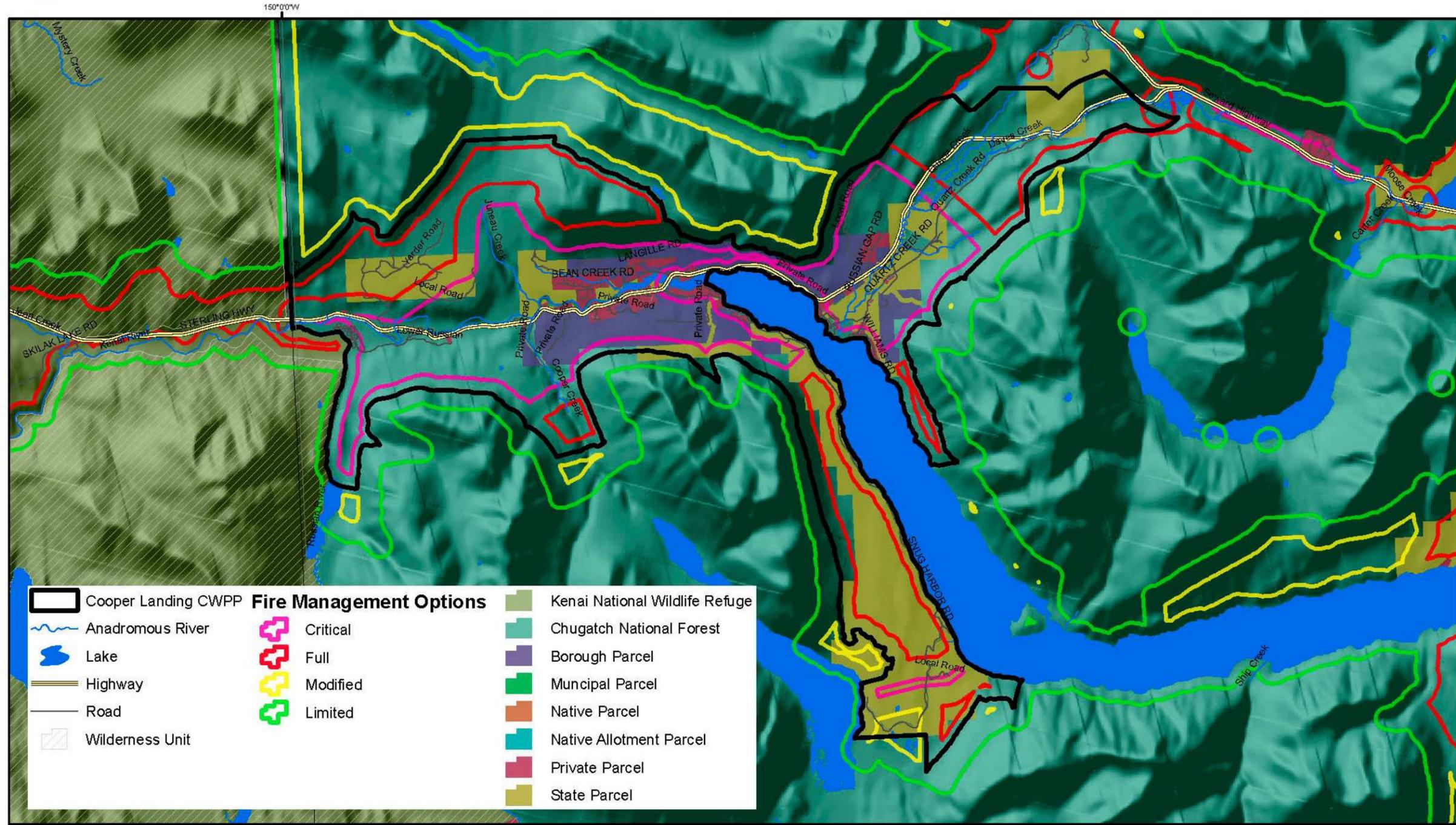




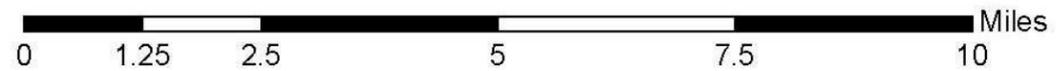
U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

Cooper Landing CWPP Landuse



Produced By: Dawn Magness
11/28/2012



**Appendix D: Diamond
Ridge, Fritz Creek, and Fox River**

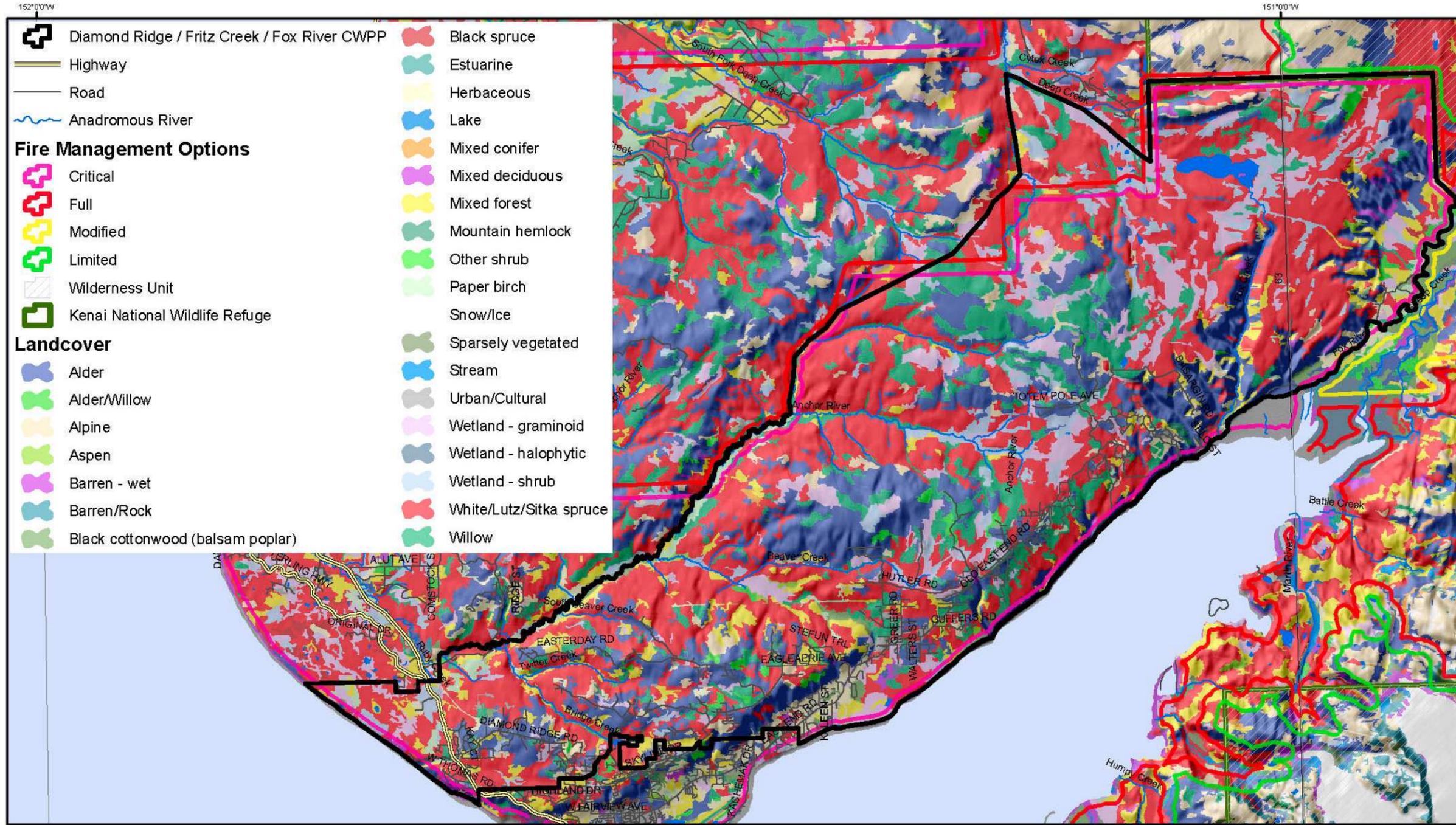


U.S. Fish & Wildlife Service

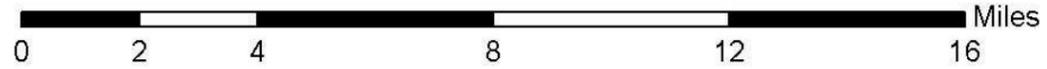
Kenai National Wildlife Refuge

Soldotna, Alaska

Diamond Ridge / Fritz Creek / Fox River CWPP Landcover



Produced By: Dawn Magness
11/28/2012



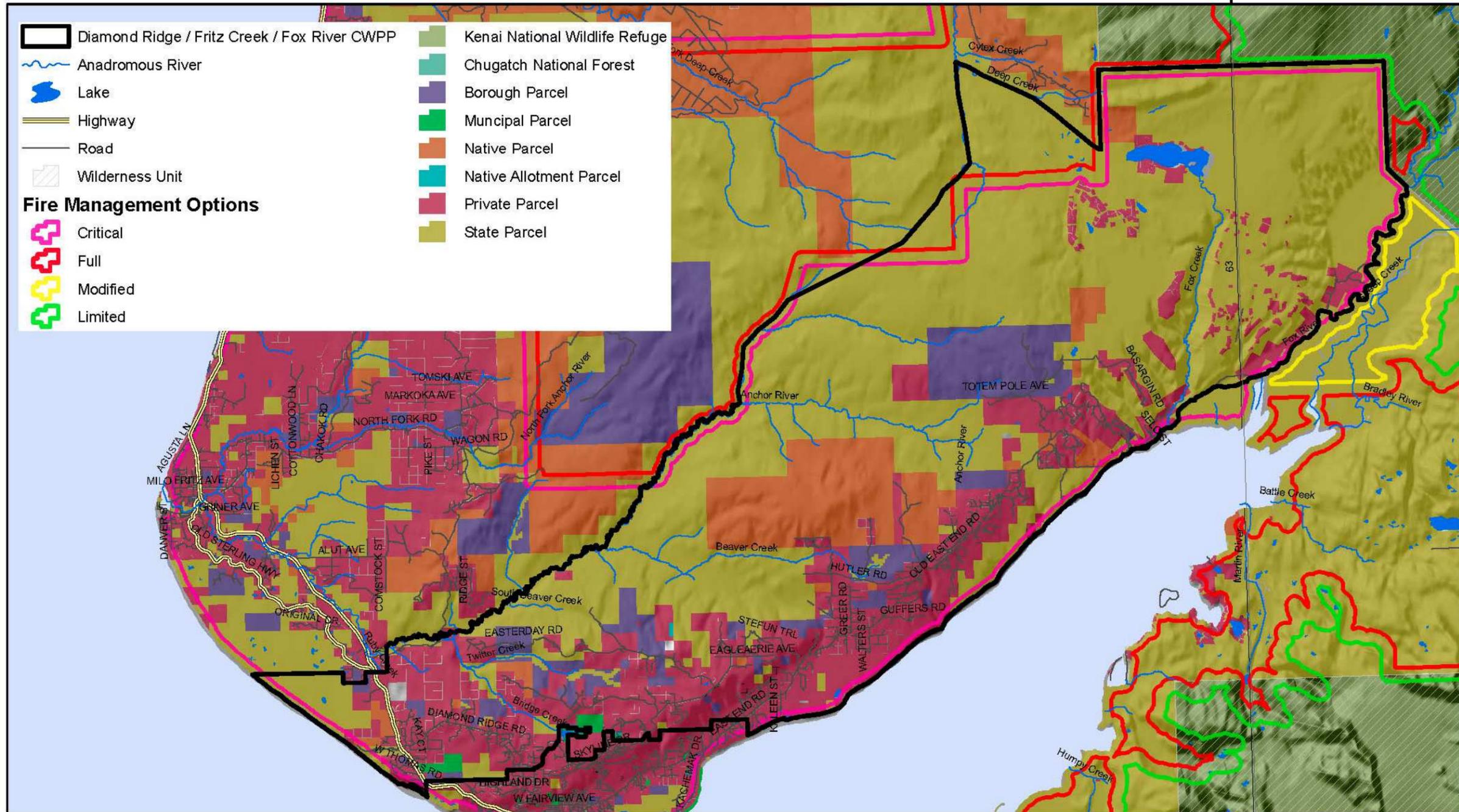


U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge

Soldotna, Alaska

Diamond Ridge / Fritz Creek / Fox River CWPP Landuse



Produced By: Dawn Magness
11/28/2012

Appendix E: Funny River

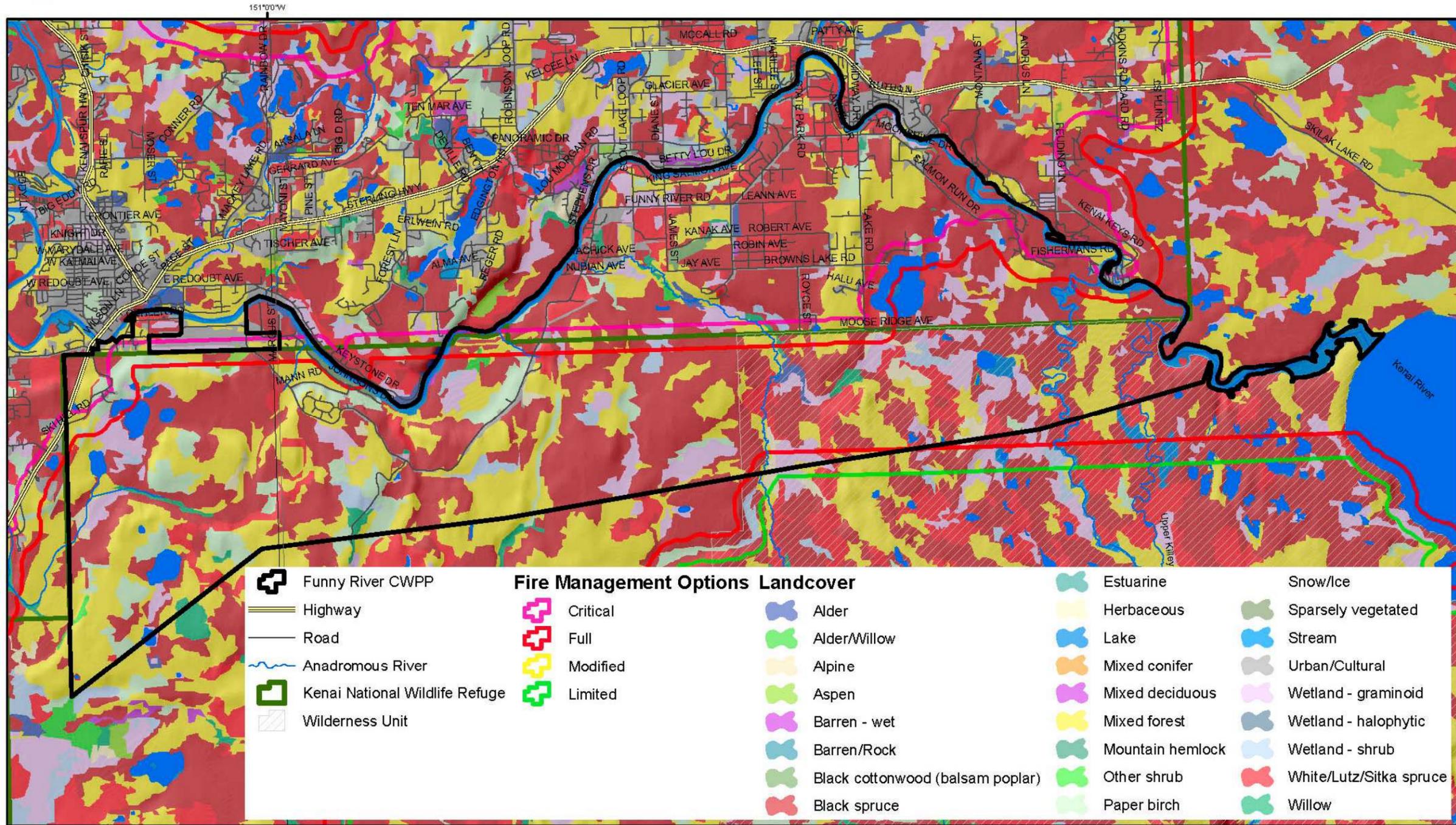


U.S. Fish & Wildlife Service

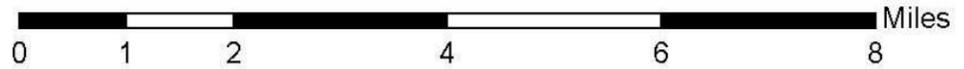
Kenai National Wildlife Refuge

Soldotna, Alaska

Funny River CWPP Landcover



Produced By: Dawn Magness
11/28/2012



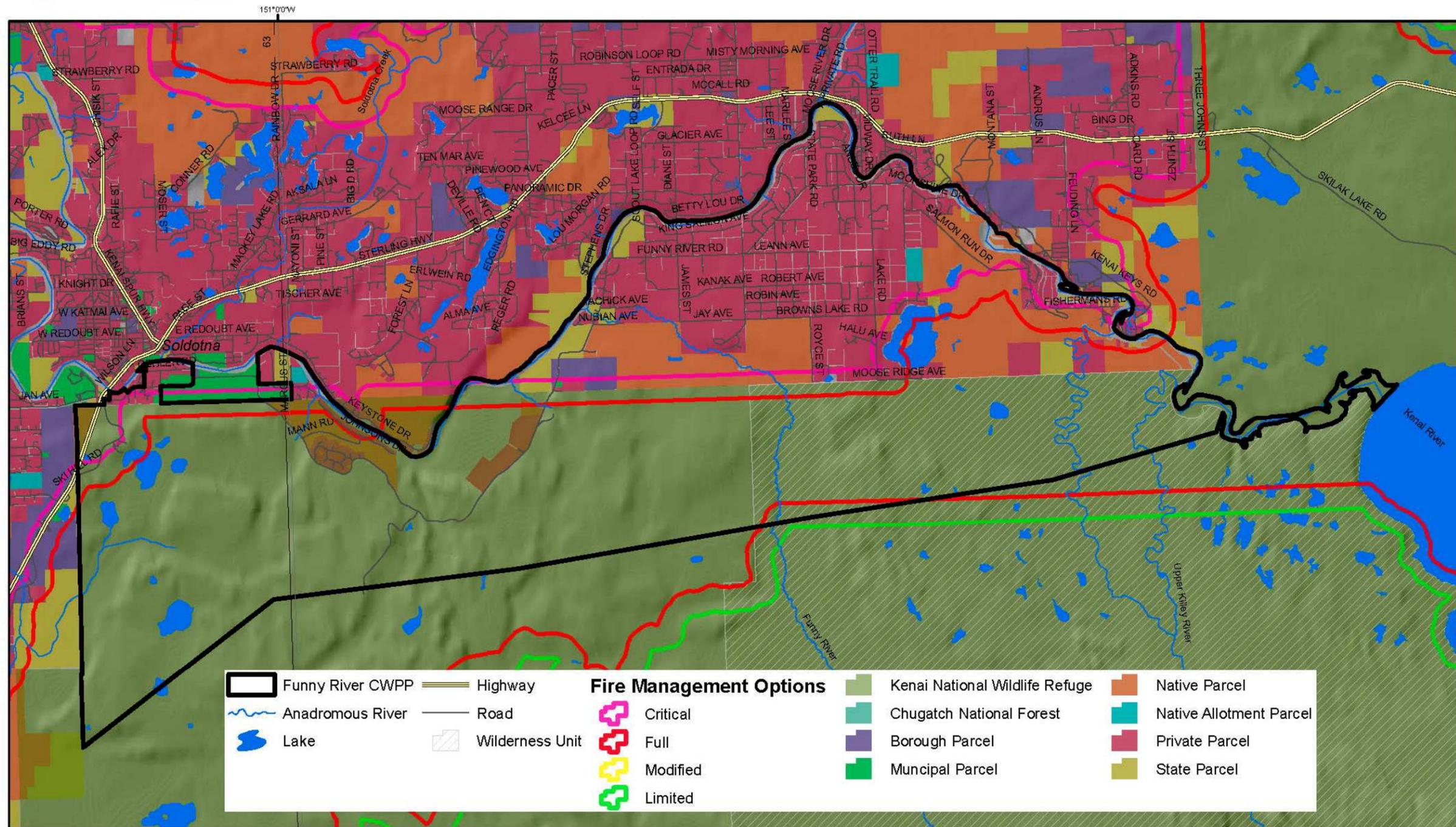


U.S. Fish & Wildlife Service

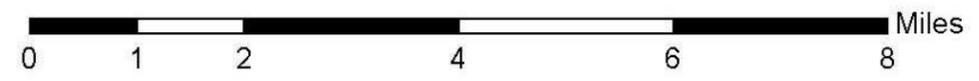
Kenai National Wildlife Refuge

Soldotna, Alaska

Funny River CWPP Landuse



Produced By: Dawn Magness
11/28/2012



**Appendix F: Kalifornsky,
Kasilof, Cohoe, and Clam Gulch**

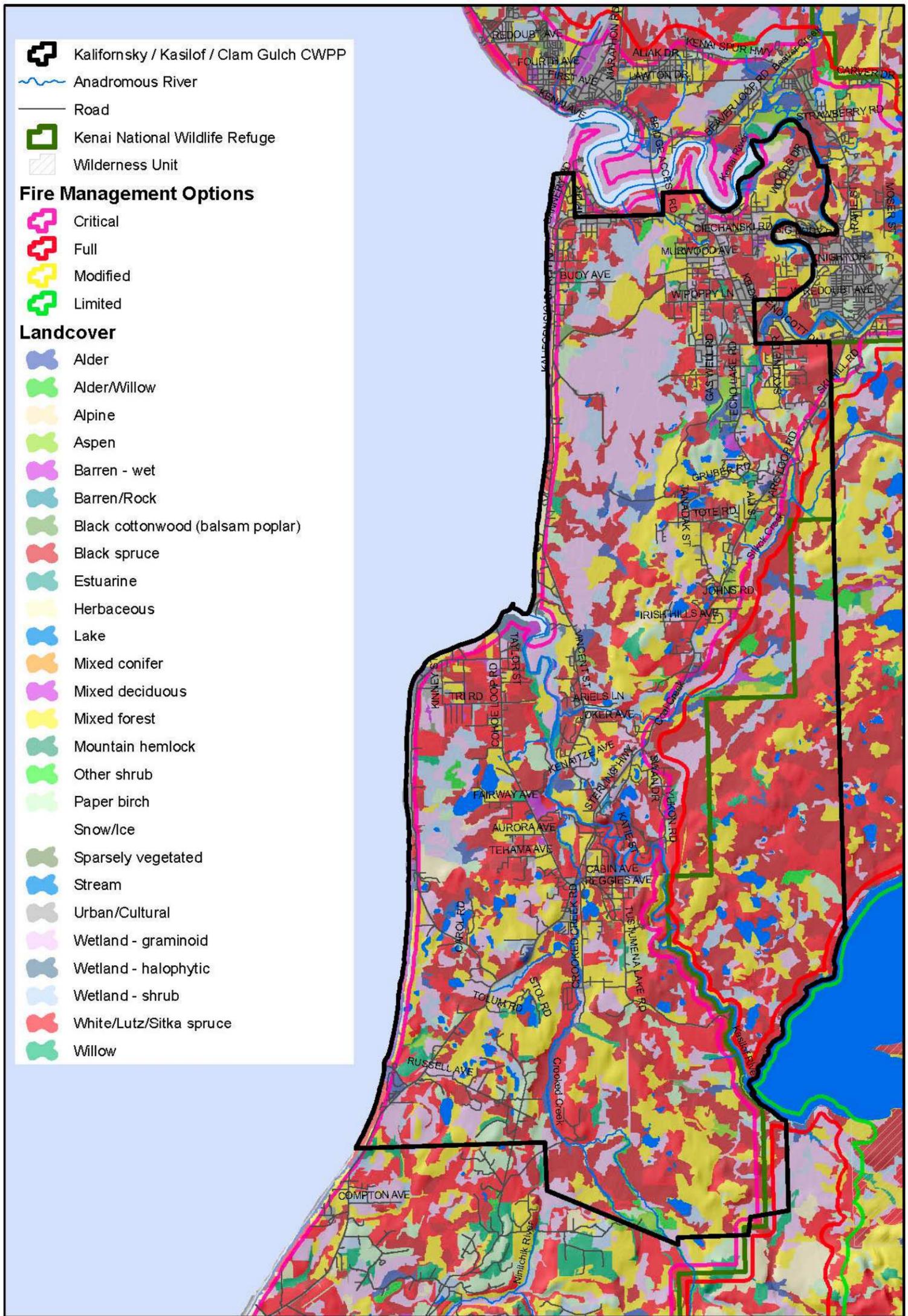


U.S. Fish & Wildlife Service

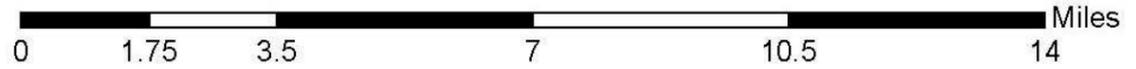
Kenai National Wildlife Refuge

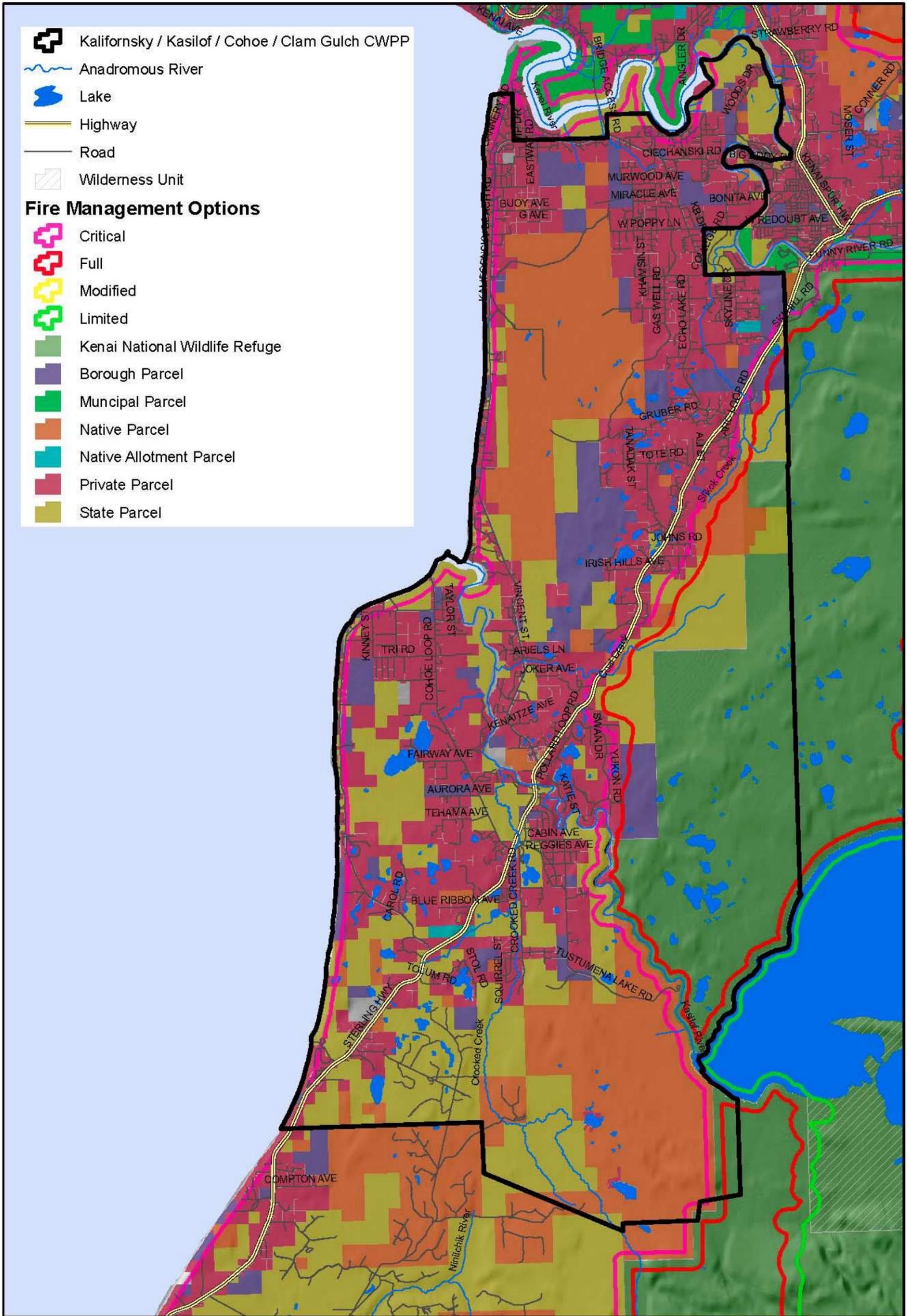
Soldotna, Alaska

Kalifornsky / Kasilof / Clam Gulch CWPP Landcover



Produced By: Dawn Magness
11/28/2012

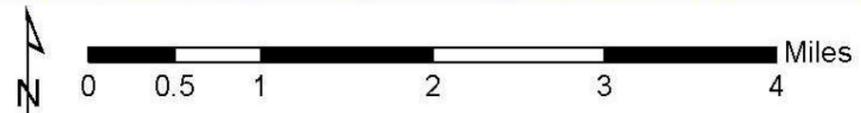
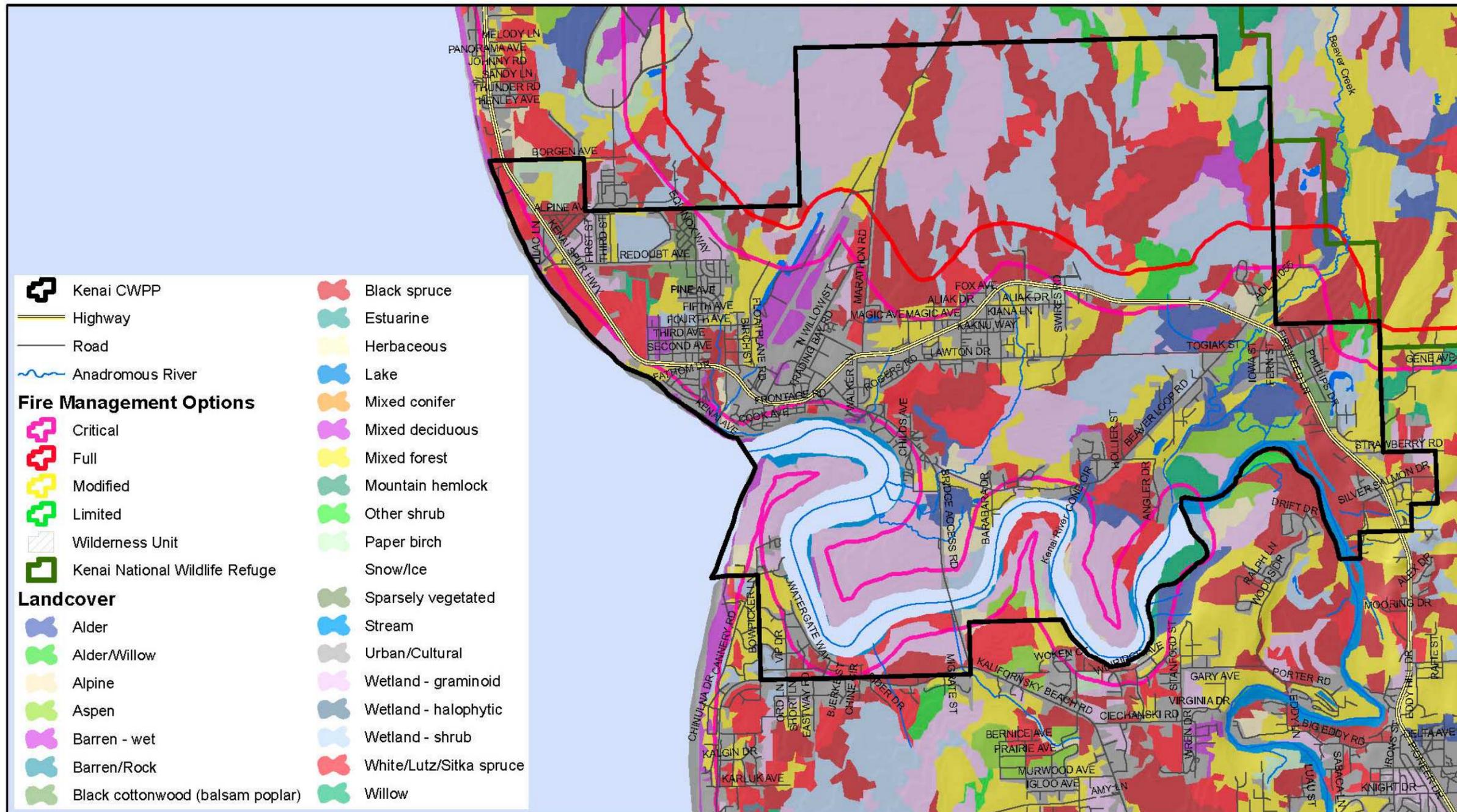




Produced By: Dawn Magness
11/28/2012



Appendix G: Kenai

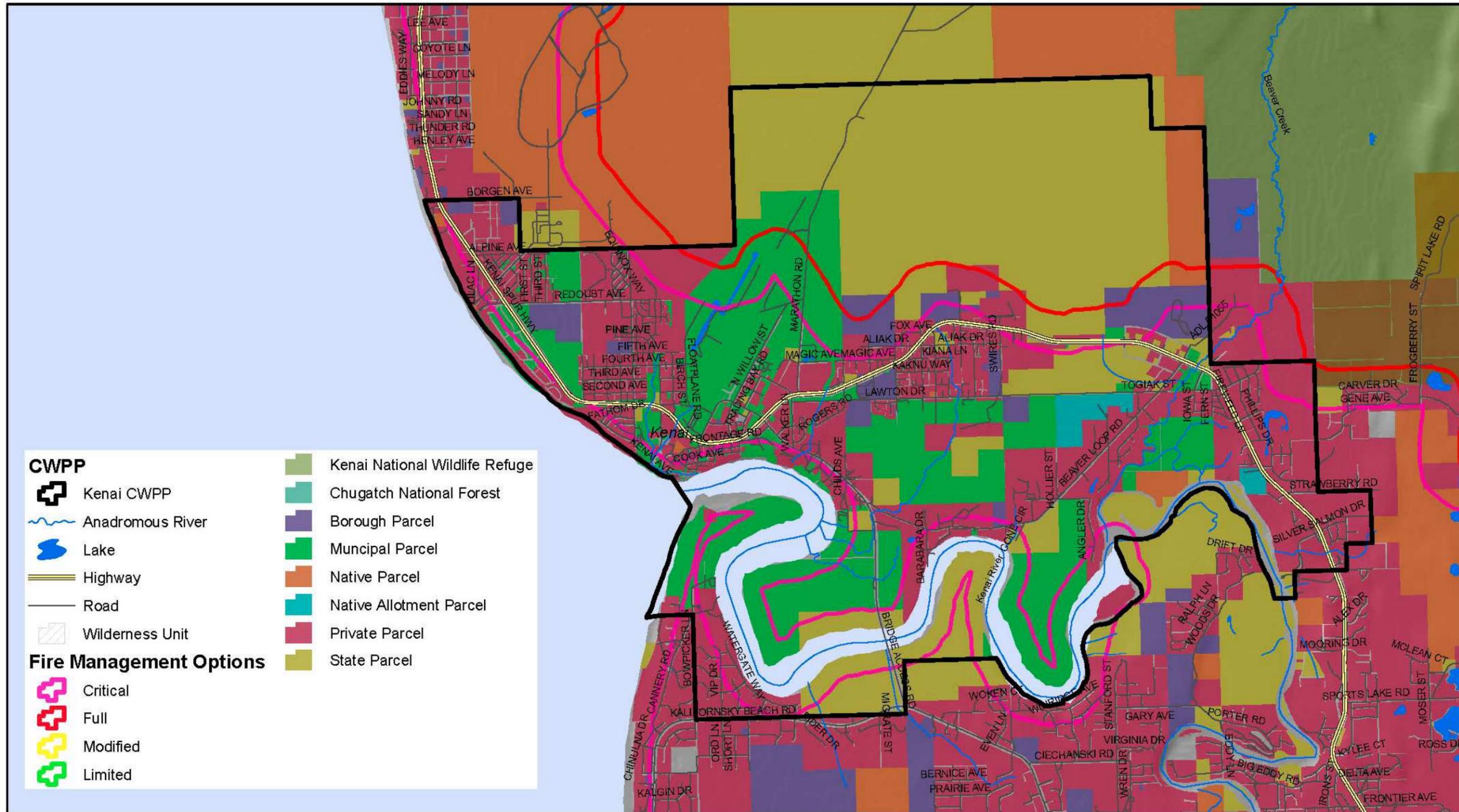




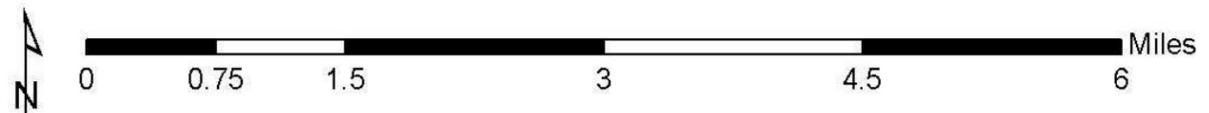
U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

Kenai CWPP Landuse



Produced By: Dawn Magness
11/28/2012



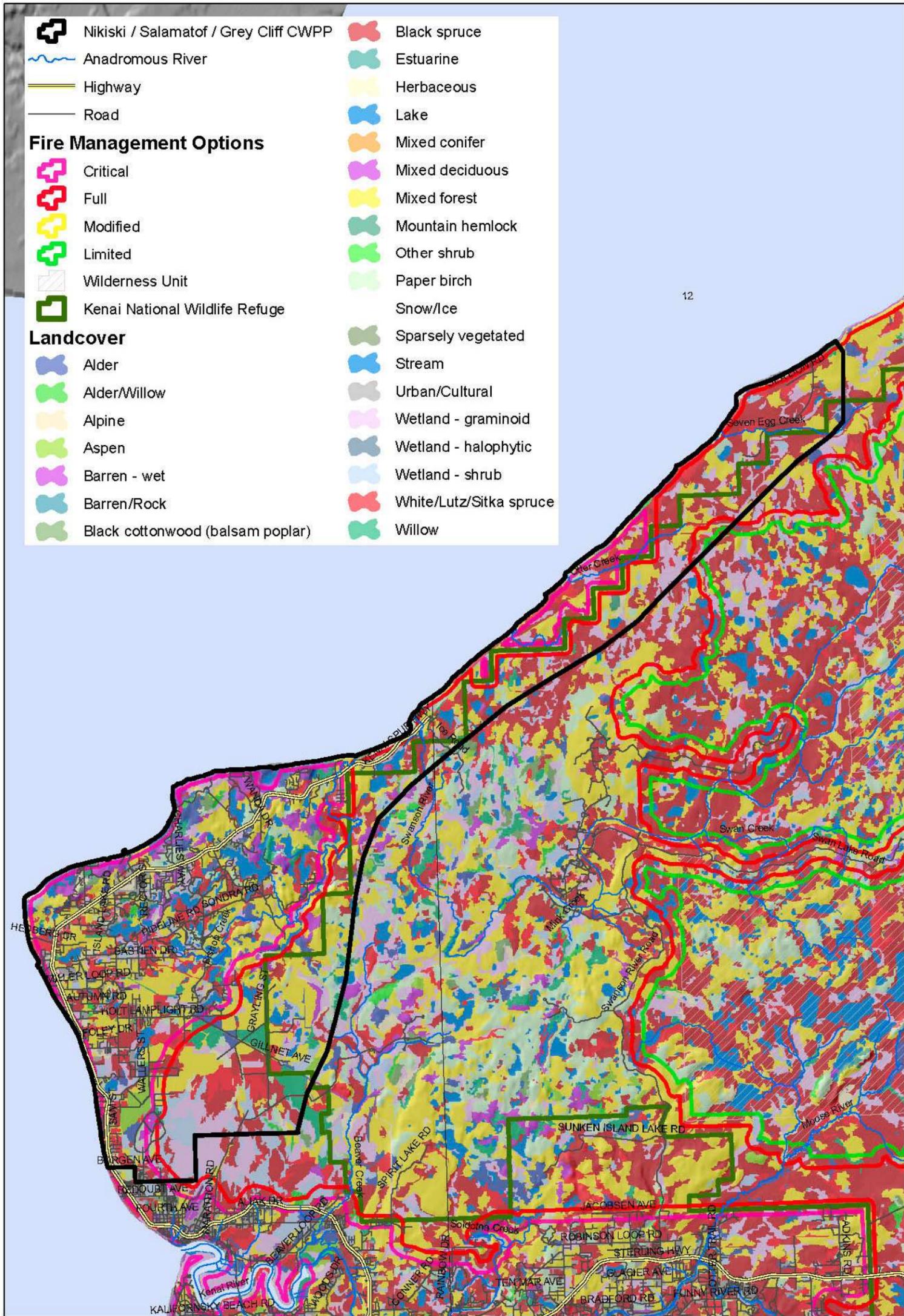
**Appendix H: Nikiski,
Salamatof, and Grey Cliffs**



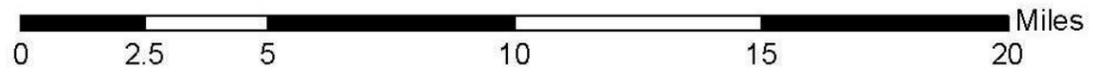
U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

Nikiski / Salamatof / Grey Cliffs CWPP Landcover



Produced By: Dawn Magness
11/28/2012

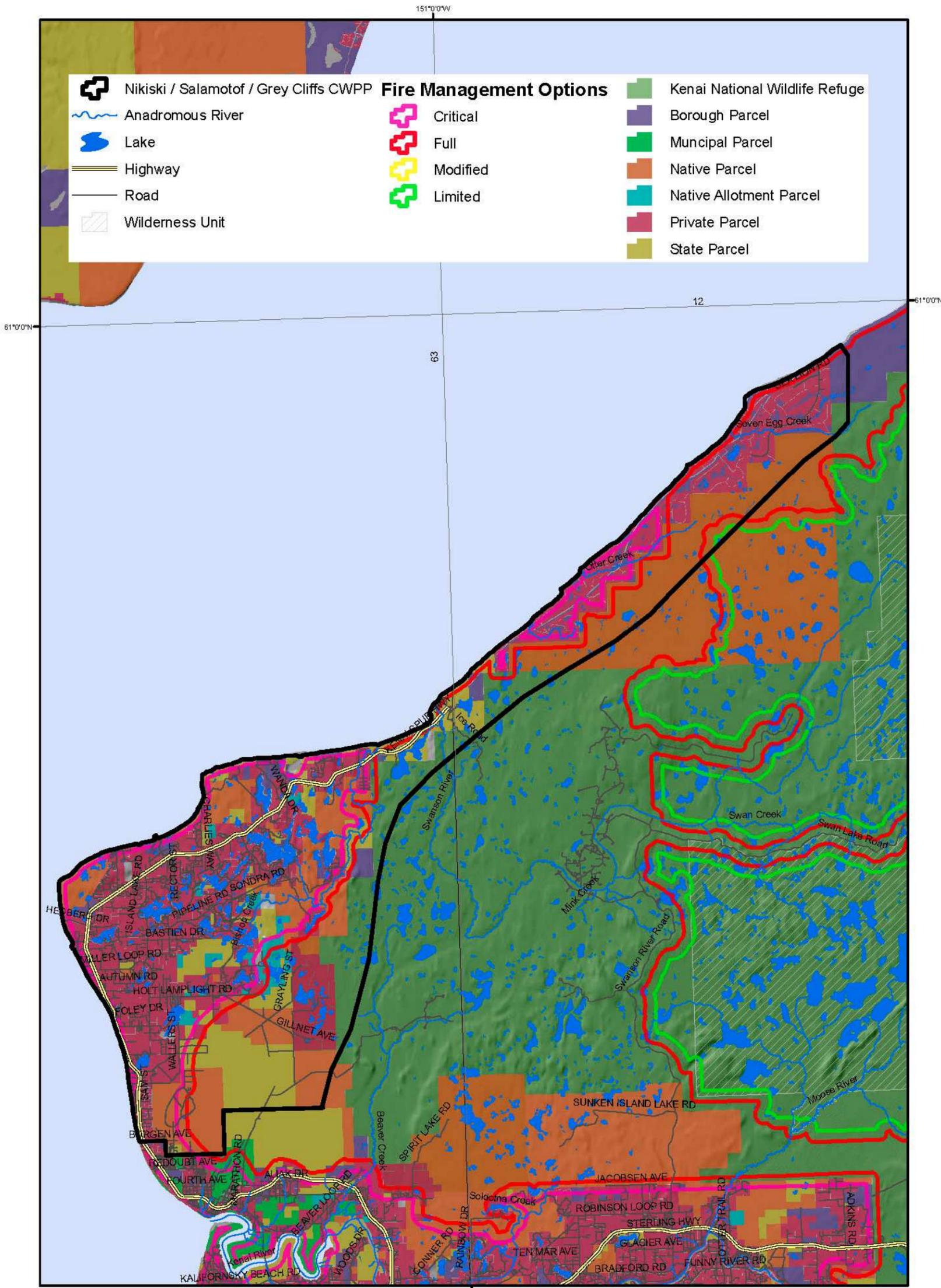




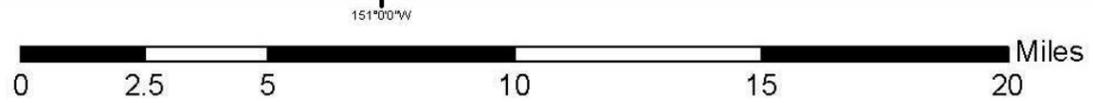
U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

Nikiski / Salamatof / Grey Cliffs CWPP Landuse



Produced By: Dawn Magness
11/28/2012



Appendix I: Ninilchik and Ninilchik Forties

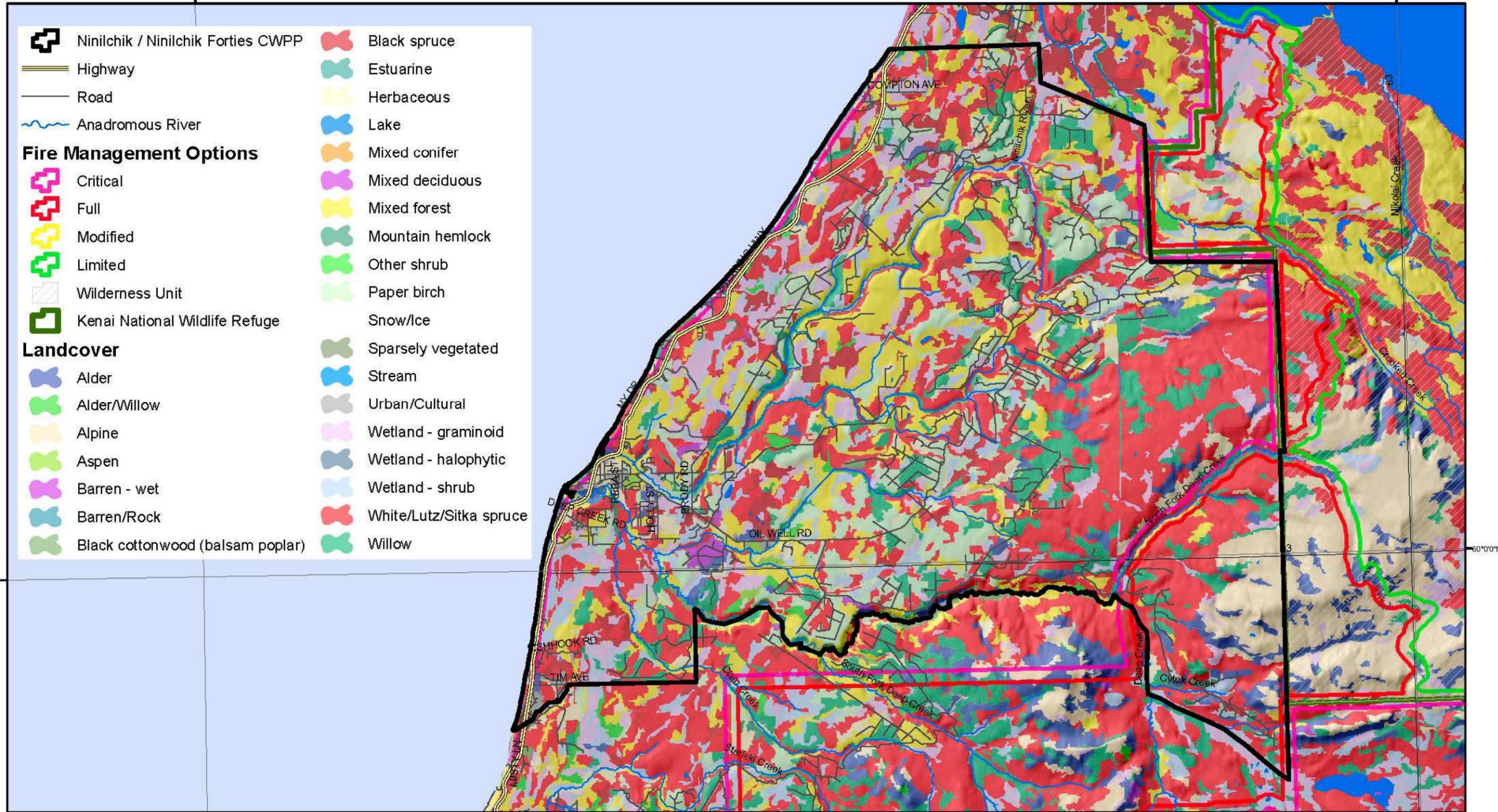


U.S. Fish & Wildlife Service

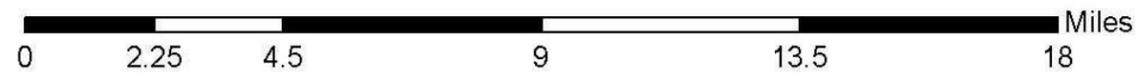
Kenai National Wildlife Refuge

Soldotna, Alaska

Ninilchik / Ninilchik Forties CWPP Landcover



Produced By: Dawn Magness
11/28/2012



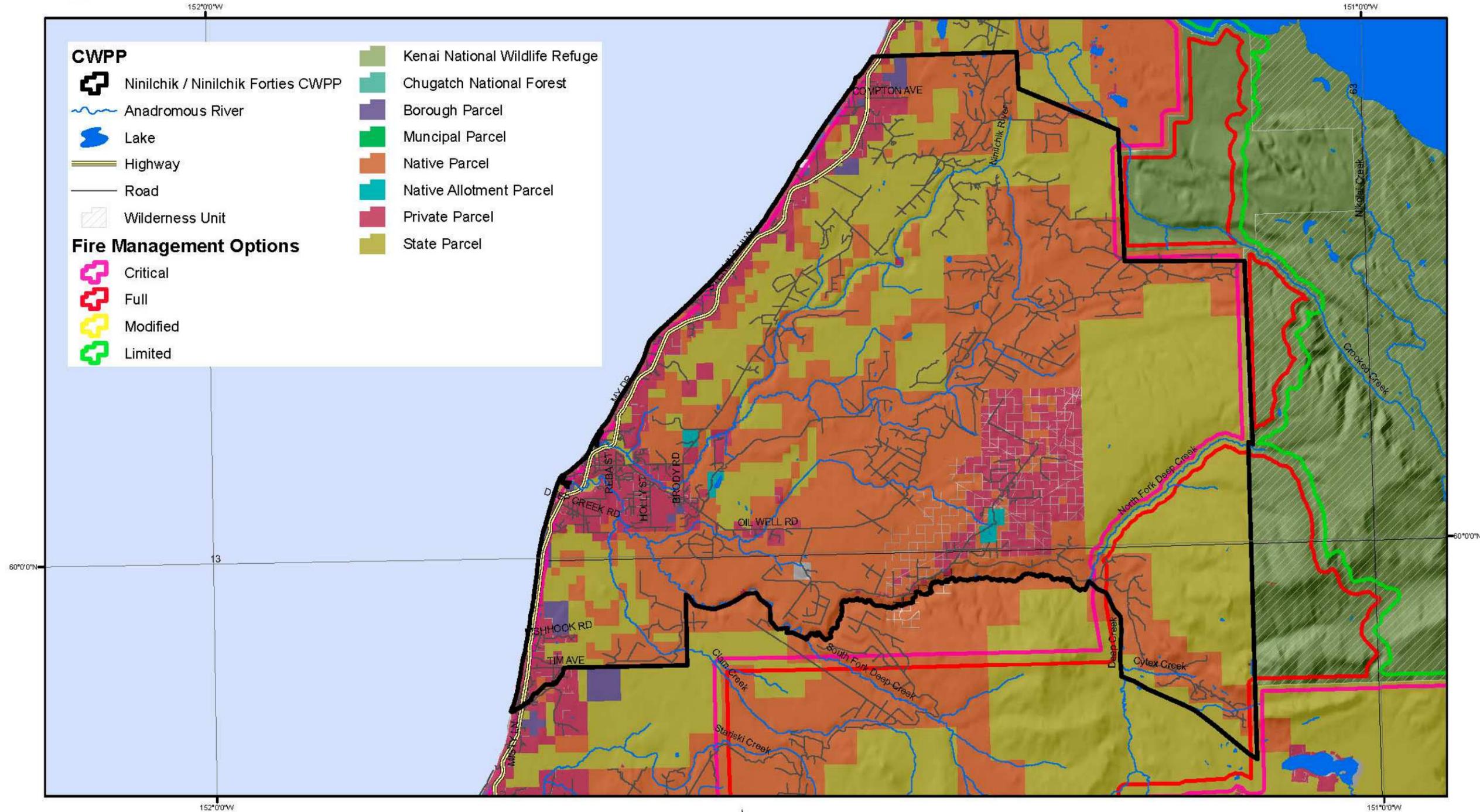


U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge

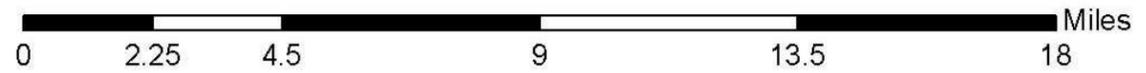
Soldotna, Alaska

Ninilchik / Ninilchik Forties CWPP Landuse



- CWPP**
- Ninilchik / Ninilchik Forties CWPP
 - Anadromous River
 - Lake
 - Highway
 - Road
 - Wilderness Unit
- Fire Management Options**
- Critical
 - Full
 - Modified
 - Limited
- Kenai National Wildlife Refuge
 - Chugatch National Forest
 - Borough Parcel
 - Municipal Parcel
 - Native Parcel
 - Native Allotment Parcel
 - Private Parcel
 - State Parcel

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11/28/2012



Appendix J: Soldotna and Ridgeway

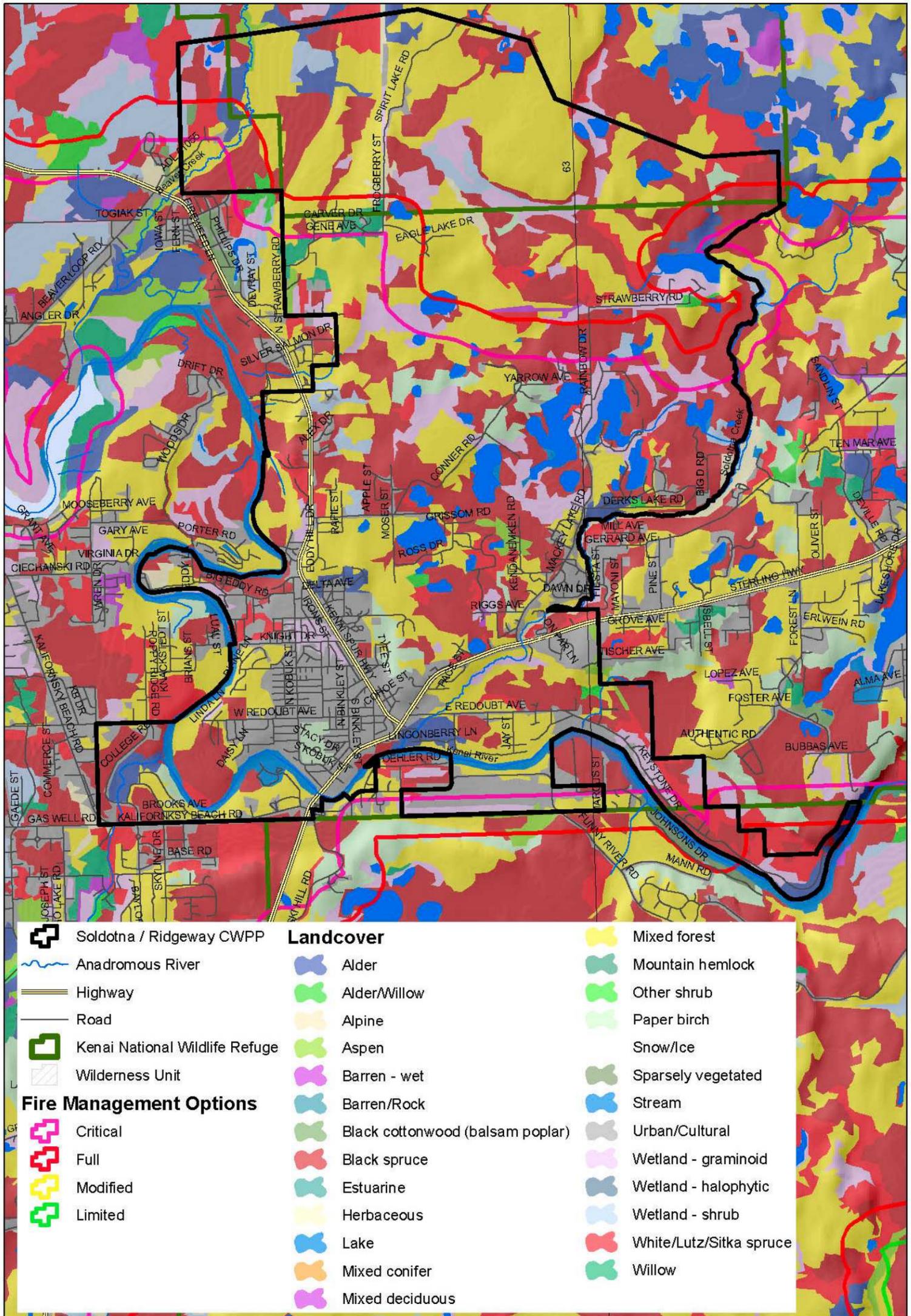


U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge

Soldotna, Alaska

Soldotna / Ridgeway CWPP Landcover



Produced By: Dawn Magness
11/28/2012

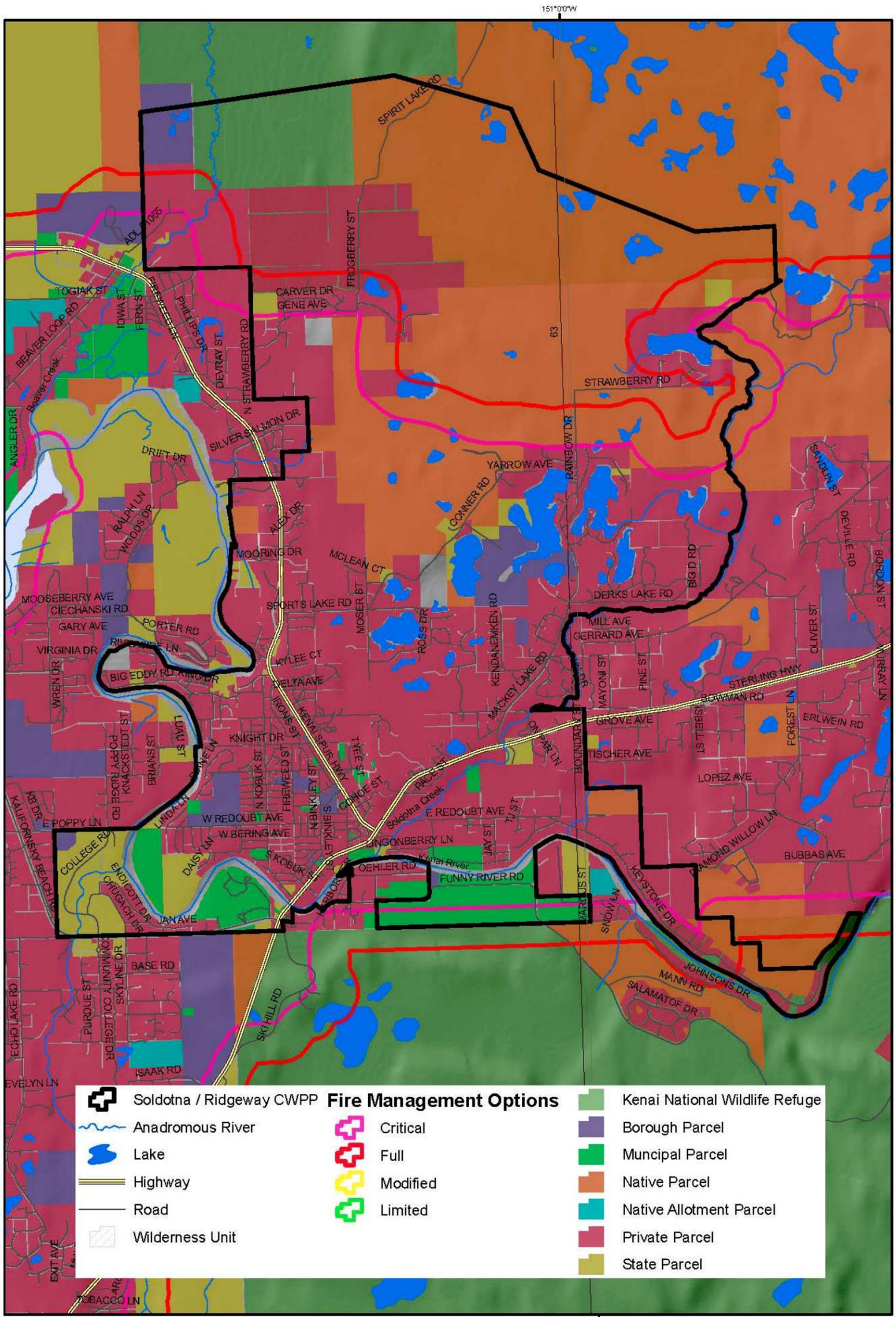




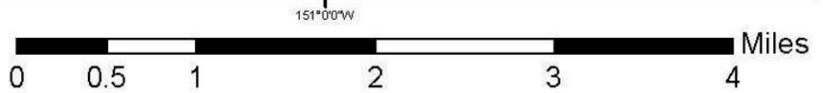
U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

Soldotna / Ridgeway CWPP Landuse



Produced By: Dawn Magness
11/28/2012



Appendix K: Sterling

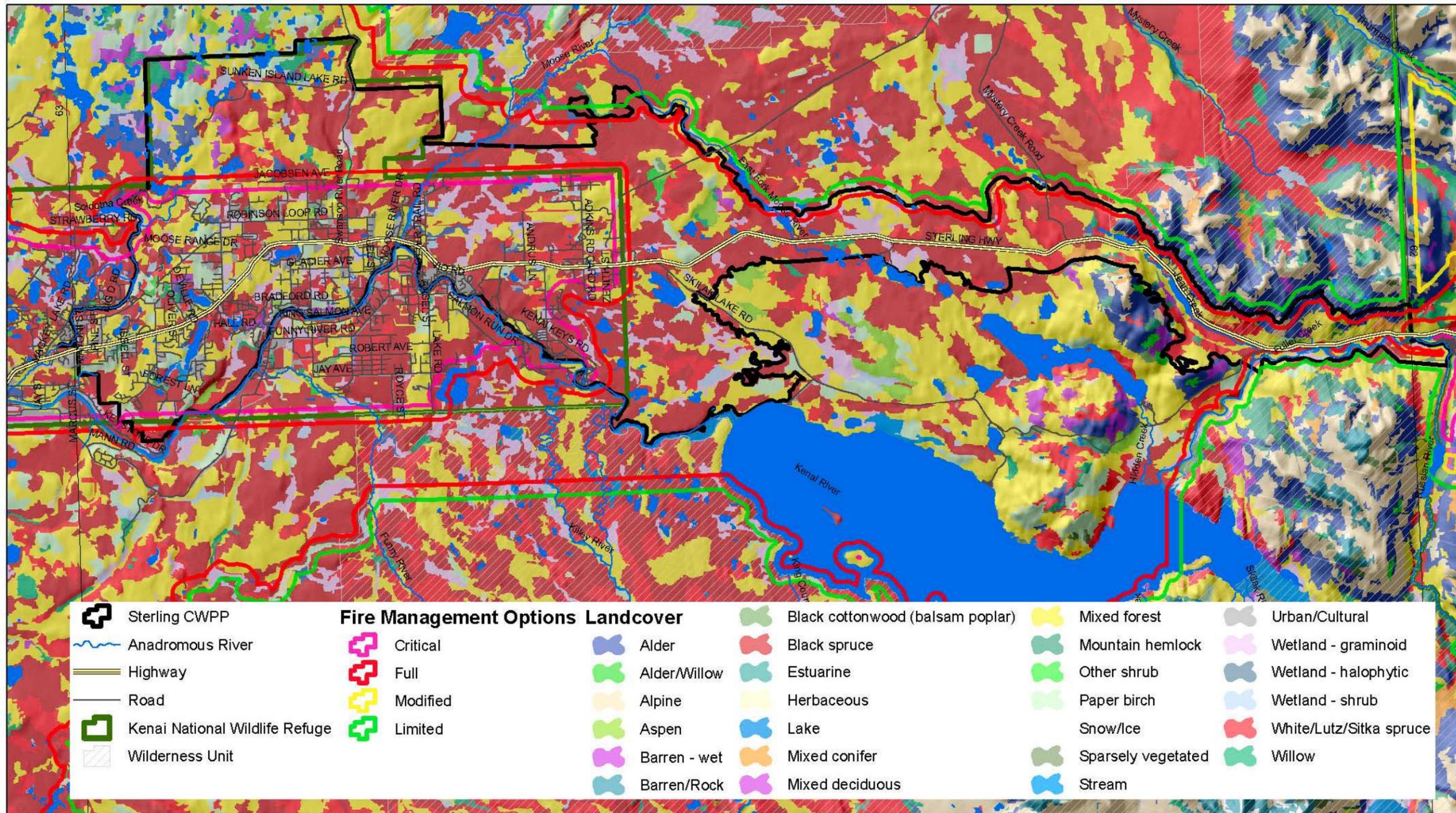


U.S. Fish & Wildlife Service

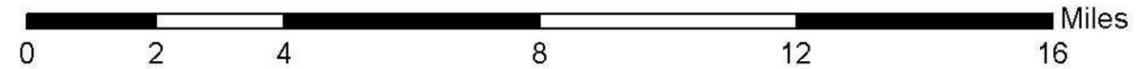
Kenai National Wildlife Refuge

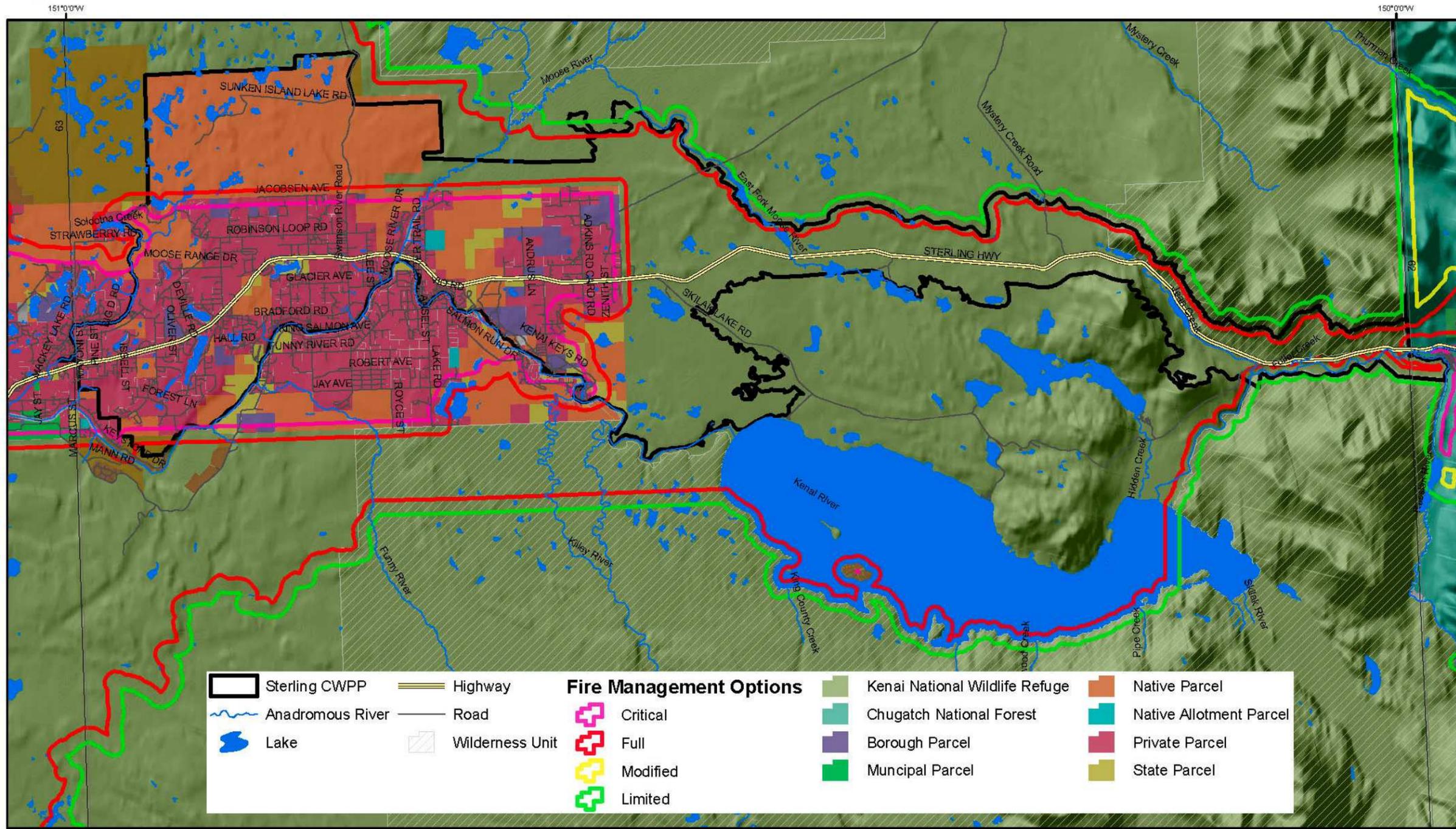
Soldotna, Alaska

Sterling CWPP Landcover



Produced By: Dawn Magness
11/28/2012





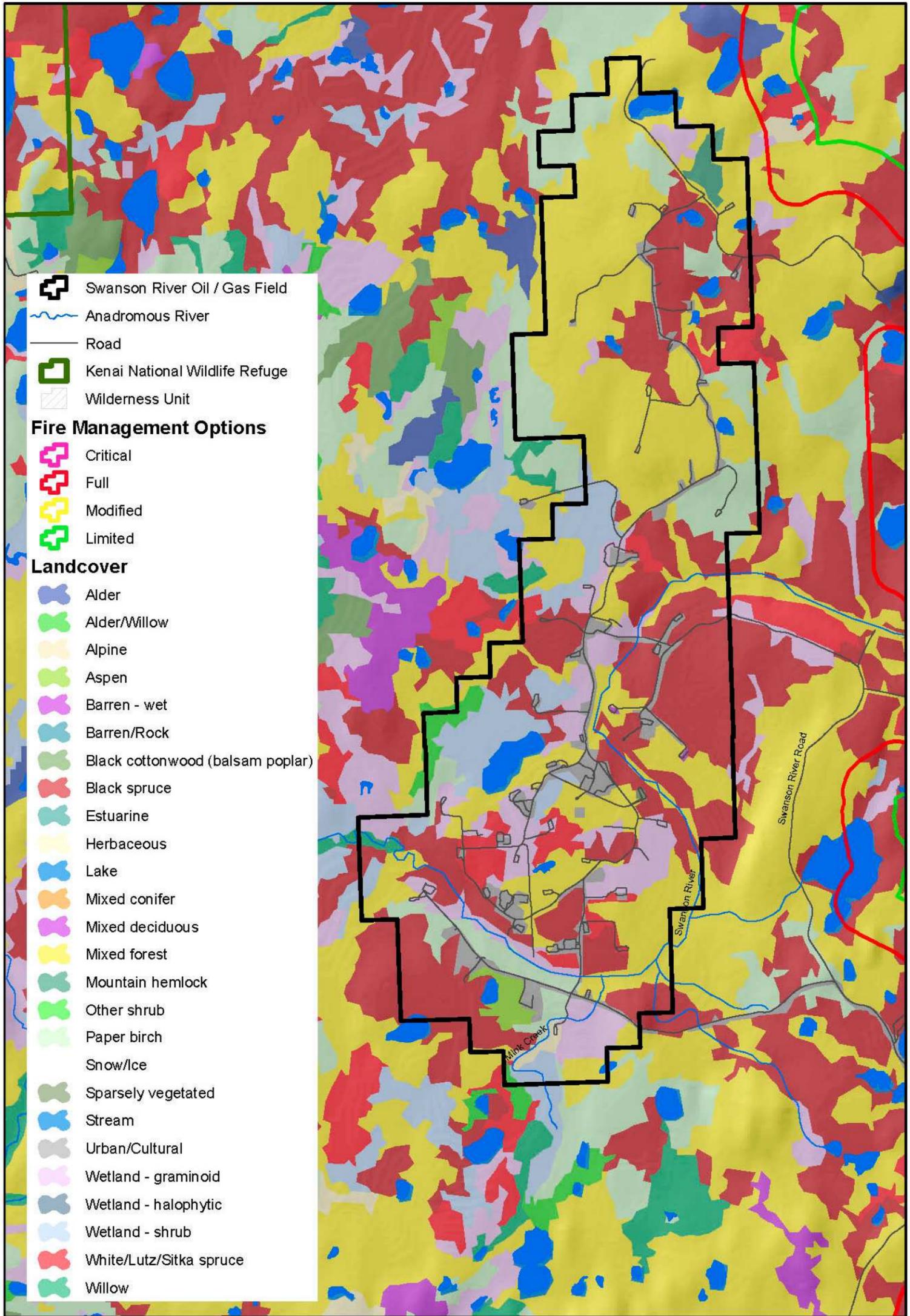
**Appendix L: Swanson
River Oil / Gas Field**



U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

Swanson River Oil / Gas Field Landcover



Produced By: Dawn Magness
11/28/2012



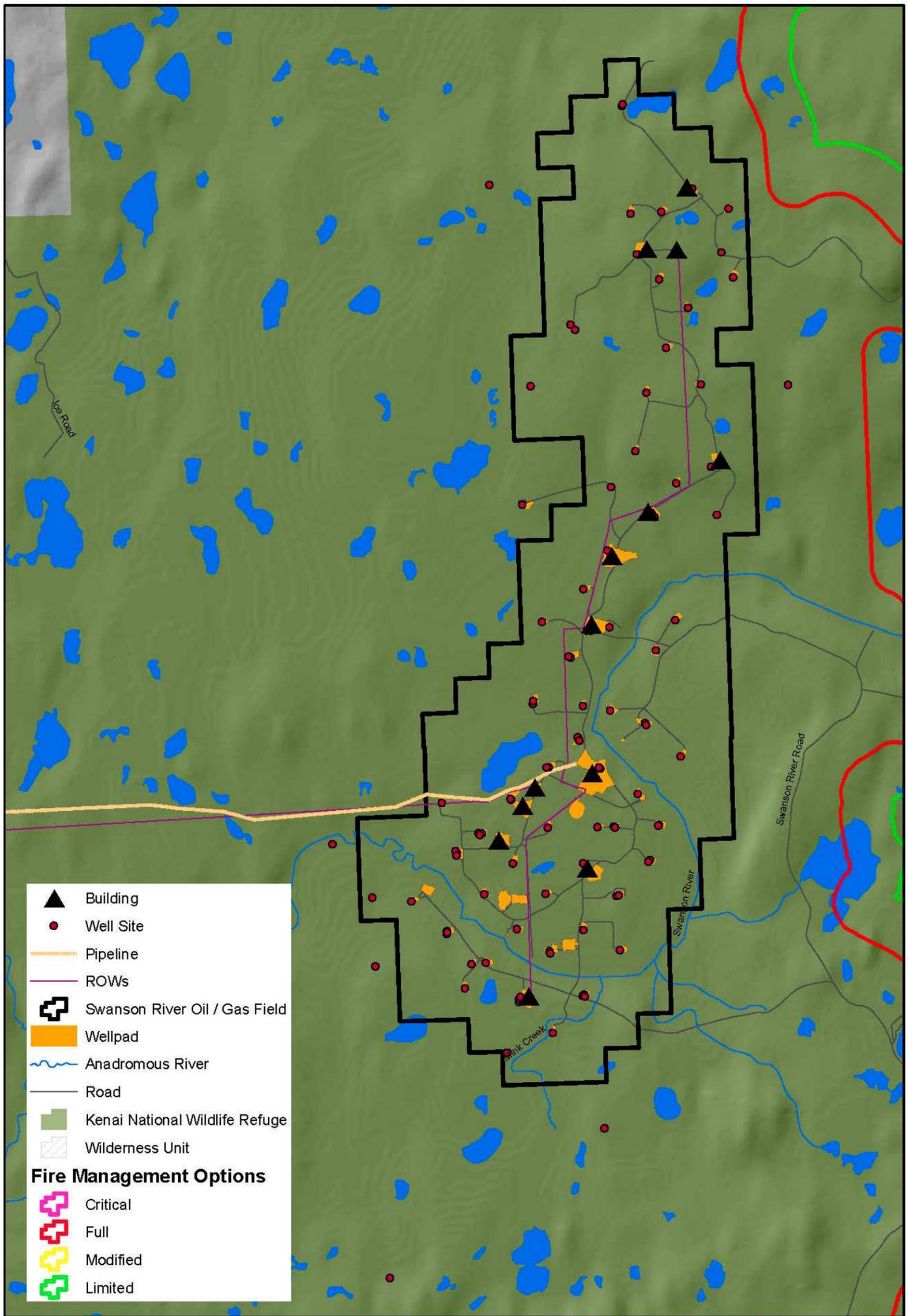
0 0.5 1 2 3 4 Miles



U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

Swanson River Oil / Gas Field Assets



Produced By: Dawn Magness
11/28/2012



0 0.5 1 2 3 4 Miles

**Appendix M: Beaver
Creek Oil / Gas Field**

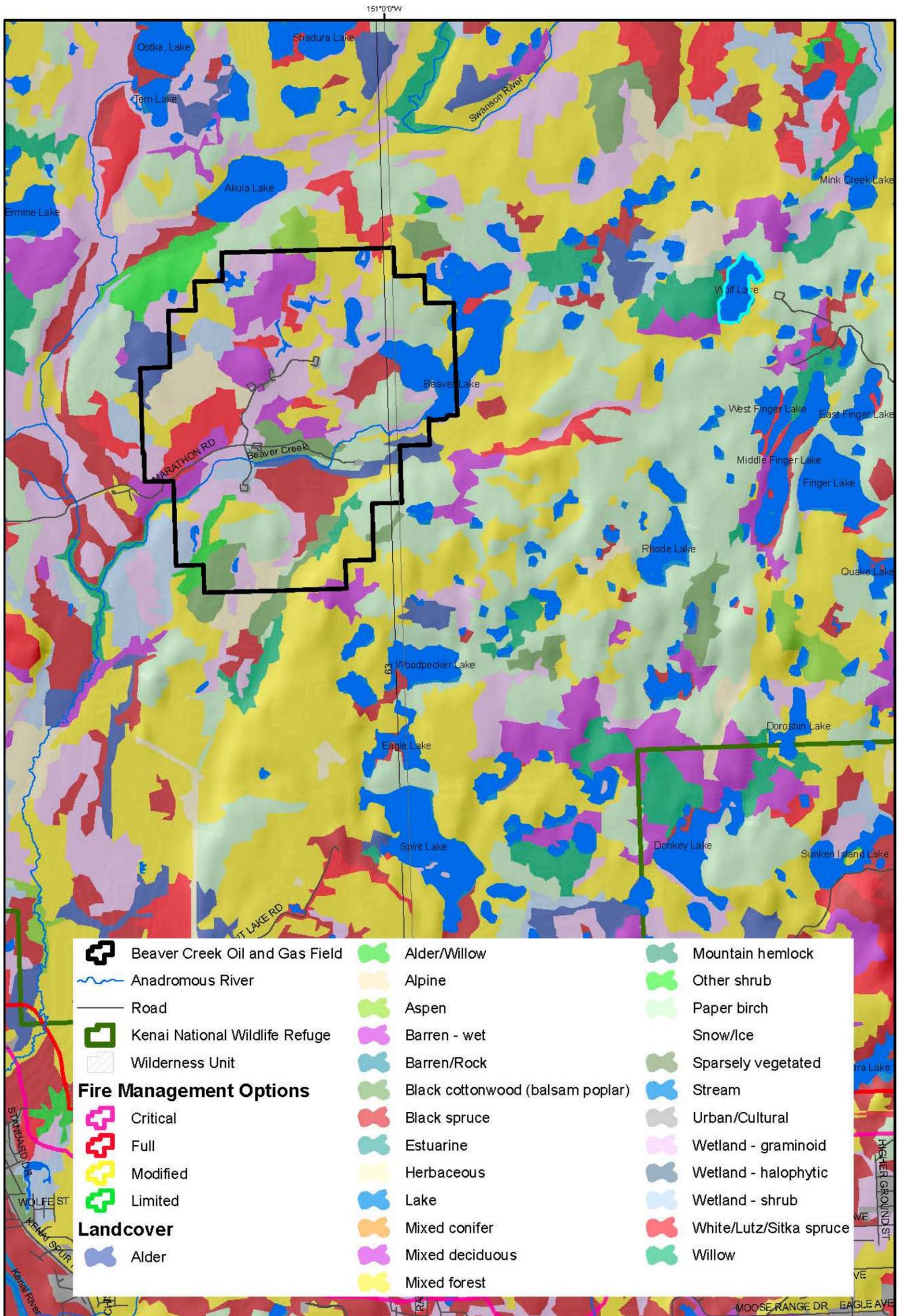


U.S. Fish & Wildlife Service

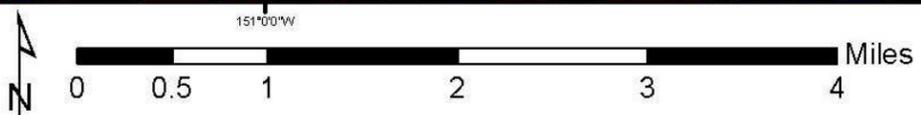
Kenai National Wildlife Refuge

Soldotna, Alaska

Beaver Creek Oil / Gas Field Landcover



Produced By: Dawn Magness
11/28/2012



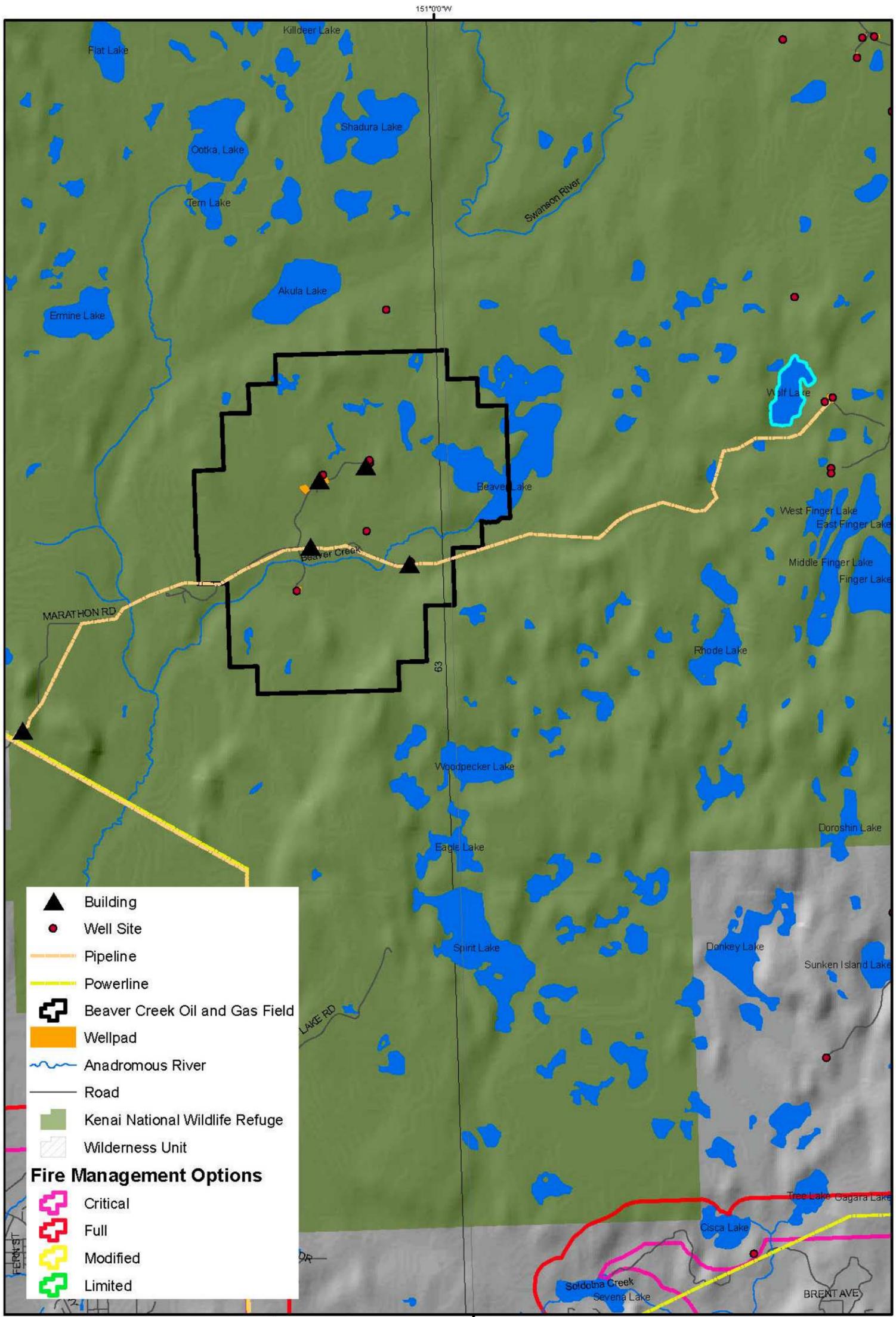


U.S. Fish & Wildlife Service

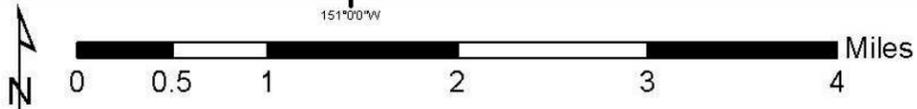
Kenai National Wildlife Refuge

Soldotna, Alaska

Beaver Creek Oil / Gas Field Assets



Produced By: Dawn Magness
11/28/2012



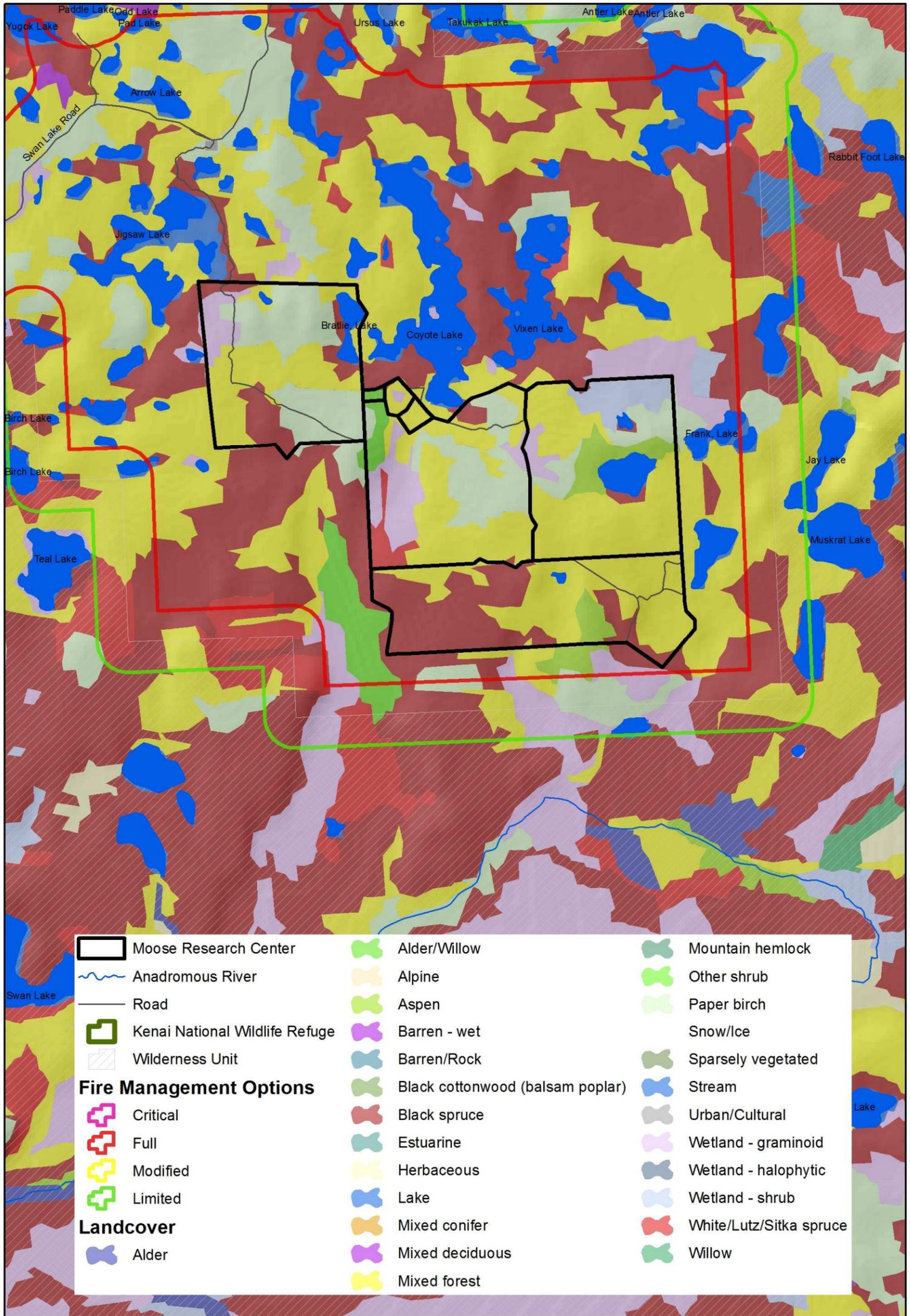
Appendix N: Moose Research Center



U.S. Fish & Wildlife Service

Kenai National Wildlife Refuge
Soldotna, Alaska

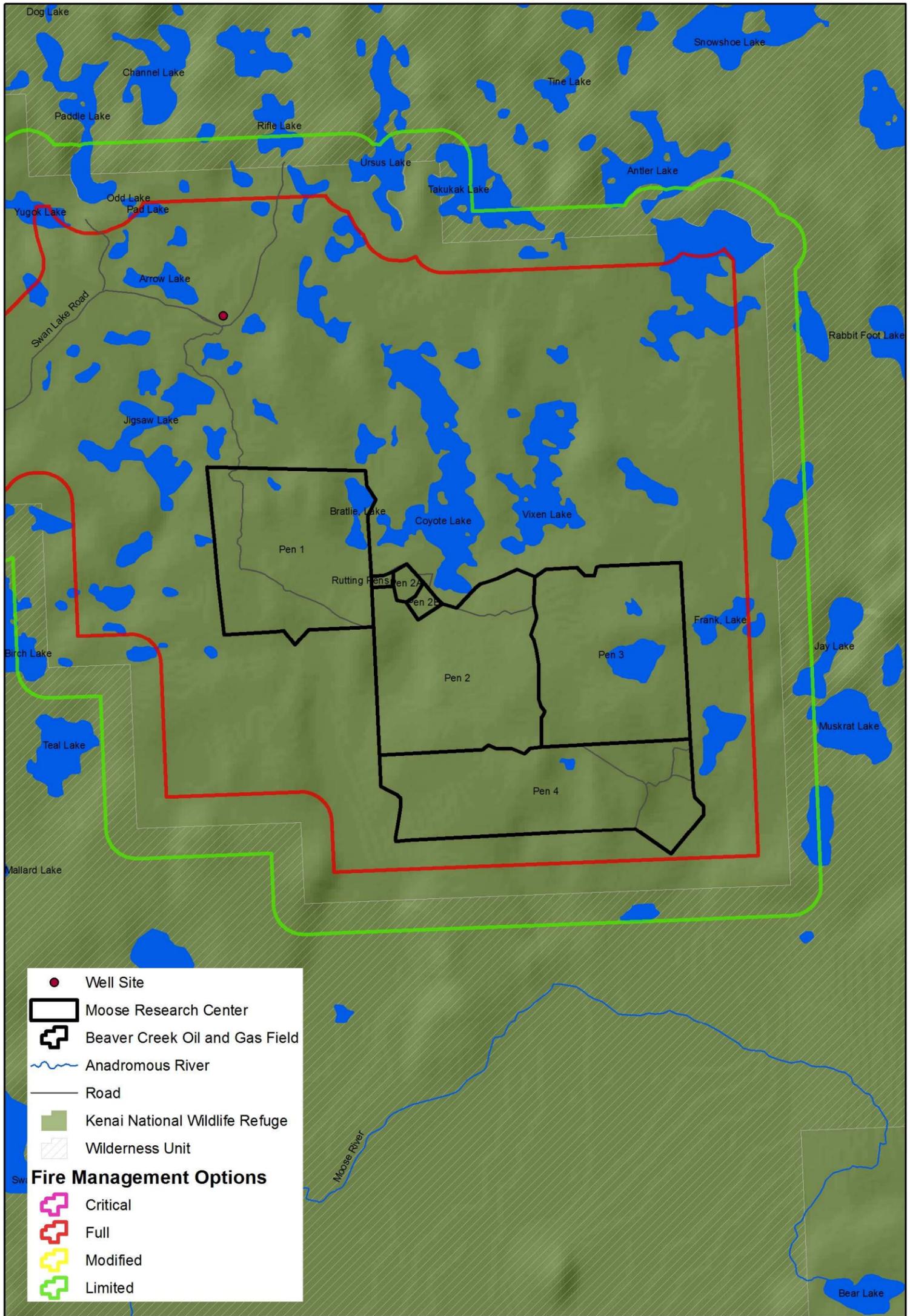
Moose Research Center Landcover



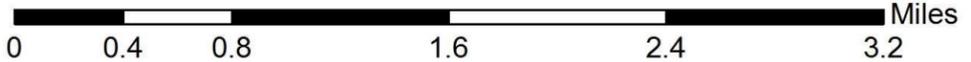
Produced By: Dawn Magness
11/28/2012



0 0.4 0.8 1.6 2.4 3.2 Miles



Produced By: Dawn Magness
11/28/2012



**Appendix O: Moose Research Center
Habitat Enhancement Plan 2013**

Alaska Department of Fish and Game

Kenai Moose Research Center

Habitat Enhancement Plan 2013

The Kenai Moose Research Center (MRC) is the only captive animal research facility in Alaska that has the capacity to maintain moose on natural forage. Studying captive moose is needed to understanding the complex relationships between available forage, both quality and quantity, and intake.. The MRC has contributed vast amounts of research literature to help manage wild moose populations, publishing over 100 peer reviewed papers. Currently, habitat management has come to the forefront for managing moose populations on the Kenai Peninsula. Vegetation on the northern Kenai Peninsula lowlands, including the MRC, has been slowly maturing after large wildfires in 1947 and 1969. As forest succession slowly changes the available forage for moose on the Kenai Peninsula, moose populations have declined and are showing evidence of nutritional stress. In 2012, the state of Alaska Board of Game designated the Kenai Peninsula as an intensive management area for moose, and the state legislator has set aside funds specifically for habitat management. The MRC has conducted habitat management with various techniques, and is an ideal place to conduct controlled habitat enhancements with known moose density. Habitat management goals at the MRC, including maintaining moose on natural forage year round, can be used to evaluate habitat management techniques that can be applied on a large scale to the Kenai Peninsula. Understanding the history of the MRC and future management goals is essential before implementation of any habitat management plan.

History

The MRC was proposed in the early 1960's at the Alaska Interagency Moose meetings. The Alaska Department of Fish and Game (ADFG), along with Federal resource agencies

involved with land and wildlife management in Alaska (U.S. Fish and Wildlife Service, U.S. Forest Service, Bureau of Land Management, National Park Service, U.S. Army, and U.S. Air Force) agreed that a facility should be constructed to research the interrelationships between moose and their environment. The site for the MRC was selected on the northern Kenai Peninsula, located on the Kenai National Moose Range, administered by the U.S. Fish and Wildlife Service (FWS). Construction of four enclosures, approximately 1 square mile each (Figure 1 [note that all figures are at the end of this appendix]), of 8 foot high woven wire fence began in 1965, and the facility has operated continuously since 1969 as a cooperative venture between ADFG and FWS. In 1980 the Alaska National Interest Lands Conservation Act redesignated the Kenai National Moose Range to the Kenai National Wildlife Refuge (KNWR). Cooperative research was ongoing between the FWS and ADFG through 1981, when the FWS research staff position was eliminated by the Denver Wildlife Research Center, and since that time ADFG has had sole responsibility for research at the MRC. Currently, ADFG operates the MRC on KNWR lands under a Memorandum of Agreement with the FWS (Memorandum of Agreement, 29 April 2004). Kenai National Wildlife Refuge is responsible for habitat management activities within the MRC that are mutually agreed upon between ADFG and FWS.

The MRC was established at a time when browse production on the northern Kenai Peninsula was high following the large 1947 wildfire. In the late 1970's, as vegetative succession decreased available browse on portions of the Kenai National Moose Range, experiments with a LeTourneau mechanical drum crusher began on 4 sites near the MRC. Enhancements included crushing near Willow Lake (461 acres), 2 sites along Mystery Creek (945 acres and 910 acres), and one site south and west of the MRC enclosures (584 acres). In conjunction with these enhancements outside of the MRC, 158 acres were crushed within the

MRC in 1977. Further tree crushing within the MRC occurred from 1985-89 with an additional 764 acres treated (Figure 2). Recent habitat enhancements at the MRC include 17 acres of hand cut trees by KNWR fire crew, 25 acres of trees treated with a Feller-Buncher, and 30 acres of trees treated with a Hydro-axe (Figure 2). Currently, portions of the MRC that have remained undisturbed since the 1947 burn are mature mixed coniferous-deciduous forest. Those areas crushed within the MRC in the late 1980's have matured to the stem exclusion state with little woody or herbaceous vegetation near the ground for winter moose forage. The 3 small areas recently treated have been heavily utilized by moose during the growing season, resulting in little birch and aspen sapling regeneration and high establishment of bluejoint reedgrass (*Calamagrostis canadensis*). Existing winter browse consists of heavily broomed aspen (*Populus tremuloides*), paper and Kenai birch (*Betula papyrifera*, *Betula kenaica*), aspen bark, lowbush cranberry (*Vaccinium vitis-idaea*), and very few Scouler's willow (*Salix scouleriana*). Each of the 4 pens has a different mosaic of vegetation, a result of the rolling topography, previous moose densities, and previous enhancement projects.

Management Goals

Vegetative succession, coupled with various levels of moose densities, has reduced the quantity and quality of natural forage available to moose within each pen at the MRC. Available forage, including herbaceous vegetation in the understory during the summer, has declined as canopy cover increases from maturing paper birch, aspen, and spruce. Currently, woody browse accessible to moose for winter forage is the limiting factor. The capacity for MRC to overwinter even small numbers of moose in a healthy condition primarily on natural forage is compromised and further degrading. Management goals and objectives for the MRC to operate and maintain a healthy moose population are listed below.

Goals:

- Provide adequate natural forage with minimal supplemental feed to maintain up to 6 moose in each pen on natural forage (18-24 moose within the entire facility). Moose will be able to overwinter on natural forage and have measurable rump fat at the end of winter (April 15th).
- Through active vegetation management, maintain at least 35% of each large pen in deciduous woody vegetation that is less than 15 years old, while maintaining at least 20% of the pen in mature old growth forest.
- Determine vegetation age structure and composition on the MRC and evaluate the potential effects of forestry practices on moose habitat for land management applications on the Kenai Peninsula

Objectives:

- Use mechanical vegetation management to initially enhance 20% of each large pen to create early seral deciduous forest by 2014.
- Use mechanical vegetation management to enhance another 15% of each large pen by 2019.
- Create a rotation vegetation enhancement plan to keep at least 35% of each pen in early seral deciduous forest, treating each pen on a 5 year rotation after 2019.

Management Plan**Pen 1 (Figure 3)**

Pen 1 is 592 acres, comprised of mixed aspen, birch and spruce forest, with intermixed areas of bogs and small lakes. Pen 1 contains the second largest lake on the MRC, 29 acres located at the northeast corner of the pen. There are 2 vegetation enclosures in Pen 1, a 6.5 acre enclosure at the northwest corner, and a 5 acre enclosure at the southeast corner. A USDA

Natural Resources Conservation Service Snotel site is also located in Pen 1 in a large stand of mature mixed forest. Pen 1 has had several habitat enhancements beginning in the late 1970's (Figure 3). Portions of Pen 1 were crushed in 1977 (158 acres) and 1986 (166 acres), with smaller areas enhanced by hand cutting in 2004 (17 acres), and cut and stacked with a feller-buncher then burned in 2008-2010 (25 acres). High moose densities in Pen 1 after tree crushing in the late 1980's and 1990's resulted in heavy utilization of birch and aspen regrowth. The small hand cut area was to provide ground fuel for a prescribed fire, but was never completed, resulting in no seed bed preparation for seedling establishment. The areas that were cut, stacked and burned with a feller-buncher have seen little establishment of birch and aspen in the burned areas, but are expected to provide adequate seedling establishment with time. Both areas have seen heavy moose use during late spring and early summer, with moose selecting fireweed (*Epilobium angustifolium*) and Jacob's ladder (*Polemonium pulcherrimum*), and probably are removing the few birch and aspen seedlings that are present in these areas. Given the small size of the hand cut and feller-buncher enhancements, and limited regeneration of aspen and birch, the areas have seen an establishment of bluejoint reedgrass, with intermixed fireweed and Jacob's ladder. Three additional areas in Pen 1 (< 40 acres each) have been prepared for prescribed burning; however, prescribed fires are compromised in any given year by weather conditions, availability of fire personnel and equipment, and risk of smoke affecting air traffic near Anchorage. Currently, given the low availability of winter browse in Pen 1, winter feeding is required to maintain the 4 MRC bulls in the pen, requiring felling of aspen and birch trees and supplemental pelleted ration from November 1st to April 15th.

Pen 1 will be enhanced by mechanical treatment in 2013, treating 115 acres (20% of the pen). Twenty-five acres, identified as having greater than 75% birch and aspen, will be treated

with a dozer or hydro-axe, breaking trees off at the root crown. All aspen stands treated shall have all trees removed, including adjacent mature aspen that may need to be cut by hand to promote sprouting. 50 acres, identified as having greater than 25% black spruce, will be treated with a shearblade, shearing the trees near the ground surface and push the debris into parallel wind-rows perpendicular to the slope that will later be burned. Furthermore, 40 acres of previously treated (hand-cut and feller-buncher) and now dominated by grass will be scarified, on the contour, to create an adequate seedbed for birch, aspen, and willow regeneration with a dozer blade. By synchronizing the 115 acres treatment with scarification of the smaller, previously treated areas, it will decrease moose pressure on a single area allowing seedling trees to establish. An additional 45 acres of mature forest shall be removed or crushed by 2018 (Table 1), and 40 acres of previously treated aspen/birch will be removed with dozer or hydro-axe at the same time. After 2018, a minimum of 65 acres need to be treated every 5 years to maintain 35% of the pen (195 acres) in early seral deciduous forest less than 15 years old (Table 1).

Table 1. Pen 1 Habitat Enhancement Rotation Plan (PT = Previously Treated)

Year	Acres	% of Pen	% of Pen <15yrs	Treatment	Community Treated
2013	40	7%	7%	Scarify	PT Aspen/Birch
2013	50	9%	16%	Shearblade/Burn	Black Spruce
2013	25	4%	20%	Hydro-axe or Dozer	PT Aspen/Birch
2018	45	8%	28%	Timber Removal	Mature Mixed Forest
2018	40	7%	35%	Hydro-axe or Dozer	PT Aspen/Birch
2023	65	12%	47%	Hydro-axe or Dozer	PT Aspen/Birch
2028	65	12%	38%	Hydro-axe or Dozer	PT Aspen/Birch
2033	65	12%	35%	Hydro-axe or Dozer	PT Aspen/Birch

Pen 2 (Figure 4)

Pen 2 currently is 559 acres, as the northern portion has been split to create a 7 acre rutting pen (Rut Pen), 2 holding pens adjacent to the lab (Pen 2A, 17 acres; Pen 2B, 14 acres), and a 56 acre calf rearing pen (Pen 2C). Currently, adult cow moose occupy the main portion of Pen 2, and calves are overwintered in Pen 2C. Pen 2 consists of mixed aspen, birch and spruce forest, with intermixed areas of bogs. One small lake is found in Pen 2A. Portions of Pen 2 were enhanced in the winters of 1986 and 1987 with the LeTourneau tree crushers, treating approximately 359 acres. Following tree crushing, moose were present in Pen 2 at a lower density than in Pen 1 and stands of birch and aspen have matured to the stem exclusion state. An additional 25 acres were treated in 2010 with a hydro-axe. Aspen and birch saplings are present in the 2010 treatment; however, moose have concentrated in this area, removing most seedlings over 2 feet tall. Areas within the 2010 treatment need to be scarified to promote seedling establishment, and additional areas in Pen 2 need to be enhanced to alleviate moose browse concentrating on the treated areas, otherwise bluejoint reedgrass may become dominant similar to the smaller treatments in Pen 1. Currently, 7 MRC cow moose and at least 1 wild cow moose occupy Pen 2, requiring felling of aspen and birch trees with minimal supplemental winter feeding.

Pen 2 will be enhanced by mechanical treatment in 2012, treating 115 acres (21% of the pen). Areas identified as having greater than 75% birch and aspen will be treated with a dozer or hydro-axe, breaking trees off at the root crown. All aspen stands treated shall have all trees removed, including adjacent mature aspen that may need to be cut by hand to promote sprouting. In addition, 25 acres of previously treated birch and aspen will be scarified, on the contour, to create an adequate seedbed for birch, aspen, and willow regeneration with a dozer blade. An

additional 55 acres of mature forest shall be removed or crushed by 2018 (Table 2). After 2018, a minimum of 65 acres need to be treated every 5 years to maintain 35% of the pen (195 acres) in early seral deciduous forest less than 15 years old (Table 2).

Table 2. Pen 2 Habitat Enhancement Rotation Plan (PT = Previously Treated)

Year	Acres	% of Pen	% of Pen <15yrs	Treatment	Community Treated
2012	115	21%	21%	Hydro-axe or Dozer	PT Aspen/Birch
2013	25	4%	25%	Scarify	PT Birch
2018	55	10%	35%	Timber Removal	Mature Mixed Forest
2024	65	12%	47%	Hydro-axe or Dozer	PT Aspen/Birch
2029	65	12%	33%	Hydro-axe or Dozer	PT Aspen/Birch
2034	65	12%	35%	Hydro-axe or Dozer	PT Aspen/Birch

Pen 3 (Figure 5)

Pen 3 is 616 acres in size, comprised of aspen, birch, and spruce mixed forest. Pen 3 contains the largest lake (42 acres) on the MRC, located in the middle of the eastern half of the pen. Pen 3 contained a 2.7 acre vegetation enclosure in the northwest corner; however, this enclosure is now open. In the winters of 1988 and 1989, approximately 239 acres of Pen 3 were enhanced with LeTourneau tree crushers. From 1989 to 1998 there were no moose present in Pen 3, allowing birch and aspen to establish without browsing. In 1999, 2 moose were placed in Pen 3, and increased to 6 moose in 2003. Moose have been utilizing natural forage year round since 1999 with no supplementation. Currently 6 MRC cow moose, and at least 1 wild cow moose, occupy Pen 3. Winter browse is becoming limited to overwinter animals without any supplemental feeding or felling of trees.

Pen 3 will be enhanced by mechanical treatment in 2013, treating 115 acres (20% of the pen). Areas identified as having greater than 75% birch and aspen will be treated with a dozer or

hydro-axe, breaking trees off at the root crown. All aspen stands treated shall have all trees removed, including adjacent mature aspen that may need to be cut by hand to promote sprouting. An additional 90 acres of mature forest shall be removed or crushed by 2018 (Table 3). To promote hardwood regeneration, 70 acres of mature forest will be removed. Any area where mature forest will be removed will not be wider than 4 times average birch height (birch height on adjacent untreated areas) for seed dispersal. Scarification in these sites will be accomplished during mature stand removal to promote seedling establishment. Furthermore, 20 acres of aspen and white spruce will be selectively removed at the same time, leaving mature birch for seed dispersal. After 2018, a minimum of 65 acres need to be treated every 5 years to maintain 35% of the pen (195 acres) in early seral deciduous forest less than 15 years old (Table 3).

Table 3. Pen 3 Habitat Enhancement Rotation Plan (PT = Previously Treated)

Year	Acres	% of Pen	% of Pen <15yrs	Treatment	Community Treated
2013	115	20%	20%	Dozer	PT Aspen/Birch
2018	90	16%	36%	Timber Removal	Mature Mixed Forest
2025	65	11%	47%	Hydro-axe or Dozer	PT Aspen/Birch
2030	65	11%	38%	Hydro-axe or Dozer	PT Aspen/Birch
2035	65	11%	34%	Hydro-axe or Dozer	PT Aspen/Birch

Pen 4 (Figure 6)

Pen 4 is 646 acres total, comprised of mixed mature forest (birch, aspen and white spruce), mature black spruce forest, and a large bog in the southeast corner. There are two vegetation enclosures, a 3.6 acre enclosure along the north fence, and a 1 acre enclosure on the south fence. Pen 4 has had no habitat enhancements, and any influences on vegetation have been from manipulating moose densities in the pen. Given inadequate forage to maintain moose year round in Pen 4, captive moose have not been kept in Pen 4 since 2002; however, up to 4 wild

moose were in the pen in early 2012. Using fence line traps and external gates, all wild moose have been removed from the pen.

Pen 4 requires the most enhancements to establish a rotation plan. Pen 4 will require enhancing 150 acres of black spruce in 2013 (23% of the pen). Areas of predominant black spruce will be treated with a shearblade, shearing the trees near the ground surface and push the debris into parallel windrows perpendicular to the slope that will later be burned. In 2018 and 2022, to promote hardwood regeneration, A total of 150 acres of mature forest will be removed (complete stand removal and selective removal). Any area where mature forest will be removed will not be wider than 4 times average birch height (birch height on adjacent untreated areas) for seed dispersal. Scarification in these sites will be accomplished during mature stand removal to promote seedling establishment. Selective removal of aspen and white spruce will leave leaving mature birch for seed dispersal. All aspen stands treated shall have all trees removed to promote root sprouting. After 2022, a minimum of 75 acres need to be treated every 5 years to maintain 35% of the pen (225 acres) in early seral deciduous forest less than 15 years old (Table 4).

Table 4. Pen 4 Habitat Enhancement Rotation Plan (PT = Previously Treated)

Year	Acres	% of Pen	% of Pen <15yrs	Treatment	Community Treated
2013	150	23%	23%	Shearblade/Burn	Black Spruce
2018	75	12%	35%	Timber Removal	Mature Mixed Forest
2022	75	12%	42%	Timber Removal	Mature Mixed Forest
2027	75	12%	35%	Hydro-axe or Dozer	PT Aspen/Birch
2032	75	12%	35%	Hydro-axe or Dozer	PT Aspen/Birch

Vegetation Monitoring

Representative areas of each vegetation class will be evaluated to describe the site. For each site, a sampling plot will be established to determine tree density and percent ground cover

(Figure 7). Tree density will be evaluated using two, 11.7 foot radius subplots placed 120 feet apart (adapted from Herrick et al. 2005, Monitoring Manual for Grassland, Shrubland and Savanna Ecosystems). Percent ground cover will be evaluated on a 100 foot transect between the tree plots (Herrick et al. 2005). From the center of each tree density plot, a picture will be taking in the direction of the ground cover transect. After vegetation enhancement, seedling establishment will be evaluated in a 1 meter by 5 meter plot established randomly on the ground cover transect.

Figure 1. Kenai Moose Research Center

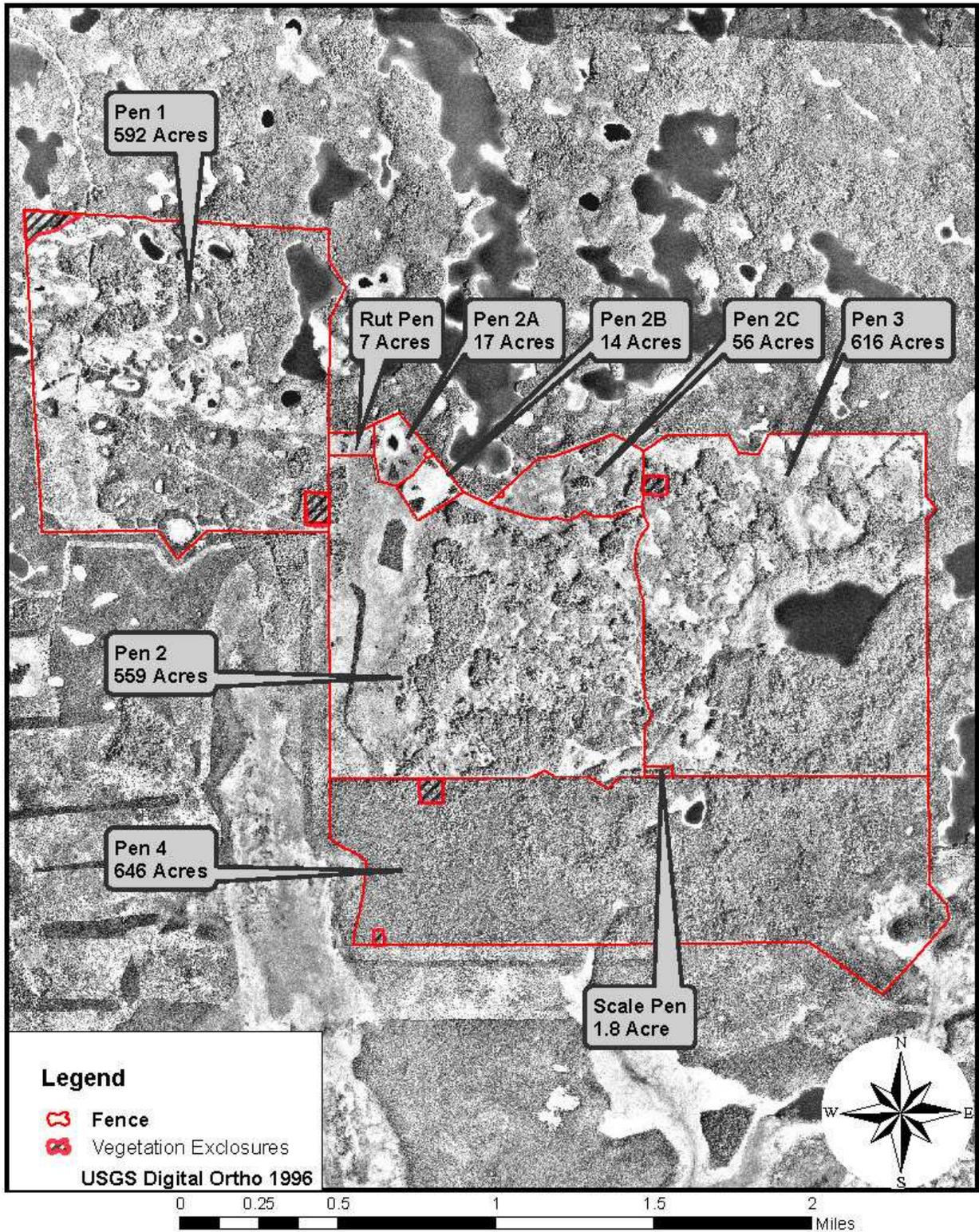


Figure 2. Kenai Moose Research Center habitat enhancements

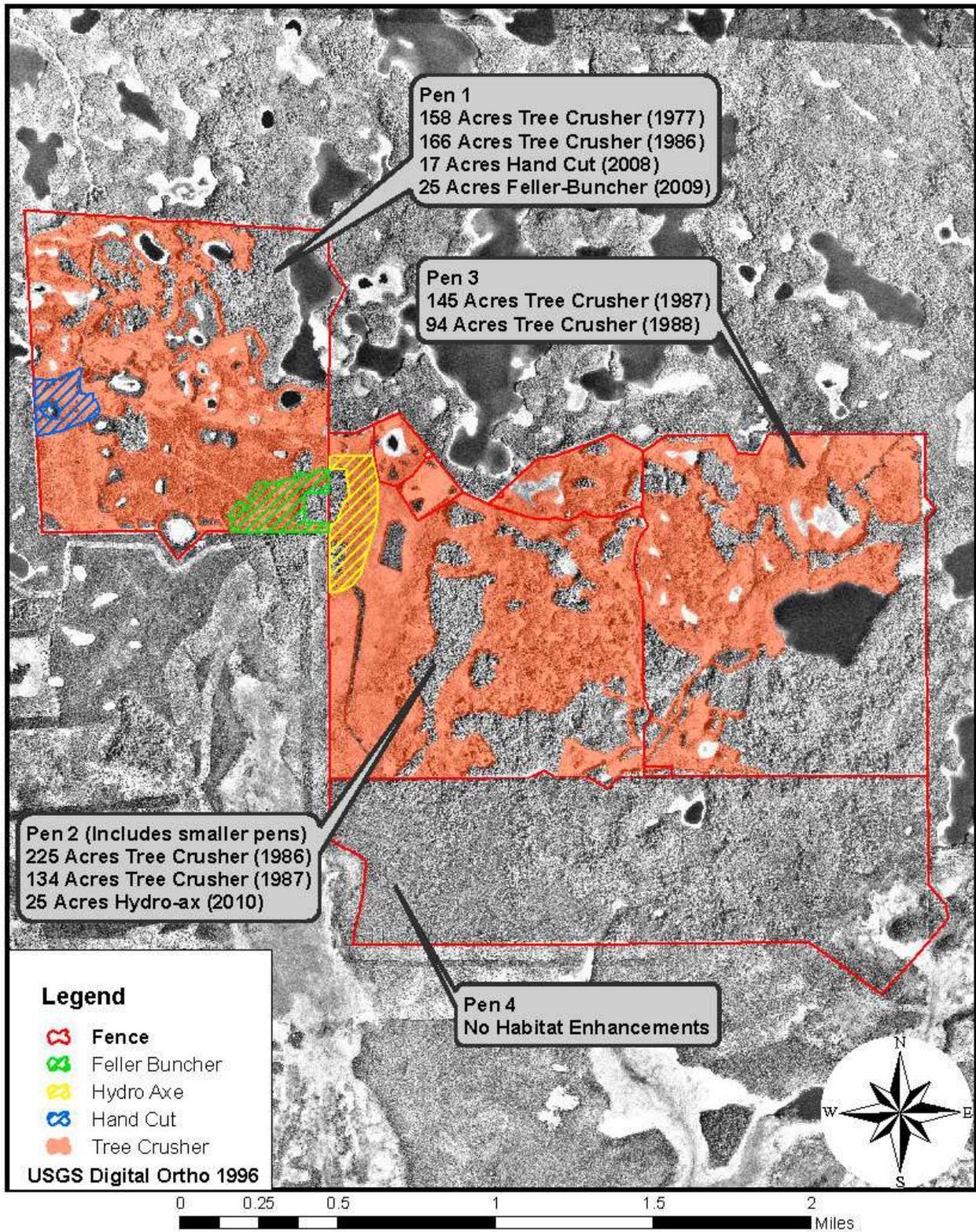


Figure 3. Pen 1 proposed habitat enhancements

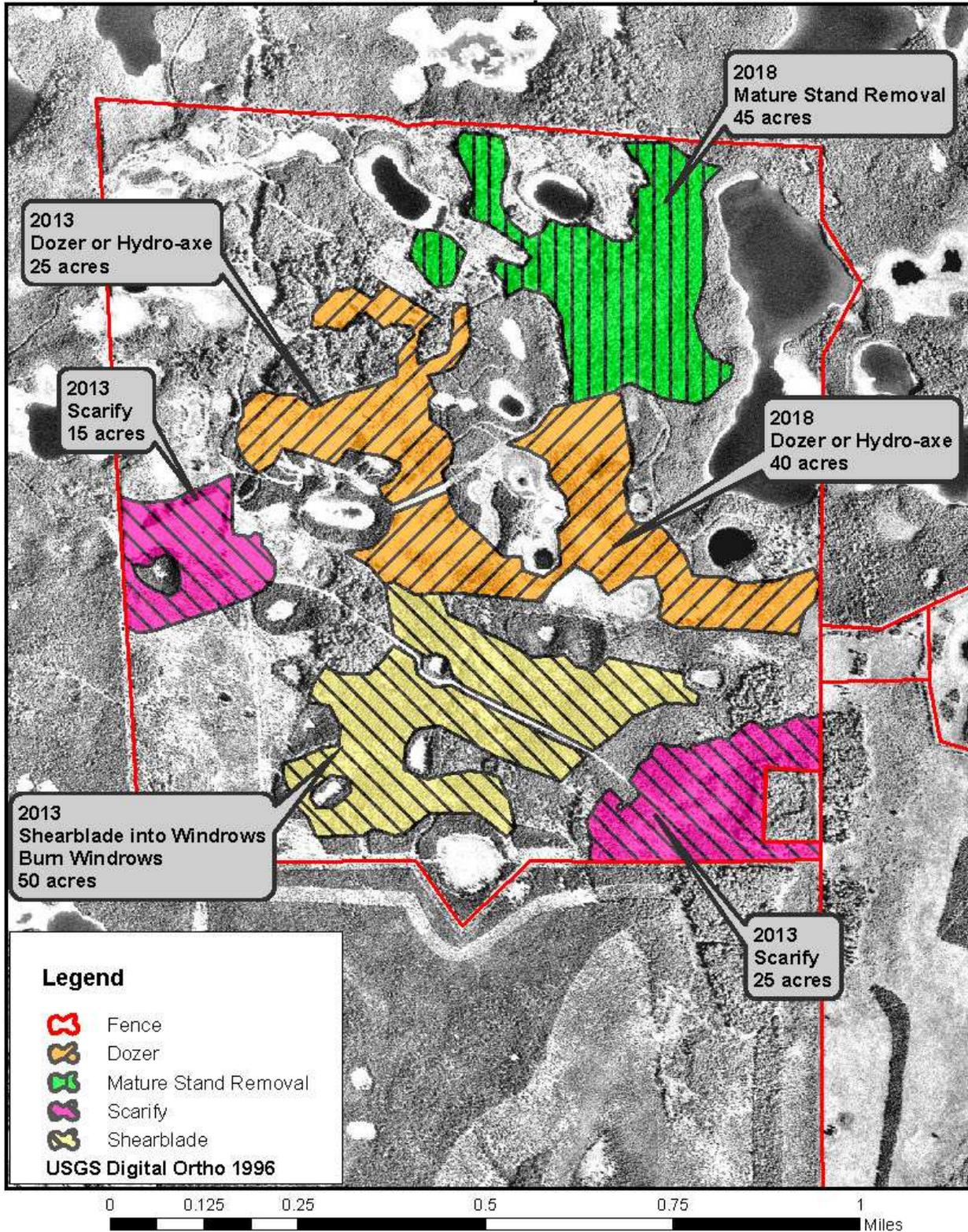


Figure 4. Pen 2 proposed habitat enhancements

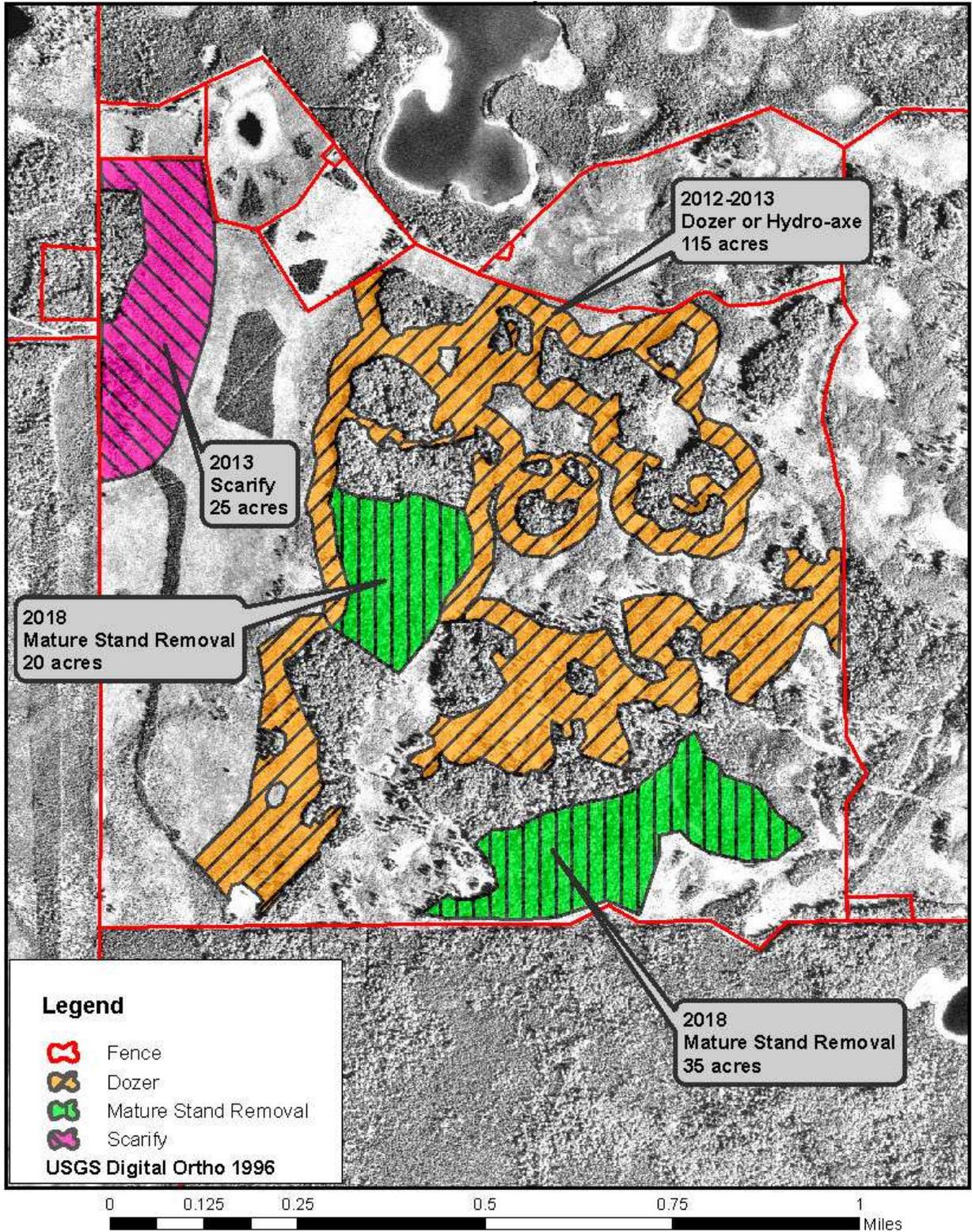


Figure 5. Pen 3 proposed habitat enhancements

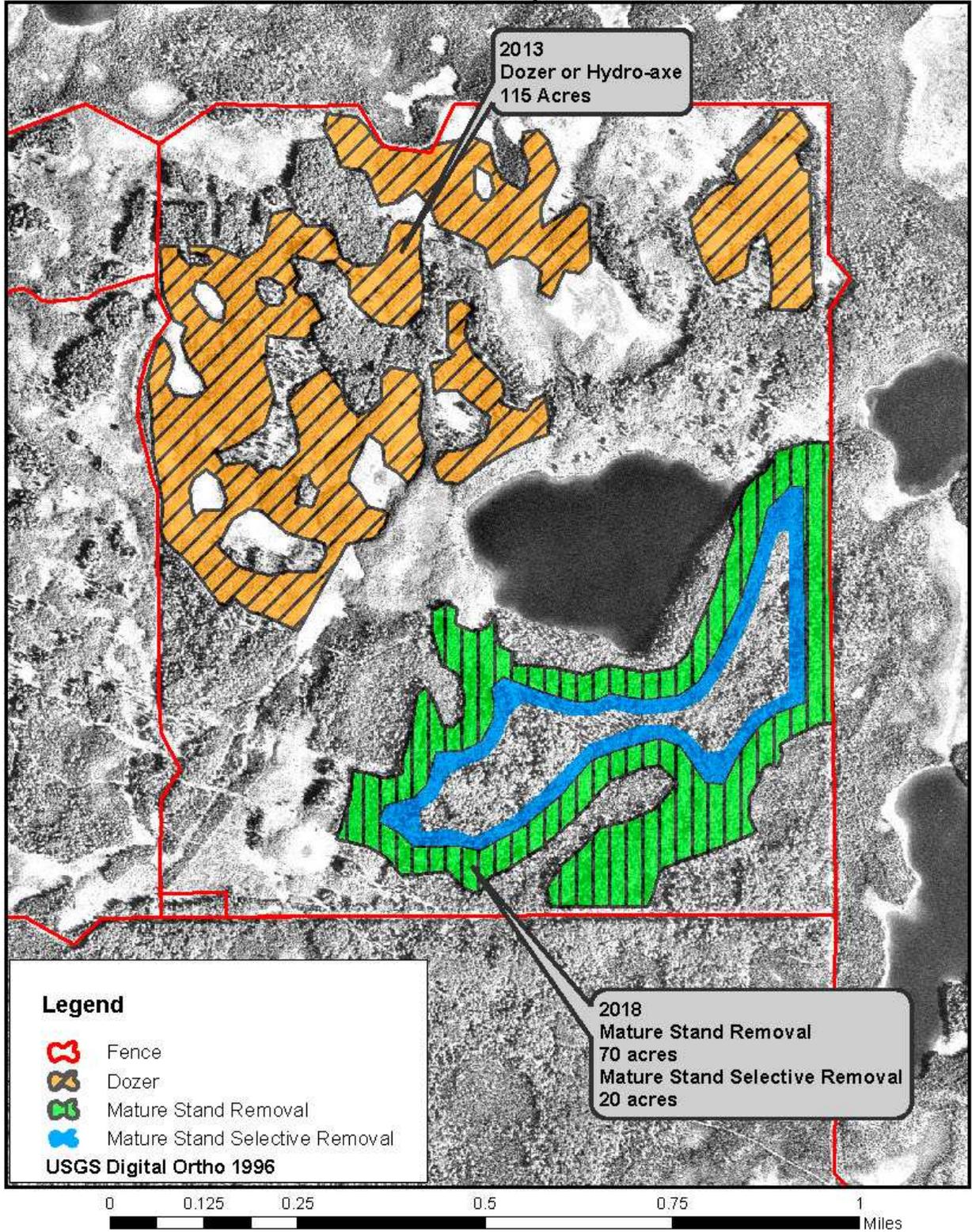


Figure 6. Pen 4 proposed habitat enhancements

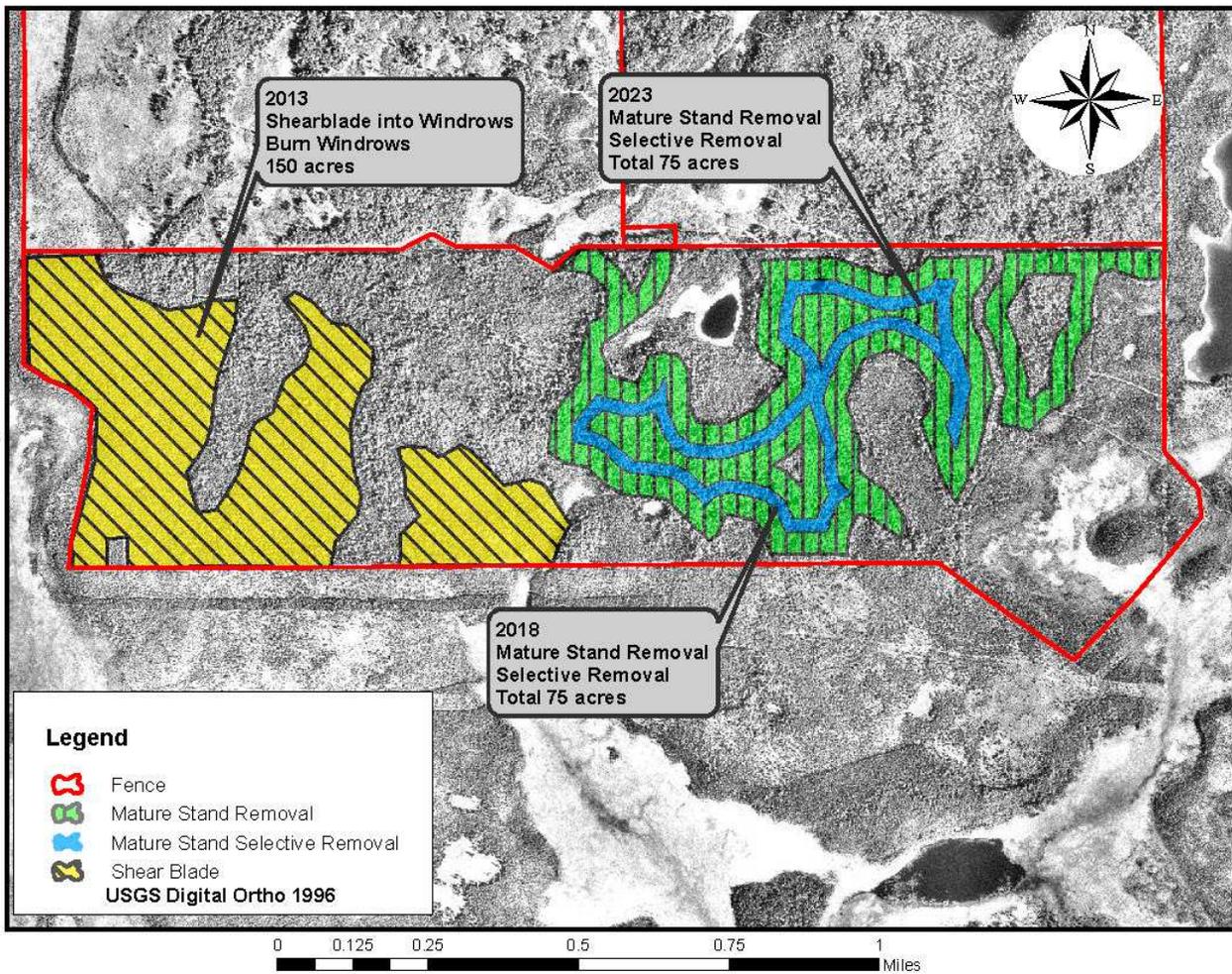


Figure 7. Tree density sampling plots and percent ground cover transect

