Chapter 3 – Environment and Effects

Purpose and Organization of this Chapter

Chapter 3 combines two chapters often published separately in environmental impact statements: the "Affected Environment" and the "Environmental Consequences." The primary purpose of this chapter is to describe the environments of the Chugach National Forest and to disclose the effects of the Revised Forest Plan and the alternatives on these environments.

This chapter contains a description of the physical, biological, and social environments of the Chugach National Forest and surrounding area. It is divided into five major categories:

1. Physical Elements;
2. Biological Elements;
3. Use and Designation of the Forest;
4. Production of Natural Resources; and,
5. Social and Economic Elements.

Each category is further subdivided. For example, the Physical Element is subdivided into three topic areas: air, soil, and water/riparian/wetlands. For each topic, the applicable statutory requirements, key indicators used in comparing alternatives, resource protection measures, affected environment, and environmental consequences of the alternatives are all discussed.

Many additional items were screened out of the analysis process. The reasons for eliminating them included the following:

1. analysis of the item not being considered important to the integrity of the Forest environment;
2. analysis of the item not indicating the potential for direct or indirect environmental effects; and,
3. analysis of the item not being acknowledged or required by law.

Resource Protection Measures

Mitigation measures include: (1) avoiding the impacts altogether by declining to take an action or part of an action; (2) minimizing impacts by limiting the degree or magnitude or an action or its implementation; (3) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating the life of an action; and/or, (5) compensating for the impact by replacing or providing substitute resources or environments.

Environmental Consequences

Where applicable, this section first describes the effects of management area allocation or prescriptions on the environment. Next, the direct, indirect, and cumulative effects on the environment resulting from activities permitted or proposed by management area prescriptions are disclosed. It also displays the output levels, or key indicators, of this element for each of the alternatives. If a resource management activity has no direct or indirect effect on a particular element under any of the alternatives, there is no discussion.

Direct environmental effects are those that occur at the same time and place as the initial action. An example would be the on-site soil disturbance by road construction. Indirect environmental effects are caused by the action, but occur later in time or are spatially removed from the action. An example would be the downwind effect of a prescribed fire. Cumulative effects result from actions taken to achieve the goal of a particular alternative, along with past, present, and reasonable foreseeable activity, undertaken by the Forest Service or by other parties. Not all cumulative effects are disclosed at the programmatic level.

To ensure long-term productivity of the land, the environmental consequences of the alternatives are limited by several management requirements. Many requirements are founded in law, federal regulation, and Forest Service policy. Other requirements to limit the environmental consequences are called Forestwide standards and guidelines. Forestwide standards and guidelines are listed in the Revised Forest Plan. They apply to each alternative. The alternatives considered in detail, with their attending Forestwide and management area standards and guidelines, were designed to prevent or minimize environmental consequences.

Relationships Between Programmatic and Site-specific Effects Analysis

This FEIS is a programmatic document. It discloses the environmental consequences at a large scale, at the planning level. This is in contrast to analyses for site-specific projects. These decisions are made after more detailed analysis and further public comment. The FEIS presents a programmatic action at the Forest level of analysis but does not predict what will happen each time the standards and guidelines are implemented. Environmental consequences for individual, site-specific projects on the Forest are not disclosed (except for access management). The environmental consequences of individual projects will depend on the implementation of each project, the environmental conditions of each project location, and the application of the standards and guidelines in each case.

The affected environment and environmental consequences discussions in Chapter 3 allow for a reasonable prediction of consequences for any individual location on the Forest. However, the document does not describe every environmental process or condition.

Physical Elements

Air

Soils

Water/Riparian/Wetlands

Air

Introduction

The Chugach National Forest, for the most part, has remarkably pristine air quality. Alaska's Department of Environmental Conservation (ADEC) has divided the state into five Intrastate Air Quality Control Regions. The Chugach lies within two of these regions: Cook Inlet and Southcentral Alaska. The Cook Inlet Intrastate Air Quality Control Region covers about a quarter of the Forest, and comprises all watersheds flowing into Cook Inlet (for the Forest this means anything flowing into the Kenai River, or Turnagain and Knik Arms). This portion of the Forest has the greatest potential for air quality impacts from both off-site pollution sources (such as Anchorage and Kenai/Soldotna) and on-site sources (such as highway traffic, and wildland and prescribed fires). The rest of the Forest lies within the Southcentral Intrastate Air Quality Control Region where there is less potential for air quality impacts.

Legal and Administrative Framework

- The **Clean Air Act of 1977, as amended (1977, 1990)** established three air class areas. The Chugach National Forest is currently classified as Class II. The Clean Air Act requires the Forest Service to comply with all federal, state, and local air quality regulations and to ensure that all management actions conform to the State of Alaska's Implementation Plan. The Clean Air Act requires the Forest Service to evaluate all management activities to ensure that they will not:
    - cause or contribute to any violations of ambient air quality standards;
    - increase the frequency of any existing violations; or,
    - impede a state's progress in meeting their air quality goals.
- **Alaska Department of Environmental Conservation – 18 AAC 50 – Air Quality Control** are the air quality control regulations for the State of Alaska. The Chugach abides by the provisions of these regulations. The regulations set ambient air quality standards for the state (for eight contaminants), as well as allowable maximum increases to air quality.

  The Alaska Department of Environmental Conservation is the state regulatory agency responsible for air quality in Alaska. The state has the primary responsibility for enforcement of EPA's air quality standards. This responsibility is carried out through the State Implementation Plan.

Key Indicators

- Number of acres of wildland and prescribed fire
- Miles of unpaved roads
- Number of recreation visits

Resource Protection Measures

Within Class I areas, the Forest Service has specific responsibilities for protection of air quality. This responsibility is carried out through the Prevention of Significant Deterioration (PSD) permit process. Because no Class I areas are designated on the Chugach National Forest, our PSD permitting responsibilities are limited. The Forest Service will evaluate PSD permits as to potential adverse effects on sensitive receptors in Recommended Wilderness. Areas recommended for Wilderness have the greatest probability of attaining Class I status at some point in the future.

Smoke from prescribed fires is managed under a cooperative agreement between the State of Alaska and the Forest Service. Prescribed burning is planned on days when air quality degradation can be minimized. Smoke dispersion is a key consideration in any decision to implement prescribed burns. Compliance with the agreement ensures prescribed burning will not violate the State of Alaska standard for particulate matter (PM-10). An ADEC permit is required for burns greater than 40 acres.

Road dust is evaluated on projects where it is determined to be an air quality issue. Mitigation measures could include type of surface, daily time use restrictions, road closures, and the use of dust abatement products or road watering.

Affected Environment

Forestwide

Airborne dust produces the largest source of air pollution on the Forest. The greatest quantity of airborne dust is blown from natural sources, particularly floodplains of glacial rivers and tidal silt flats. This dust is most prevalent on clear, windy days in the spring and fall when stream flows are low and floodplains are dry and exposed. On some occasions the Forest receives a dusting of fine volcanic ash from volcanic eruptions coming from the Alaska Range. Most recently eruptions occurred in 1986, 1989, and 1992. An ash plume from the 1992 eruption (Crater Peak on Mt. Spurr) deposited fine particulates across much of the Forest.

Emissions from fire, including wildland fire, prescribed fire, and recreational campfires, are other sources of air pollution on the Forest.

Cook Inlet Intrastate Air Quality Control Region

About a quarter of the Forest lies within this Air Quality Control Region. This includes all Forest drainages flowing into the Kenai River, the seven watersheds flowing into Turnagain Arm (Resurrection Creek, Sixmile Creek, Seattle/Ingram Creeks, Placer River, Portage Creek, Twentymile River, and Glacier Creek), a small piece of the Chickaloon watershed flowing into lower Turnagain Arm, and small portions of the Eagle River and Knik River watersheds flowing into Knik Arm. It is the portion of the Forest heavily impacted by spruce bark beetle infestation, and is where most prescribed burns have occurred and are most likely to be proposed. It is also the part of the Forest with by far the most available roads and vehicle traffic.

Western and northern portions of the Forest within this Air Quality Control Region may be affected by upwind urban contaminants from Anchorage and the Kenai/Soldotna area. Anchorage has been classified as a “non-attainment area” for meeting carbon monoxide standards (this non-attainment generally occurs during winter cold snaps).

Concerns have been expressed about smoke from prescribe burning on the Forest, although active complaints during burning have been minimal.

Southcentral Intrastate Air Quality Control Region

This Air Quality Control Region includes eastern three quarters of the Forest. The Forest’s portion of this Region includes all of Prince William Sound and the Copper and Bering River areas. Under the 1984 Chugach Forest Plan, about 1.9 million acres in Prince William Sound were recommended for Wilderness designation. Only Wilderness designated before August 7, 1977, is currently classified as Class I under the Clean Air Act. Although all areas of the Forest are designated Class II, areas of recommended Wilderness are given special consideration if impacts to air quality are at issue.

Sources of air contamination within the Forest’s portion of this Air Quality Control Region are most likely to come from communities (Valdez, Seward, and Cordova) or from marine and air traffic. No prescribed burning occurs here, and wildland fires are very infrequent due to high precipitation and cool summer temperatures. Along the Copper River and its floodplains, high particulate loads frequently impact air quality. This is due to heavy silt loads carried and deposited by the river, and high winds occurring along the river corridor.

Environmental Consequences

General Effects

None of the alternatives considered would substantially change the existing air quality on the Forest. The alternatives have few significant differences that would affect air quality. Air quality is temporarily lowered on roads and at developed recreation sites by vehicle emissions, dust, and smoke from campfires. Air quality is also temporarily lowered during burning, both by wildland and prescribed fires.

Direct and Indirect Effects

Effects from Fire Management

Table 3-1 shows the acres of burning on the Forest that could affect air quality each year by alternative.

Table 3-1: Acres burned per year by alternative.

Burning Activity	No Action	Preferred	A	B	C	D	E	F
Wildland fire	15	15	15	15	15	15	15	15
Wildlife habitat improvement burns	2,248	2,248	2,248	2,248	2,248	1,558	910	920
Slash disposal	22	22	22	22	22	22	22	22
Site preparation burns	58	23	92	60	26	21	16	14
Fuel reduction burns	400	400	400	400	400	400	400	400
Total	**2,743**	**2,708**	**2,777**	**2,745**	**2,711**	**2,016**	**1,363**	**1,371**

As displayed in Table 3-1, all alternatives are close to or below the number of acres currently being burned under the No Action Alternative. Therefore, none of the alternatives would substantially change the existing air quality on the Forest.

Acres burned by wildland fire on the Forest have been low over the last two decades, and are projected to remain low through the planning period. Projected wildland fire acres on the Forest do not vary between alternatives (average 15 acres/year). Air quality can be sharply impacted locally for days or weeks in the unusual event of a large wildland fire. Most wildfires on the Forest are quickly contained and have very limited air quality impacts.

For prescribed fires (slash disposal, wildlife habitat improvement, and fuels reduction), the No Action Alternative, the Preferred Alternative, and Alternatives A, B and C have the largest number of acres treated (about 2,700 acres/year), and have the largest potential to impact air quality. Alternative D proposes about 30 percent less prescribed burning, while Alternatives E and F both have about 60 percent less prescribed burning.

Prescribed fires generally burn at lower intensity than wildland fires and have more limited impacts to air quality. Prescribed fire air quality impacts are usually for just a few days, since the fires burn within a set area. Air quality in adjacent areas, particularly valley bottoms, can be temporarily impacted by smoke during prescribe burning. Areas that have been treated by prescribed fire would burn cooler and more sparsely than during a wildland fire. Prescribed burning (over 40 acres) is done under an ADEC permit which would help reduce the impact of any smoke to local communities.

Effects from Travel Management

Table 3-2 shows the miles of unpaved Forest roads by alternative that could affect air quality.

Table 3-2: Miles of open, unpaved road by alternative[1].

Year	Alternative							
	No Action	Preferred	A	B	C	D	E	F
2000	63	68	84	96	76	62	62	62
2005	100	75	122	143	87	71	68	68
2010	131	88	176	191	98	80	75	72

[1] Road miles displayed do not include existing paved roads; 20 percent of new roads are projected to be paved.

As displayed in Table 3-2, all alternatives would increase the total miles of open, unpaved roads on the Forest. Unpaved road mile increases over a decade would be greatest under Alternative B (95 miles), then Alternative A (92 miles), then the No Action Alternative (68 miles). All other alternatives propose between a 10 and 22-mile increase in unpaved roads over a decade. Dust impacts from roads under all alternatives would not substantially change existing air quality on the Forest except very locally and on a very intermittent basis.

Table 3-3 displays the total recreation visits by alternative that could affect air quality.

Table 3-3: Total recreation visits by alternative (in millions of visits per year).

Base Level	Alternative							
	No Action	Preferred	A	B	C	D	E	F
8.09	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15

Since nearly all visitors drive to and on the Forest, the number of visitors provides a way to compare amounts of petroleum combustion between alternatives. Adverse air quality effects have not been encountered to date on the most heavily traveled highway routes on the Forest (the Seward and Sterling Highways). Petroleum combustion impacts from visitor use under all alternatives would not be expected to substantially change existing air quality on the Forest. Table 3-3 indicates that the number of visitors under all alternatives would increase over the base level.

Snowmobile use on the Forest is widely disbursed, and under no alternative would it be expected to produce a measurable effect on air quality. Snowmobile emissions have negative effects on air quality. Snowmobile emissions include air pollutants and volatile organic compounds. Snowmobile two-stroke engines emit about 20 to 33 percent of the consumed fuel through the exhaust (Hines 2000, USDI National Park Service 1996). Snowmobile hydrocarbon emission exceeds emissions from most other motor vehicles, with exhaust carbon dioxide levels around 1,000 times higher than an automobile operating at similar speeds (Fussell 1997). Areas available for snowmobile use vary considerably between alternatives (greatest in the Preferred Alternative and Alternatives A, B and C, and least in Alternatives E, D and F). Alternatives with limited areas open to snowmobiling could concentrate snowmobiling could concentrate snowmobile use into specific locations, causing higher air quality impacts at those locations.

Snowmobile use may degrade the air quality that currently exists within localized areas of the Chugach National Forest. Localized short-term high concentrations of carbon monoxide and other pollutants would occur where snowmobiles are used. Snowmobile use would diminish the air quality in areas where high concentrations of snowmobiles assemble. These are primarily the Turnagain Pass and Lost Lake areas.

Studies within the West Yellowstone, Montana area have found levels of snowmobile generated carbon monoxide that have exceeded federal standards. These occurrences are primarily during days of high snowmobile traffic, with over 1,000 snowmobiles moving through the National Park entrance per day, and during periods of air stagnation and temperature inversion. In comparison, use is much less and snowmobile traffic patterns are less concentrated within the Chugach National Forest. The Turnagain Pass area has the highest snowmobile use concentrations on the Forest. Use studies of motorized and nonmotorized users (Skustad 2001) have indicated significantly less use intensities compared to West Yellowstone use patterns. Maximum use counts indicated a peak of 100 vehicles per day associated with snowmobile users. Generally, use was less than 50 vehicles on weekend days. Weekday numbers averaged around 10.

Unlike West Yellowstone, the Turnagain Pass area is not in a mountain basin prone to air stagnation due to temperature inversions. Present use of the area indicates no visibility impairment (Skustad 2001). While no measurement of carbon monoxide or nitrogen oxides has been undertaken within the Forest by Chugach National Forest personnel, the relatively small number of snowmobile users in the area indicates that impacts to air quality from carbon monoxide or nitrogen oxide levels generated would be minor. This diminishment of air quality would likely be below federal standards for pollution, but additional monitoring may be needed to verify that these standards are not being exceeded.

Cumulative Effects

Cumulative effects to air quality include (1) air contaminations from urban communities (see Affected Environment section), (2) dust and vehicles emission from people traveling along federal, state, and Forest highways and roads, and (3) burning form both wildland fires and prescribes fires on Forest and adjacent federal, state and private lands, especially on the Kenai Peninsula. All areas on the Forest are currently in compliance with National Ambient Air Quality Standards. Any cumulative effect most likely would be temporary and would not be expected to substantially degrade long-term air quality on the Forest.

Air quality could be affected in the event of future oil, gas, and mineral exploration and development. Effects would be short-term, and include engine emissions from drilling activities, emissions from flaring gas during well testing, and gas release during drilling. The amount of projected development would not have a significant effect on air quality.

Soils

Introduction

Soil is the basic component of the environment. Most living things depend on the soil for their initial source of nutrients from which most other living things evolve. Soil absorbs and holds nutrient rich water, releasing it at varying rates to supply nutrients for microorganisms and plants that become the food and habitat for larger animals and people. All renewable resources on the Chugach National Forest depend on soil, which is considered a nonrenewable resource because of the long period of time it takes for its formation.

The ability of a soil to function can be described as soil health or soil quality. The Soil Science Society of America has defined "Soil Quality" as "The capacity of a specific kind of soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and support human health and habitation" (SSSA 1995). "Soil Quality" also includes adequate porosity to handle water flow and organic matter to ensure aggregate stability and nutrient cycling. Before soil quality can be protected it must be recognized that there are numerous kinds of soil and that the properties of a soil affect a wide variety of ecosystems on the Forest.

The primary goal of soil management on the Forest is to maintain soil quality. This process includes inventorying soils, vegetation, and landscape characteristics to identify and locate the soils, making interpretations for appropriate Forest management activities, and assuring soil recommendations are implemented.

Legal and Administrative Framework

There are two Acts that have set the basis for the protection of soil health and quality.

- The **Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA)** requires an assessment of the present and potential productivity of the land and provides guidelines for land management plans which will insure that timber will be harvested from national forest lands where …soil, slope, or other watershed conditions will not be irreversibly damaged.
- The **National Forest Management Act of 1976 (NFMA)** amended RPA by adding sections that stressed the maintenance of productivity and the need to protect and improve the soil and water resources, and the avoidance of permanent impairment of the productive capability of the land. The specific guidelines are found in 36 CFR 219 of the Code of Federal Regulations.

Key Indicators

- Acres of disturbance from road, trail, campground, and cabin construction

Resource Protection Measures

Protection measures must be implemented in order to assure the maintenance of the soil quality and long-term productivity. These protection/mitigation measures are found in the 1984 Forest Plan, watershed analyses, environmental assessments, soil quality standards, and the Alaska Region's Best Management Practices (BMPs).

The protection measures apply to all alternatives. Once an alternative has been selected and implementation starts, monitoring will be initiated to determine if the appropriate protection measures have been implemented and if the measure is adequate. Changes in either the method of implementation or the protection measure will occur if either does not adequately protect the soil quality or productivity.

Affected Environment

Forestwide

The Chugach National Forest has used the "National Hierarchical Framework of Ecological Units" (ECOMAP 1993) as the basis for mapping landscapes, soils, and vegetation. The most appropriate levels of delineation for Forest level planning are the "Subsection" and the "Landtype Association" levels. On the Forest, the major subsection delineation criteria are climate and its relationships to the topography. There are 13 subsections on the Forest (Davidson 1997). The landtype associations are the highest level of actual landscape delineation in the ecological hierarchy. The criteria used on the Forest to delineate landtype associations have been similar geomorphic and hydrologic processes, and similar landforms, soils, and vegetation cover types. Criteria used to delineate the subsections (climate, topography, etc.) modify the landtype associations that occur within each subsection to further differentiate similar appearing landtype associations in one subsection from those in another subsection. There are eight reoccurring landtype associations on the Forest.

Organic Matter/Wetlands

Developed mineral soils on the Chugach National Forest are typically covered with an organic layer ranging from 10 centimeters on freely drained soils to greater than 40 centimeters thick on more poorly drained soils. The organic layer also insulates the mineral soil, lowering the soil temperature and sometimes reducing the productivity.

Organic layers thicker than 40 centimeters are classified as organic soils and are indicative of wetlands. Organic soils are not highly productive in regards to trees, but they do have very high values relative to fish and wildlife habitat, as well as, produce plant communities that add to the mosaic of scenic beauty throughout the Forest. The total wetlands as inventoried by the National Wetlands Inventory using the Cowardin system (Cowardin 1979) cover about 23 percent of the Forest (Table 3-7).

Soil Productivity

Soil productivity is considered a function of the inherent characteristics of the soil, the site, and the climate. It can be affected by on-site disturbance from wind, fire, natural erosion, and landslides, or it can be human related. Soil productivity varies considerably from soil to soil. Most nutrients are produced and stored in the surface organic layer and the upper horizons of the mineral soil. Soil drainage, texture, depth, water holding capacity, and site characteristics, including elevation, slope, slope position, and aspect, all determine the soil productivity. The most productive soils are moderately well drained to well drained with a moderate texture. They are found on older less active, alluvial fans and floodplains (Landtype Association 80), and on lower sideslopes, foot slopes, and terraces (Landtype Association 40). Soils on these landforms in Prince William Sound are more productive that those on the Kenai Peninsula because of more moderate temperatures and higher amounts of precipitation.

Past practices have resulted in lost soil productivity from the construction of roads, recreational trails, campgrounds, and placer mines. Impacts to the soils as a result of timber harvest activities have increased the time it takes for reforestation, because of the lack of surface soil mixing, resulting in increased plant competition. Surface disturbance that exposes a mixture of organic and mineral soil will best accelerate reforestation on the Kenai Peninsula in fine texture soils. Surface disturbance, however, is not desired on coarse texture soils. Soil compaction from over use by people or machines has also lowered or eliminated the productivity on high use sites.

Soil Erosion and Compaction

Soil erosion either from surface sheet or rill erosion and landslides reduces soil productivity. It can also result in sedimentation in streams, degrading water quality and fish habitat. Soil disturbance occurs from both human and natural causes. Too much disturbance can remove individual particles through surface erosion or remove large masses of soil through landslides resulting in the loss of the nutrient rich surface organic layer and the productive upper layers of the mineral soil. Eroded soil particles sometimes degrade the water quality in streams and lakes, or are deposited elsewhere to impact ecosystems.

Soil compaction is most prevalent in soils with finer surface textures that hold more moisture than coarser soils. Removal of the surface organic layer and repeated trampling or driving over the soil compacts the upper layers to reduce the porosity and permeability resulting in less plant cover and greater water runoff. These conditions occur most frequently on skid trails in timber harvest areas, foot trails, and adjacent to hardened campsites.

Surface erosion includes sheet, rill, gully, and stream channel bank erosion of exposed mineral soils. On the Forest, since most mineral soils are covered by moss and decayed plants, surface erosion is usually not a major concern. The five major activities that expose mineral soil are road construction, timber harvest, placer mining, recreational development, and overuse by people trampling the vegetation and exposing the soils adjacent to streams.

Mineral soil is exposed from skid trails, road surfaces, cut and fill slopes, log transfer site, and borrow sites on timber harvest sites. Most of the timber harvest on the Forest has occurred in the Cooper Landing area (early 1990s) on the Kenai Peninsula, on the Knowles Head land acquisition from the Tatitlek Native Village (1990-1995) in northeastern Prince William Sound, and on the west side on Montague Island (1970s). Monitoring past timber harvest in the Cooper Landing area resulted in 18 to 33 percent soil disturbance (Davidson 1993). The only obvious erosion after major rainfall events was restricted to the main skid trails. Visual inspection of the disturbed sites since reclamation has not identified any serious erosion. Natural revegetation has successfully invaded most sites within five years to establish a cover of greater than 75 percent, except on landings where wood chips have been spread over the sites. After five years there is still less than five percent cover on these sites.

Mineral soil exposed and compacted from over-use by people, adjacent to major fish streams and at remote campsites, is the most serious consequence to other resources (fish habitat, water quality, stream characteristics, etc.). The exposed mineral soil or stream bank then erodes during periods of high water or floods. The lower three miles of the Russian River, the Kenai River, and parts of Quartz Creek on the Kenai Peninsula have suffered the greatest erosion. Remote campsites along the major hiking trails on the Peninsula and kayak campsites in Prince William Sound have numerous locations where mineral soils have been exposed and compacted. There are about 150 impacted campsites along trails on the Kenai Peninsula of which 50 are designated as official sites (Lindquist personal communication). As of 1996 (Monz 1998) there were 63 inventoried sites in northwestern Prince William Sound with vegetation/soil disturbance that range from 9 to 225 square meters with an average of 28 square meters. There is an additional 40 sites (Twardock personal communication) that have been inventoried since 1996, but the specific data is not yet available. There are likely more sites in the Sound that have not been found or inventoried.

Placer mining for gold in numerous streams on the Kenai Peninsula has severely impacted the adjacent alluvial soils and vegetation. Most of this mining took place in the early to mid 1900s, but much evidence still remains, especially where tailings or waste areas have yet to revegetate. The most significant sites are in Resurrection, Bear, Mills, Juneau, Quartz, Crescent, Canyon, and Sixmile Creeks.

Landslides

Landslides are not a common occurrence on the Chugach Forest. They most frequently occur on slopes steeper than 72 percent (Swanston 1997) in soils that have a layer restrictive to downward water flow. This restrictive layer is usually bedrock or compact till. Landslides are also common in clay/silt lacustrine (lake bottom) sediments. Landslides that occur as a result of human activities are caused by roads that cut a portion of the retaining slope, the concentration of water on otherwise stable slopes, timber harvest on shallow soils over bedrock on slopes upwards to 90 percent or more, and road construction over unstable soils on steep slopes when they are saturated. Natural landslides have been identified in the Knowles Head area in northeastern Prince William Sound, Montague Island, and scattered across the Kenai Peninsula. All of these areas have some slides that may have resulted from previous management activities.

Environmental Consequences

General Effects

General effects on the soil productivity are the result of either the removal or the change in the physical characteristics of the upper organic and mineral productive layers. Usually, the greater the disturbance the greater and longer lasting the impact on soil productivity. Management activities that purposely remove the vegetation and the upper soil layer, result in the elimination of soil productivity. These activities include construction of roads, trails, gravel pits, parking areas, and administrative facilities. Less impacting activities that do not intentionally remove the soil are those that kill the protective vegetation and change the soil structure (compaction, etc.). These activities include skid trails in timber harvest units, recreational cabin and campsites, primitive trails, and peripheral areas adjacent to campgrounds, viewing sites, and other recreational attractions. Development of access routes to remote sites that attract users to streams and wetlands accelerate impacts to stream banks, and the fragile organic soils in the wetlands.

The Revised Forest Plan, through management area prescriptions, allocates uses for different parcels of land, and uses standards and guidelines, to direct how these activities are to be implemented. Through responsible Forest management, disturbance/ impacts to the soil will be kept to a minimum. Different prescriptions permit different activities. Some prescriptions permit timber harvest and others permit recreational development. Most disturbances that result from timber harvest are usually associated with road construction and maintenance. Disturbance associated with recreation is usually associated with road and facility construction and from overuse caused by people. Development of numerous small recreation sites could have a cumulative effect far greater that a timber sale on disturbance of the soil. By following standards and guidelines and Best Management Practices, impacts to soils would be minimized. Since site-specific activities are not identified at the Forest Plan level, the discussion of environmental consequences will deal with those management activities allowed by the prescriptions and how they might disturb the soil.

Direct and Indirect Effects

Effects from Timber Harvest

All alternatives would allow the harvest some acreage for firewood and hazard tree removal. Firewood/hazard tree sales are proposed within a mile of existing road systems and would generally treat any given acre lightly, that is, most of the trees would be left standing. Only Alternatives A, B and the No Action Alternative include commercial timber harvest. Alternative A would allow nearly twice the acreage of commercial timber harvest than the next closest alternative, the No Action Alternative. Alternative B would harvest just over a third as many acres as

Alternative A. Harvest techniques and locations would not vary significantly between these alternatives.

Continuous strips of exposed mineral soil would reduce the productivity and allow for erosion. Timber harvest would affect the soil directly through skidding, decking or transfer sites, and site preparation for reforestation. Skid trails would compact soil or remove the upper, nutrient rich, soil layers. Dispersed ground skidding in the harvest area would expose patches of mineral soil by mixing the upper mineral and organic soil layers during harvest which reduces vegetative competition and aids in natural reforestation, or it provides planting sites for induced reforestation.

Timber harvest would indirectly affect the next generation of plant communities, because of the amount and intensity of surface disturbance. Thus the amount of soil disturbance would have an indirect effect on the type and quality of wildlife habitat and species that depend on a forested plant community.

Effects from Roads

Road construction ranges from 1.3 miles per year under Alternative F to 11.4 miles under Alternative A. Alternatives A and B would have the most new road construction. The No Action Alternative would have slightly more than half of the miles of new road construction as Alternatives A and B. In descending order, the Preferred Alternative, Alternatives C, D, E, and Alternative F would all have substantially less proposed road miles. Table 3-4 shows the long- and short-term effects of road construction on the soil productivity by alternative.

Table 3-4: Long- and short- term effects on soil productivity from road construction (acres) – first decade.

Management Activities	Alternative								
	Existing	No Action	Preferred	A	B	C	D	E	F
Timber Harvest Roads (1)	0 0	75 75	0 0	138 138	58 58	0 0	0 0	0 0	0 0
Roads for Facilities (2)	67 60	42 37	61 54	61 54	59 53	53 48	42 37	30 27	25 22
Other Road Construction (3)	106 95	0 0	0 0	0 0	30 27	0 0	0 0	0 0	0 0
Trails Converted to Roads	0 0	2 2	2 2	2 2	36 32	2 2	0 0	0 0	0 0
Total Potential Disturbance from Roads	**173** **155**	**119** **114**	**63** **56**	**201** **194**	**183** **170**	**55** **50**	**42** **37**	**30** **27**	**25** **22**

(1) Calculations based on a 14-foot wide running surface (top line, 1.7 acres of long term disturbance per mile) and 7-foot fill and cut slope (bottom line, 1.7 acres of short term disturbance per mile) on either side of the road.
(2) Calculations based on a 16-foot wide running surface (top line, 1.9 acres of disturbance per mile) and 7-foot fill and cut slope (bottom line, 1.7 acres of short term disturbance per mile) on either side of the road.
(3) Assume road design similar to that under Roads for Facilities (2).

The construction of roads provides the potential for soil disturbance and a loss in soil productivity in all of the alternatives. Alternative A provides the largest potential for disturbance with the potential long-term loss of soil productivity from road construction on 201 acres and a shorter-term reduction in soil productivity of 194 acres. A majority of the disturbance would come from the construction of roads for proposed timber harvest. Alternative B would have soil disturbance on 183 and 170 acres. A majority of the disturbance would come from roads constructed for recreational or facility access. Alternative F would have the smallest potential for the disturbance from road construction with the potential long-term loss in soil productivity of 25 acres and a shorter-term reduction of 22 acres. There would be a total of 63 acres of long-term soil disturbance and 56 acres of short-term disturbance under the Preferred Alternative. This is much less than Alternatives No Action, A, and B, but greater than Alternatives C, D, E, and F.

The travel surface of roads eliminates the soil productivity (long-term). The cut and fill slopes or borrow ditches reduce the productivity (short-term) for the time period it takes for vegetation to reestablish to the pre-disturbance state. Roads that are associated with timber harvest and mining are usually temporary, and remove the soil productivity while they are in use. They are usually obliterated and allowed to revegetate upon completion of the timber harvest. Stockpiled topsoil can be spread to accelerate revegetation once the road has been closed. Roads that are used as access to permanent recreation or administration facilities (campgrounds, work centers, trail heads, etc.) permanently remove the productivity of the soil.

An indirect effect resulting from the construction of roads is the tendency of unwanted plant species and weeds to invade areas of substantial soil disturbance such as road cuts and fills, or to revegetate seed mixtures that do not include species indigenous to the specific areas.

Effects from Trails

Trail construction varies from 4.0 miles per year under Alternative F, to 22.6 miles per year under Alternative C. The Preferred Alternative and Alternatives C, D, B, and A would have the most new trail construction. Alternative E, the No Action Alternative, and Alternative F would have the least trail construction. The construction of recreational trails, both motorized and nonmotorized, would result in soil disturbance and a loss in soil productivity similar to that of roads. There is less linear disturbance per mile with trails. Table 3-5 gives an estimate of the loss in soil productivity for trail construction for each of the alternatives.

Table 3-5: Long- and short-term effects on soil productivity from trail construction (acres) – first decade.

Management Activities	Existing Trail Disturbance	No Action	Preferred	A	B	C	D	E	F
				Alternative					
Summer Trails (1)	11	31	46	46	169	81	5	4	4
Motorized (2)	14	38	56	56	206	99	7	4	5
Summer Trails (3)	256	279	330	330	242	335	369	314	283
Nonmotorized (2)	389	424	502	502	369	510	561	478	430
Total Potential Disturbance for Trails	**267 403**	**310 462**	**376 558**	**376 558**	**411 575**	**416 609**	**374 568**	**318 482**	**287 435**

(1) Calculations based on a 5-foot wide running surface (0.6-acre long-term disturbance per mile).
(2) Calculations based on a 3-foot cut and a 3-foot fill average for the trail (0.73-acre short-term disturbance per mile).
(3) Calculations based on a 4-foot wide walking surface (0.48-acre long-term disturbance per mile).

Presently, there are 267 acres where existing trails have eliminated the soil productivity on the Forest, for the long term. Alternative C proposes the largest amount of disturbance from trail construction with a long-term loss in soil productivity of 416 acres and a short-term reduction of the area adjacent to the trails of 609 acres. Alternative F would have the smallest potential for the disturbance from trail construction with a long-term loss in soil productivity of 287 acres and a short-term reduction of 435 acres. There would be a total of 376 acres of long-term disturbance and 558 acres of short-term disturbance from trail construction under the Preferred Alternative. This is the same amount of disturbance under Alternative A and slightly less disturbance as under Alternatives C and D.

In all of the alternatives, proposed trail construction would disturb an area larger than that from road construction. This is especially true in the Preferred Alternative and Alternatives D, E and F. In Alternative A, which has the largest proposed amount of road construction, there would be more than twice the soil disturbance from trail construction than from roads.

Many of the prescriptions allow for a variety of recreational development or subsistence use. The wilderness prescriptions allow for trail development, motorized access for subsistence, hardened dispersed campsites, conditional mineral entry, and the construction of Forest Service recreational cabins. All of these activities tend to concentrate people. An indirect consequence would result from overuse by people such as trampling of the stream banks of high use fishing rivers, trail development in fragile wetlands, and the establishment of non-developed campsites. This would eventually result in killing the vegetation allowing for erosion, sedimentation to streams, and a loss in soil productivity.

Effects from Recreation

Campgrounds, day use facilities, administrative sites, parking lots, and viewing sites are usually planned to remain for the long term. These sites have associated permanent roads, vehicle parking, and intensive use areas. The disturbance caused by the roads is included in Table 3-4. Table 3-6 includes the loss in soil productivity attributed to the campsites and cabin areas and the area trampled by use.

Table 3-6: Effects on soil productivity from campsite and cabin construction (acres) – first decade.

Recreational Use	Existing Disturbance	Alternative							
		No Action	Preferred	A	B	C	D	E	F
Campsites (1)	6.8	3.0	3.5	5.1	5.8	5.8	5.0	3.2	2.7
Cabins (2)	1.0	0.7	0.7	1.0	1.0	1.0	0.8	0.7	0.2
Total Disturbance	**7.8**	**3.7**	**4.2**	**6.1**	**6.8**	**6.8**	**5.8**	**3.2**	**2.9**

(1) Disturbance estimated using 400 square feet for each campsite and 300 square feet for the access trail (100 feet long by 3 feet wide).
(2) Disturbance estimated using 1000 square feet for each cabin. (The area of disturbance for access trail is included in the trails table.)

Alternatives B and C would have the greatest amount of disturbance with a total of about 6.8 acres, and Alternative F would have the least amount of disturbance with only 2.9 acres. An indirect effect from the camp cabin sites, especially in Prince William Sound and the Copper River area, would be the tendency for adventurers to make trails in wetlands and other fragile areas.

Effects from Fires

In most instances, wildland or prescribed fires would not burn hot enough to remove enough of the organic surface layer to cause a potential for soil erosion. Long duration smoldering in tree roots would burn through the organic layer, but these sites are usually small in size. This could reduce the thickness of the organic layer and the density of the canopy that would allow the soils warm somewhat and stimulate an increase in biological activity and accelerate plant growth.

Effects from Mineral Development

Mining, both on the surface and underground, eliminates the soil productivity for the area where the soil is removed and the area where the tailings are placed. Normal practices require the stockpiling of the topsoil that would accelerate revegetation and restore some of the soil productivity once the mining has been completed and the topsoil has been replaced. There would be minimum effects from oil and gas development due to the low number of projected wells (one).

Cumulative Effects

Cumulative effects represent the loss in soil productivity that would occur at the completion of the ten-year planning period after full implementation of soil disturbing activities. Cumulative effects include the amount of long and short-term soil disturbance from potential road construction to support timber harvest and recreational facilities, and summer use trails. For analysis, the Forest was divided into three areas: the Kenai Peninsula, Prince William Sound, and the Copper River Delta. The assumptions used to determine the amount of disturbance are the same as used in the direct effects analysis (Tables 3-4, 3-5 and 3-6). Soil disturbance from the construction of camp and cabin sites would be insignificant when compared to the roads and trails, and therefore, it has not been included in the analysis.

Cumulative effects to soil disturbance/soil productivity are displayed in Figures 3-I and 3-2. Generally, the short-term soil disturbance would be equal to or greater than the long-term disturbance. Road construction for timber activities accounts for the smallest amount of soil disturbance under each of the alternatives. Roads that support recreational activities account for the next largest amount of soil disturbance, especially on the Kenai Peninsula. Road construction accounts for the greatest amount of disturbance on the Kenai Peninsula with lesser amounts on the Copper River Delta. None is projected for Prince William Sound. Trail construction would account for the greatest amount of long and short-term disturbance in all three areas, with the greatest effect on the Kenai Peninsula. The soil disturbance that would occur from the potential construction of trails exceeds the total disturbance from the construction of roads in all of the alternatives except in Alternative B, where there would be greater disturbance from roads proposed for recreational development than trails on the Kenai Peninsula. Of all the alternatives, the Preferred Alternative proposes the greatest amount of disturbance from trail construction on the Kenai Peninsula. Even though the cumulative disturbance would exceed two square miles in some cases, it accounts for a very small amount of the entire accessible portion of the Forest.

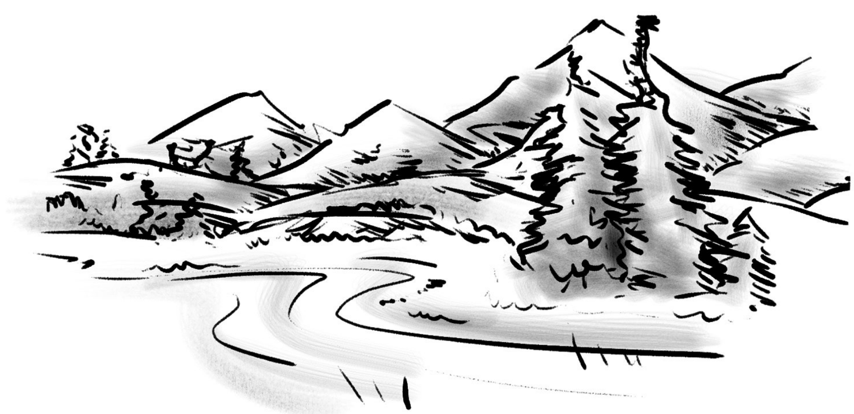


Figure 3-1: Total short-term soil disturbance from recreation and timber roads and trails by geographic area.

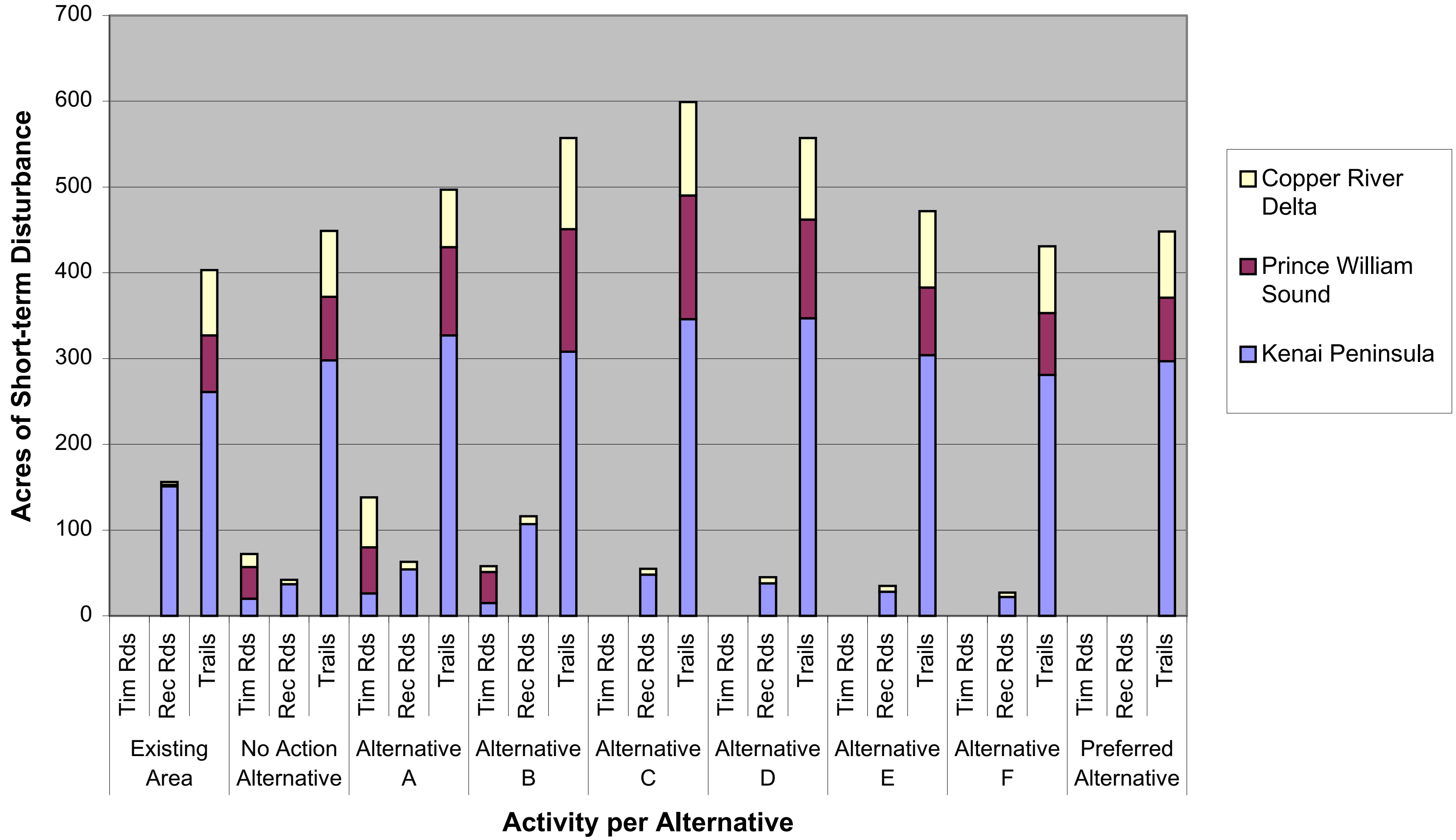
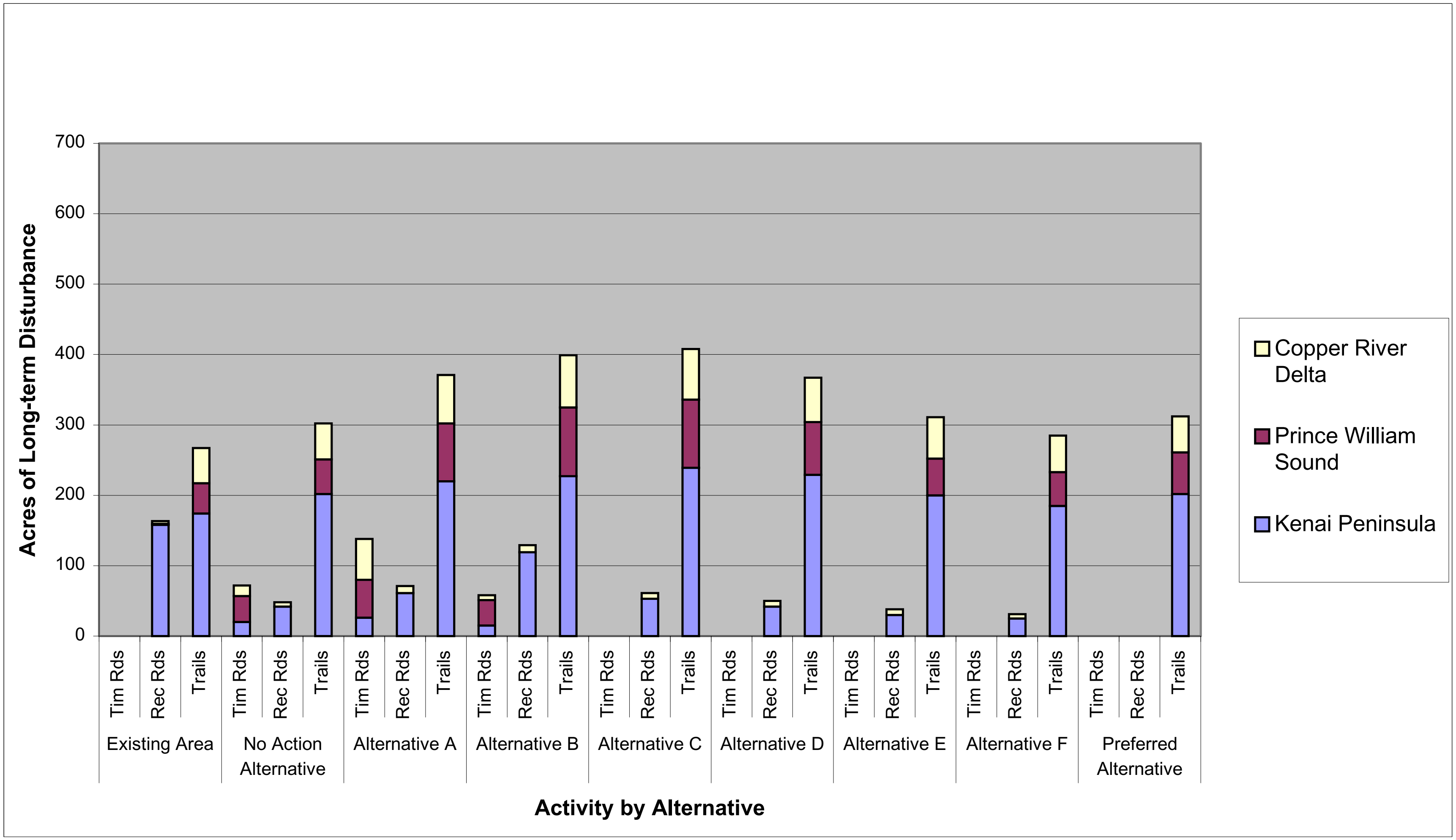


Figure 3-2: Total long-term soil disturbance from recreation and timber roads and trails by geographic area.



Water/Riparian/Wetlands

Introduction

The Chugach National Forest, situated along the Gulf of Alaska's northern coast, has abundant water resources. Frequent storms trending eastward across the North Pacific Ocean encounter the Forest's Chugach Mountains, and drop copious quantities of rain and snow. Glaciers are present over about a third of the Forest, and require heavy precipitation and/or cool year-round temperatures in order to persist. Many thousands of lakes dot the Forest, the largest being Kenai Lake (14,000 acres.) Average annual precipitation for the Forest is around 100 inches, but varies locally from 20 inches to over 300 inches. Snow's contribution to the annual precipitation varies from less than 50 percent in low-lying coastal areas, to 100 percent in the highest mountain regions. Precipitation runoff, within streams, wetlands and forests, is a critical medium for both fish and wildlife species. Use of the waters on the Forest for development and human consumption purposes is limited.

The Chugach is somewhat unique among national forests in that hundreds of its streams flow directly into the Pacific Ocean. Most of these stream systems in near pristine condition. Forest drainages flowing to the ocean vary in size from the 24,000-square-mile Copper River basin and the 2,200-square-mile Kenai River basin, down to tiny first order drainages. For some of these drainages, only a portion lies within the Forest boundary.

The Forest can be divided roughly into three hydrologic units: Cook Inlet, Prince William Sound/Outer Coast, and Copper and Bering River system complexes. In general, the Prince William Sound/Outer Coast unit receives the greatest amount of precipitation and has the highest streamflows per square mile, while the Cook Inlet unit has the lowest amount.

Forest runoff is predominantly high-quality surface water. The exception is runoff from glacial drainages, which carries naturally high sediment loads. Surface and ground water from the Forest is put to use both consumptively (mining, hatcheries, drinking water and other domestic uses) and non-consumptively (fish, visual aesthetics, recreation). Management activities on the Forest that have the potential to affect water timing, quantity and quality and the overall watershed condition include recreation, mining, timber management, road construction, hydropower development, oil, gas, and mineral exploration/ extraction, and intensive developed recreation.

The Forest protects watershed conditions and water quality through the use of Best Management Practices (BMPs) as prescribed in the Alaska Region Soil and Water Conservation Practices handbook (FSH 2509.22). These practices reduce to the extent feasible, nonpoint sources or pollution (silviculture and mining for example). For forestry activities, the Forest Service must meet or exceed the requirements of the Alaska Forest Resources and Practices Act and regulations. Other activities on the Forest, must meet the requirements of the State of Alaska Water Quality Standards and Drinking Water Standards.

Legal and Administrative Framework

- The **Organic Administration Act of 1897 (16 USC 475)** states that one of the purposes for which the national forests were established was to provide for favorable conditions of water flow.
- The **Federal Water Pollution Control Act, (Clean Water Act) as amended**, intends to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Required are: (1) compliance with state and other federal pollution control rules to the same extent of nongovernmental entities, (2) in stream water quality criteria needed to support designated uses, (3) control of nonpoint source water pollution by using conservation or "best management practices," (4) permits to control discharge of pollutants into waters of the United States.
- The **Sustained Yield Forest Management Act of 1944 and the Multiple Use Sustained Yield Act of 1960** allow for the production of multiple quality goods and services at sustained levels over time, including maintenance of water supply.
- The **Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA),** known as the Resource Planning Act (RPA), requires an assessment of present and potential productivity of the land. The act contains many references to suitability and capability of specific land areas, to maintenance of productivity of the land, and the need to protect and, where appropriate, improve the quality of the soil and water resources. The act specifies that substantial and permanent impairment of productivity must be avoided and has far-reaching implications for watershed management (including monitoring, inventories, condition and trends, and support services) on national forests.
- The **National Forest Management Act of 1976 (NFMA)** prevents watershed conditions from being irreversibly damaged and protects streams and wetlands from detrimental impacts. Land productivity must be preserved. Fish habitat must support a minimum number of reproductive individuals and be well distributed to allow interaction between populations.
- The **Safe Drinking Water Act Amendment of 1996** provides the states with more resources and authority to enact the Safe Drinking Water Act of 1977. This amendment directs the states to identify source areas for public water supplies that serve at least 25 people or 15 connections at least 60 days a year.

- The **Corps of Engineers Regulations for Permits for Dredge and Fill Material into Waters of the United States** establishes the guidelines for obtaining permits when activities will affect not only rivers/streams but also wetlands. The **Wetland Delineation Manual (Army Corps of Engineers 1987)** provides the standards for determining areas of wetlands. Land areas are defined as wetlands when soil, hydrology, and vegetation all meet the technical criteria for establishment.
- **Executive Order 11988** directs federal agencies to provide leadership and take action on federal lands to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains. Agencies are required to avoid the direct or indirect support of development on floodplains whenever there are practicable alternatives and evaluate the potential effects of any proposed action on floodplains.
- **Executive Order 11990, as amended,** requires federal agencies exercising statutory authority and leadership over federal lands to avoid to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands. Where practicable, direct or indirect support of new construction in wetlands must be avoided. Federal agencies are required to preserve and enhance the natural and beneficial values of wetlands. Other laws pertinent to watershed management on National Forest System lands can be found in Forest Service Manual 2501.1.

Regulations have been developed in support of laws listed above. The regulations require:

- protection of surface resources and productivity from all natural resource management activities; and,
- limitations of resource use to protect watershed condition.

Other laws pertinent to watershed management on National Forest System lands can be found in Forest Service Manual 2501.1 and Appendix D.

Key Indicators

- Miles of new road and trail construction
- Acres disturbed by roads, trails, timber harvest, fire, campsites and campgrounds, and mineral development
- Number of recreation visits

Resource Protection Measures

Healthy watersheds provide for good water quality and stream channels that maintain a dynamic equilibrium between sediment and water inputs. Natural disturbance processes, such as landslides, fires, flooding, and wind throw, are part of the dynamic equilibrium of each watershed and channel. This dynamic equilibrium can be changed through management activities that alter the balance between sediment and water inputs in a watershed. Where activities occur once (pulse events), a watershed/channel may recover to its dynamic equilibrium. Where management activities occur continuously (pressed events), the watershed/channel may or may not return to its dynamic equilibrium depending on the physical features of the watershed/channel.

Watershed/channel condition will be protected by limiting disturbance in each watershed to levels that safeguard the integrity of stream flow, fluvial systems, and water quality. In addition to limiting the amount of disturbance within a particular watershed, the use of BMPs will be used to protect the integrity of watersheds. Remedial projects will be proposed, planned, and implemented to restore watershed health if watersheds are at risk or near tolerance levels.

Executive Orders 11988 and 11990 require federal agencies to take action to protect riparian and wetlands. Timber sale and other contracts and permits have provisions protecting streams and water quality, such as stream course protection, erosion control, operating season, and temporary roads.

Watershed Improvement Needs
Watershed improvement planning entails watershed condition assessment that identifies the causes of degradation and resource coordination necessary for developing a plan to improve the watershed condition. The Forest is in the process of identifying high priority watersheds for restoration work. Of particular note are historic mining sites, old and "ghost" roads, intensive recreation sites, and past timber operations which impacted streamside zones. Historic mining sites needing restoration include both placer gold sites (usually within streamside zones), and lode mining sites, which are more likely to occur on uplands. Projects will focus on restoring the natural drainage pattern of a watershed to the extent feasible and reducing the connected disturbed areas. Specific projects will be identified during Watershed Condition Assessments and documented in Watershed Restoration Plans. Monitoring will be conducted following project implementation to track the effectiveness of the restoration work.

Affected Environment

Watersheds

The Chugach National Forest is subdivided into 94 watershed associations. These watershed associations range in size from 30 to 240 square miles, and are about the size of 5th level watersheds under the Natural Resources Conservation Service (NRCS) hydrologic unit code (HUC) program. The boundaries for the Chugach National Forest's watershed associations do not meet the national and State of Alaska protocols for 5th level watersheds. The national and state delineation protocols for 5th and 6th level hydrologic units are still in draft form, but are currently being used with national acceptance. The Forest is in the process of mapping and digitizing the 5th and 6th level watersheds, using the national and state protocols. Under these protocols, 5th level watersheds range in size from 40,000 to 100,000 acres, and 6th level watersheds from 10,000 to 40,000 acres. Based on initial mapping, the Chugach National Forest covers approximately 50 fifth level watersheds, and 180 sixth level watersheds. Once digitized and reviewed by NRCS, these 5th and 6th level watersheds will be used in future planning efforts on the Forest.

The existing condition of watersheds (watershed health) on the Forest varies depending upon amount of disturbance found within each watershed and the degree of natural integrity of the system. Disturbance in the form of land management activities, such as timber management, road construction, mining, recreation, and special-uses, can adversely affect a watershed's condition.

Past management activities have been concentrated within certain watershed associations. Most watershed associations on the Forest are virtually untouched by roads or large-scale management activities, and retain pristine watershed characteristics. Management activities have been most concentrated within watershed associations flowing into Cook Inlet. Also, several watershed associations in Prince William Sound have had timber harvest activities, some showing restoration needs. Management activity effects are influenced in part by the local terrain, the precipitation regime, and the potential geohazards.

Surface Water

Approximately 9,600 miles of perennial stream channels flow through the Forest. Most of these channels are home to fish species. The Forest also has 11,285 lakes totaling over 110,000 acres. Surface waters on the Forest originate as runoff from snowmelt, rainfall, and glacial melt, yielding approximately 40 million acre-feet of water per year off Forest lands. Snowfall is generally the greatest contributor to total runoff, while intense rainfall events usually cause the largest floods. The majority of watershed associations on the Forest have some component of glacial drainage. Glaciers on the Forest, though still very much present, have been diminishing in size over the last 100 years, releasing stored water as they melt. As glacial retreat continues, the amount for runoff from glacial melt diminishes.

The major runoff season on the Forest is from May through October, with generally in excess of 80 percent of the annual runoff occurring during these six months. Snowmelt runoff peaks usually occur from late May into June, while streams with a strong glacial component generally show their melt peaks from late June to mid-August. The largest flood peaks generally occur on major rainfall events in the late summer and early fall. Lowest flows generally occur in February through early April.

Surface water quality

Surface waters on the Forest have very limited impacts from human sources of contamination. That is to say, water quality is “good.” The most persistent “impact” to water quality is from stream sediment loading. In most cases, sediment loads are generated by natural sources, primarily glacial runoff, and also materials carried into streams by mass wasting and bank erosion. As glaciers move, they grind and tear at the bedrock below, producing a huge sediment source for streams draining them. On steep mountain slopes, gravity is constantly pulling sediments from the slopes down towards the stream. Management related stream sedimentation also occurs on the Forest, relating to such activities and features as roads, skid trails, mining, and intensive recreation activities in and near streams.

Other water pollutants that can be of concern on Forest streams and lakes include: fecal coliform from human waste, petroleum and other lubricants from roads and heavy equipment operations near creeks, and acid drainage from past hardrock mining operations.

Section 305(b) of the Clean Water Act (CWA) requires states prepare and submit every two years a water quality summary report to the U.S. Environmental Protection Agency (EPA). In addition, CWA Section 303(d) requires states to submit to EPA lists of waterbodies that meet 303(d) listing criteria. This list, produced by the Alaska Department of Environmental Conservation, identifies water quality-limited waterbodies. Water quality impacts can be from point and/or nonpoint sources of pollution, and may require additional controls to meet state water quality standards. These waterbodies are prioritized based on the severity of the pollution and other factors. Currently, no Chugach National Forest waterbodies are designated as impaired on the state’s Section 303(d) list.

The Alaska’s Water Quality Assessment Report is updated every two years. Stream segments may be added or removed from the impairment list as more information becomes available. Analysis for proposed Forest projects will consider the potential effects of management activities on water quality. Measures will be implemented to prevent degradation.

Areas of the Forest have had historic surface and subsurface mining, primarily for gold and to a lesser extent for copper. Gravel and rip-rap is also mined on the Forest, primarily for road construction, and generally from highway and/or railroad accessible sources.

Quality of surface water is affected by the integrity of the fluvial system and aquatic habitat. The integrity of fluvial systems on the Forest is exceptionally good. Some concerns exist for watersheds where mining, timber management, and/or riparian recreation have affected stream channel potential, including riparian condition and streambank stability. These effects are in limited locations, and changes in management could improve existing conditions.

Surface water uses

Surface water from the Forest is used both consumptively and nonconsumptively. Uses in both categories depend on high quality water.

Nonconsumptive water uses include recreation, wildlife, fisheries, and the aesthetic quality of this resource. Value on the Forest is high for these uses. Much of the recreation use on the Forest revolves around waterbodies and glaciers, including sightseeing, camping, fishing, and boating. Most campgrounds on the Forest are located near lakes and streams.

Consumptive water uses include hydropower generation, fish hatcheries, mining operations, drinking water, highway construction, dust abatement, and special use permits. Consumptive uses are presently only a very small percentage of the total outflow from the Forest. The City of Cordova has three municipal watersheds it uses for water supply. Portions of two of these watersheds, Heney Creek and Murcheson Falls Creek, lie on national forest lands. These have been selected by the State of Alaska, and are likely to be conveyed in the future. No other municipal watersheds are located on the Forest, although several communities use wells that are recharged by surface water off national forest lands. Most notable is the City of Seward, which uses high production wells recharged by the Resurrection River. The City of Whittier also uses a municipal well that is recharged by Whittier Creek, which originates on the Forest. Alyeska Ski Area, although located entirely off the Forest, uses water from Glacier Creek for snow making in the winter. The Glacier Creek watershed originates on National Forest System lands.

Four hydroelectric power projects draw water from watersheds lying in part on Forest lands. These include the Cooper Lake Project near Cooper Landing, and Humpback Creek and Power Creek near Cordova, and Solomon Gulch near Valdez. The Cooper Lake Project stores inflow to Cooper Lake and diverts it out of the watershed down to Kenai Lake for power production. The two Cordova projects are basically “run of the river” with minimal storage and no water diversion from the watersheds. The Power Creek Project is under construction and slated for power production in 2002. Solomon Gulch has only a small portion of its upper watershed on Chugach National Forest lands. Several additional sites on or adjacent to the Forest are currently being considered for hydropower development.

Five fish hatcheries are located on or near the Forest, and draw water wholly or in part from Forest watersheds. The Main Bay and Cannery Creek hatcheries use watersheds entirely on Forest lands. The Esther Creek watershed that lies primarily on Forest lands feeds Esther hatchery. The San Juan Bay hatchery has a small portion of its watershed (about 40 acres) on Forest lands, while the Trail Lakes hatchery uses wells that are recharged by Moose Creek, portions of which lie on Forest lands.

Surface water protection measures

Public water supplies are protected by the Safe Drinking Water Act (SDWA), which was amended in 1996. The SDWA does not require source areas to deliver water of potable quality with no need for treatment. In fact, waters in pristine areas usually need treatment due to natural waterborne parasites, such as giardia. The Forest Service will work with the State of Alaska to identify public supply watersheds and sources of contamination.

The Alaska Region's Soil and Water Conservation Handbook (FSH 2509.22) contains 75 Best Management Practices (BMPs) to protect water quality in compliance with the Clean Water Act. BMPs in the Handbook cover a wide variety of land management actions on National Forest System lands, including watershed management, timber, transportation and facilities, pesticide-use, recreation, minerals, fish and wildlife habitat, and fire suppression and fuels management.

When BMPs are properly applied, pollutant delivery to streams and lakes is minimal and recovery of waters and aquatic sites should be rapid. The physical, chemical, and biological integrity of waters in all watersheds should be as good as in watersheds that are managed exclusively for domestic and municipal supplies.

Water developments which are used off-Forest but have some facilities located on National Forest System lands are administered with special use authorizations. They involve water storage, transmission, or diversion facilities. Stipulations may be added to the authorizing document, which ensures the quantity of water needed to fulfill the purposes of the Chugach National Forest and for environmental instream needs is identified. As special use permits are amended, renewed, or issued, the Forest will analyze environmental effects and ascertain if mitigation or new terms and conditions are required to meet the standards and guidelines of the Revised Forest Plan. The Forest Service has statutory responsibility for all existing permits, rights-of-way, and grants of easement located on National Forest System lands, including their administration, amendment, and renewal, when authorized and appropriate.

Groundwater

Rainfall and snowmelt, as well as producing surface runoff, also recharge groundwater sources on the Forest. Groundwater aquifers release water during periods of low precipitation to maintain base flows of streams. Groundwater seeps and springs are in some cases vitally important in providing habitat for over-wintering salmon eggs and fry. Groundwater is of beneficial use both on and off-Forest, in the form of water supply wells. Communities of Seward and Whittier use groundwater for part or all of their municipal water supply, while Cooper Landing and Moose Pass residents use individual domestic wells.

Consumptive use of groundwater on the Forest is low. Such use is limited to special-use permittees and Forest Service campgrounds and administrative sites with domestic wells. The existing condition of groundwater on the Forest is good, although not all wells provide high quality drinking water. Past management activities on the Forest do not appear to have adversely affected groundwater quality, however, elevated levels of trace and heavy metals have been sampled in several old hard rock mine adits. Activities such as oil/gas/coal exploration and leasing on the Forest have been very limited. Other potential adverse effects from wastewater treatment and other equipment spills have been limited. No groundwater contamination from recreation uses (toilets) has been recorded, with all road-accessible toilets being of the pump-vault type. Some potential for such ground water contamination exists at heavily used recreation sites with limited facilities, like the lower Russian River.

Riparian Areas

Riparian areas are the transition zone between uplands and water in lakes and rivers. Riparian ecosystems are characterized by the presence of trees, shrubs, or herbaceous vegetation that require free or unbound water, or conditions that are moister than those of surrounding areas. Riparian ecosystems, aquatic ecosystems, wetlands, lakeside zones, and floodplains will be jointly referred to as riparian areas. The terms riparian zones and riparian areas are used interchangeably, but by strict ecological definition, may not be the same in all instances.

Vegetated lands on the Forest are often lacking in sharp distinction as to where riparian ecosystems start and end. Riparian ecosystems are most easily delineated in regions with limited water availability. However, water (precipitation) is generally very abundant on the Forest. Annual precipitation exceeds losses to transpiration and evaporation on all areas of the Forest, often by very large percentages. Moisture availability is infrequently a limiting factor except on well-drained sites.

Traditionally, stream and lakeside zones are the areas most likely to be mapped as riparian. On the Chugach, sharp changes in vegetation are many times lacking in cross sections of the streamside zone. When vegetation distinctions are apparent, they are often more related to flood disturbance than to moisture availability. To date, riparian areas on the Forest have not been mapped or specifically defined. The Forest Service planning regulations require that consideration be given to the land and vegetation for approximately 100 feet from the edges of perennial streams, lakes, and other bodies of water. This requirement is intended to protect stream water quality (primarily sedimentation) from adverse effects of timber harvest.

High water availability on the Forest also results in a great abundance and variety of wetlands. Wetlands are defined in the 1987 Corps of Engineers Wetlands Delineation Manual (USDD Army Corps of Engineers 1989) as:

> “Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.”

Riparian ecosystems are generally inclusive of wetlands. Healthy riparian areas, with an abundance of trees and other vegetation, slow flood waters and reduce the likelihood of downstream flooding. Riparian areas improve water quality by filtering runoff and sediment from flood flows and adjacent upland slopes. Healthy riparian areas act like a sponge, absorbing water readily during periods of excess. Water slowed by riparian areas enters the groundwater. Some of it is released later, increasing late summer and fall streamflow. Riparian areas produce an abundance of stream cover and shade, which in turn limit the amount water temperature fluctuation on the stream. This limiting in water temperature is generally advantageous to cold-water fish species.

Benefits provided by riparian areas include food, cover, and nesting habitat for birds. Many animals visit and live in riparian areas. They come for water, food, cover, and temperature moderation. Riparian areas often provide sheltered upstream and downstream transportation corridors to other habitats. Fish depend upon healthy riparian areas to provide stable channels, sustained water supply, clean and cool water, food, and streambank cover. Riparian areas are attractive and inviting to Forest visitors. People often seek water and riparian environments for recreation activities.

Management of riparian areas is considered in the context of the environment in which they are located, while recognizing their special values. Preferential consideration is given to riparian-dependent resources when conflicts among land-use activities occur. Riparian-dependent resources include fisheries, stream channel stability, water quality, and wildlife.

Wetland inventory

The U.S. Fish and Wildlife Service (USF&WS) has completed wetlands mapping for some of the State of Alaska, and all of the Chugach National Forest at a scale of 1:63,360. Original mapping was done from aerial photography with some ground-truthing. The wetlands were delineated and classified on the photographs using the USF&WS's hierarchical wetlands classification system. Wetland polygons from the photos were transferred to U.S. Geological Service (USGS) quad sheets, and subsequently digitized into a Geographic Information System (GIS) corporate database. The USF&WS's mapping designates approximately 1.28 million acres of the Forest as wetland. The acreage values displayed are undoubted lower than actual, since wetlands smaller than one acre were not generally mapped, and forested wetland areas were often not detected on the photography. Actual wetland acreages on the Forest may be higher by as much as 10-15 percent.

Table 3-7 gives a breakdown of the mapped wetlands on the Forest by system type. Estuarine wetlands are generally those in the intertidal zone that have a brackish (part salt water, part fresh water) component. Riverine wetlands include wetlands found within fresh water river channels. Lacustrine wetlands are defined as those wetlands and deepwater habitats within lakes deeper than about 6.5 feet, and larger than 20 acres in size. Palustrine wetlands are generally upland marshes, bogs, muskegs, and fens, and forested wetlands.

Not displayed on this table are 2,219,497 acres of subtidal and deepwater estuarine and marine wetlands. The Forest Service does not generally manage these wetlands.

Table 3-7: Wetland acres. [1]

Wetland System	Acreage
Marine	20,715
Estuarine	258,259
Riverine	158,404
Lacustrine	94,447
Palustrine	750,645
Total	**1,282,470**

[1] The National Wetlands Inventory includes deep water and the fiords of Prince William Sound, which is not normally included in land managed by the Chugach National Forest.

Environmental Consequences

General Effects

Management impacts on surface water

Timber harvest and other vegetation management can and does increase water yield in many locations in the western United States. On the Chugach, increased water yields from vegetation management are slight due to low evapo-transpiration rates, high percentages of most watersheds lying within alpine areas, higher precipitation loading in alpine areas, and rapid resurgence of water-using understory vegetation when the forest canopy is removed. Water yield increases from road runoff, timber harvest, wildland fires, prescribed fires, and bark beetle infestations are generally too small to be detected through routine stream monitoring. Most Forest streams have very limited water appropriations, and all flow directly to the Pacific Ocean. Increases in runoff from vegetation manipulation are generally not in demand by downstream water users.

Soil and water improvements are accomplished on an annual basis to correct problems caused by previous land management. Corrective measures include, but are not limited to, closing, obliterating, and revegetating roads; redesigning drainage structures on existing roads to reduce soil loss and stream sedimentation; stabilizing damaged streambank segments using vegetation and/or structural support; and improving the vegetative condition of streamside riparian zones. Alternative A would average about 50 acres of watershed improvement projects a year. The No Action Alternative, and Alternatives B and C would average about 40. The Preferred Alternative and Alternative D averages 30 acres per year, and Alternatives E and F, 20 acres.

Management impacts to riparian areas

Previous management activities have impacted riparian areas throughout the Forest. Water diversion projects for hydropower development have affected the amount and the timing of flows in a stream channel, which can change the natural riparian community. Historic placer mining has in some cases dramatically impacted riparian vegetation and channel form. Access roads and intensive recreation pressure from fishing, camping, and boating have also had damaging impacts to localized riparian areas.

Recreation facilities have traditionally been developed adjacent to lakes and streams. Recreation use can result in localized impacts to riparian vegetation. Riparian vegetation usually becomes adversely impacted by a combination of trampling and soil compaction, reducing the viability and rooting capacity of these riparian plants. Destruction of this riparian vegetation can reduce streambank stability and increase streambank erosion.

Logging and its related activities can also affect the extent, health and vigor of riparian vegetation. Timber sales on the Kenai Peninsula over the last two decades have generally avoided timber harvest within riparian zones. Older timber sales in Prince William Sound (1960s and 1970s) sometimes harvested timber right up the edge of local anadromous streams. Road and trail construction adjacent to streams can physically remove the riparian vegetation, especially if roads and trails cross or run parallel to stream channels.

Placer mining on the Forest is generally located within riparian areas. Placer mining activity can involve removing the riparian vegetation, and processing the gravel substrates found within these riparian areas. Past placer mining practices on the Forest have led to introduction of heavy sediment loads into the stream channels, and, in some cases, alteration of the stream channel and flood plain system. Streams on the Forest particularly affected by past placer mining activities include Resurrection Creek and its tributary Palmer Creek, Bear Creek, Sixmile Creek, Mills, Juneau and Canyon Creeks, Cooper Creek, Bertha Creek, Lynx Creek, Silvertip Creek, Gulch Creek, Quartz Creek, and Falls Creek (near Crown Point).

Oil and gas development has the potential to adversely affect water quality and overall stream health by adding sediment an/or toxic substances from road and drill pad construction and drilling activities. Potential exists for spills of drilling fluids and oil and gas products entering surface and ground waters. Oil and gas operations are prohibited in areas subject to mass soil movement, riparian areas, and wetlands. Based on this, the effects of oil and gas operations on riparian areas would be mitigated for all alternatives.

The health and vigor of Forest riparian vegetation is generally good. The spruce bark beetle infestation on the western portion of the Forest is currently reducing streamside spruce cover, especially in mature, primarily Lutz and white spruce stands. In the short-term this is increasing the large woody debris supply on sections of some streams, and in the long-term, the supply may be diminish below normal.

Direct and Indirect Effects

Surface water, groundwater, riparian, and wetlands areas are interconnected and inter-related. In this section, they are dealt with together unless specifically noted. Potential adverse effects to watersheds, riparian and wetlands are directly tied to activities that impact and disrupt these areas. Impacting activities include disruptions to soils and vegetation, particularly when occurring close to stream channels, and disruption of surface and/or subsurface water flow.

Table 3-8, displays those activities that would affect water resources by alternative.

Table 3-8: Potential disturbances affecting water resources.

Activity	Alternative							
	No Action	Preferred	A	B	C	D	E	F
Total recreation visits – millions of visits/year	10.15	10.15	10.15	10.15	10.15	10.15	10.15	10.15
Road construction – miles/year	6.7	3.3	11.4	10.0	2.9	2.2	1.6	1.3
Road construction – acres/year	11.8	6.2	20.0	16.7	5.4	4.2	3.0	2.5
Trail construction – miles/year	7.8	21.7	20.9	23.2	27.8	22.2	10.6	4
Trail construction – acres/year	3.7	10.4	10.0	11.1	13.3	10.7	5.1	1.9
Commercial timber harvest – acres/year	296	0	617	234	0	0	0	0
Firewood/hazard tree harvest – acres/year	625	375	913	770	426	355	260	235
Burned - acres/year	2,743	2,708	2,777	2,745	2,711	2,016	1,363	1,371
Campsites and cabins – acres/year	0.4	0.6	0.6	0.7	0.7	0.6	0.3	0.3
Mineral development – acres /year	20	20	20	20	20	20	20	20

Effects from Road Construction

As shown in Table 3-8, road construction (timber, recreation, and other roads) ranges from 1.3 miles per year under Alternative F to 11.4 miles under Alternative A. This would affect from 2.5 acres/year for Alternative F to 20 acres/year for Alternative A.

Potential adverse effects to water resources as a result of road construction and reconstruction are not exclusively dependent on miles or acres. Proper location, design, construction, and maintenance of the roads can have an immense effect on reducing water quality impacts. To reduce these impacts BMPs will be used in all phases of road development and use. Only the acres of watershed disturbance due to roads can by analyzed. Alternatives A and B have the highest risk of adverse effects. Alternative A proposes more new miles of roads/year than Alternative B, but also proposes obliterating more miles of road/year, so that watershed risk factors for the two alternatives are quite similar. The No Action Alternative proposes just over half the new roads as Alternatives A and B. In descending order the Preferred Alternative, then Alternatives C, D, E, and F all have substantially less proposed road miles, and would have lower watershed risks.

Roads potentially could have an impact to the riparian/wetlands areas. Location of the road within the riparian zone is the primary concern. Inappropriate width filter strips or improper drainage between the road and stream can produce additional sediment loading. Sidecast construction, poor quality surface aggregate or improper road maintenance can result in damage to riparian vegetation as well as increasing stream sediment loads.

Effects from Trail Construction

As shown in Table 3.8, trail construction varies from 4.0 miles per year under Alternative F to 27.8 miles per year under Alternative C. This would affect from 2.4 acres/year for Alternative F to 10 acres/year for Alternative C. Proper location, design, construction, and maintenance of the trails can have an immense effect on reducing water quality impacts. BMPs will be used in all phases of trail construction and maintenance. Trails potentially could have an impact to the riparian/wetlands areas. Location of trails within the riparian zone should be avoided where possible. Appropriate width filter strips and proper drainage can reduce sediment loading.

Effects from Timber Harvest

Variations in timber harvest by alternative are displayed in Table 3.8. Timber harvest includes both commercial harvest and firewood/hazard tree harvest. Timber harvest level ranges from 235 acres to 1,530 acres per year.

All alternatives would allow harvest of some acreage for firewood and hazard tree removal. Only Alternatives A, B and the No Action Alternative include scheduled commercial timber harvest. These three alternatives all propose commercial timber harvest in just four watershed associations (of 95 on the Forest), Snow River (Kenai Peninsula), Montague Outside (Prince William Sound), McKinley Lake (Copper River Delta), and Martin River Northwest (Copper River Delta). Harvest techniques and timber sale locations would not vary significantly among alternatives.

Because of similarities of how and where commercial timber sales would be located in Alternatives A, B, and No Action, acres of harvest and miles of roads become an effective tool for comparing watershed impacts among alternatives. Alternative A would allow nearly twice the acreage of commercial timber harvest and miles of road as does the next closest alternative, the No Action Alternative. Alternative B would have just over a third of the acres of commercial harvest and miles of timber roads as Alternative A.

Firewood/hazard tree sales are all proposed within a mile of existing road systems and would generally treat any given acre lightly, that is, most of the timber would be left standing. Watershed impacts would relate primarily to water concentration/erosion along skid trails. Watershed impacts from firewood sales would be substantially less than for commercial timber sales on an acre-to-acre basis. Acres of firewood/hazard tree sales can be used qualitatively to compare effects among alternatives. Alternative A would have the largest effect. Alternative B has about 85 percent of this acreage and effect; the No Action Alternative about 70 percent; Alternative C, 45 percent; the Preferred Alternative and Alternative D, 40 percent; Alternative E, 30 percent; and Alternative F, 25 percent.

Overall for personal and commercial timber harvest, Alternative A would be expected to have the most substantial impacts to water resources. Alternatives B and No Action would come next and be similar to one another; about half of Alternative A. Alternative C, the Preferred Alternative, and Alternatives D, E, and F would have successively less impacts, and a relatively small fraction of Alternative A.

Primary watershed impacts from Forest timber sales generally come from the diversion and concentration of natural runoff along roads, landings, and skid routes. Diversion and concentration of runoff can, in some instances, lead to soil erosion, and sediment supply to nearby streams, which can in turn adversely impact stream habitats. On steeper slopes, water diversion can occasionally supersaturate soils and cause slope failures, resulting in loss of long-term soil productivity through altered wetness, and large transported sediment loads.

Using acres of timber harvest to compare alternatives helps give a feel for the effects to water resources. Forest Plan alternatives indicate acres of harvest by watershed association, but are not specific about location of harvest units or roads. Actual location of the sale units, and the roads and skid trails within them, as well as the timing of the harvesting, are more useful in predicting actual impacts to water. To reduce impacts, road and sale location and timing can be controlled substantially using BMPs during sale planning and implementation.

Some timber sales around the United States have shown increased water yields and compacted soils as watershed effects of the harvest. Increased water yields from timber harvest on the Chugach are generally negligible due to low evapo-transpiration rates, vigorous understory vegetation, and the high percentage of most watersheds above timberline. Soil compaction on the Chugach mostly occurs along major skid routes, and appears not to impact regrowth, but can on occasion intensify drainage diversion and erosion rates along the route.

Effects from Fires

The Forest averages about 15 wildland fires per year. This would continue under all alternatives. The wildland fires are mostly on the Kenai Peninsula portion of the Forest where precipitation is moderate. Other parts of the Forest generally have high enough precipitation levels as to make any burning quite rare.

Prescribed burning is used to reduce fuel hazards, dispose of timber slash, and improve wildlife habitat. The No Action Alternative, the Preferred Alternative, and Alternatives A, B, C, and the No Action Alternative all propose burning a similar number of acres and should have similar watershed effects. Alternatives E and F propose burning about half the amount as the others, and Alternative D, about three quarters as much. Most prescribed burning would be done on the Kenai Peninsula. Prescribed fires on the Forest generally burn at lower temperatures and have less damaging watershed effects than wildland fires. Prescribed burns would reduce the risk for occurrence of very hot wildland fires in the future. In this sense, prescribed fires actually work to reduce watershed damage risks to the Forest over the long term.

In certain instances, fires, particularly very hot wildland fires, could affect water quality, primarily through increased sedimentation. The effects of this sediment in the drainage system will be dependent upon the composition of channel types (see Aquatic Ecosystems and Essential Fish Habitat section in this chapter) within the watershed. Watersheds with high gradient channels will tend to flush the sediment out whereas watersheds with a high percentage of low gradient channels will retain the sediment longer. Channels generally will see a reduction in sediment within the first three years.

Hot fires can eliminate the erosion protection afforded by vegetation and soil organics. This can cause increases in erosion and sediment transport caused by rainfall and sheet erosion. In some instances a hydrophobic soils layer is created that can greatly increase erosion and erosion effects. Fires on the Chugach National Forest generally do not burn at hot, soil damaging temperatures. Even the largest wildland fires are generally patchy in character, leave some organic soil, and do not create hydrophobic soils. Natural regrowth of forbs and other understory vegetation generally occurs rapidly, often with good coverage in place the following year. No severe erosion effects from either wildland fires or prescribed burns have been recorded on the Forest over the last 30 years.

Effects from Recreation Management

Many camping sites, both dispersed and developed, are near lakes, reservoirs, wetlands, and streams. Although these are desirable locations, repeated use can reduce the health and vigor of riparian vegetation and compact soils, both of which can reduce the riparian vegetation's ability to maintain streambank stability and increase sedimentation. Soil compaction is caused by the weight of vehicles, animals, and people on the ground. Soil compaction impairs infiltration and plant growth. It is generally more severe on moist or clay-rich soils and with more traffic.

Disturbing soil and concentrating runoff can cause erosion and sedimentation. Excess sediment impairs aquatic habitat. Stream sedimentation is usually more severe when disturbances occur near streams or on unstable or highly erodible soils.

The use of riparian areas by developed and especially dispersed recreation has a potential for impacts. Popular riparian areas receive intensive use for camping, fishing and hiking. Impacts may range from vegetation reduction, soil compaction and streambank trampling from overuse. Specific problems are identified and managed during project level analyses. Solutions may range from closing the area to revegetation or hardening of the site. Stream bank damage is caused by foot and wheeled traffic. Overhanging banks can be crushed and large amounts of sediment added directly to streams, with resulting damage to aquatic habitat. Bank damage is more severe where animals and people concentrate along streams.

Wetland-riparian damage occurs mostly as ruts and puddles caused by foot and wheeled traffic. Surface and subsurface drainage is changed and plant growth may be impaired.

In general, these effects are low except at points of concentrated use. Specific problems are identified and managed at project level analysis. Proper management, use of BMPs and standards and guidelines will reduce potential impacts to the water resource.

Projected recreation visits do not vary by alternative.

Effects from Snowmobiles

Adverse effects from snowmobiles are generally limited to areas of concentrated use such as on unplowed roads near access areas. When conditions are right, compacted snow can remain on roads and act as a barrier to spring runoff, which can cause erosion. Snowmobiles can also cause vegetative damage, soil compaction, and damage to wetlands when they are operated in thin snowpacks. The degree of potential erosion is dependent on site-specific factors such as slope, aspect, elevation, adjacent vegetation, level of use, and weather conditions.

Discharge from two-stroke snowmobile engines can lead to indirect pollutant deposition into the top layer of snow and subsequently into the associated surface and ground water (Adams 1975). Hagemann and Van Mouweik (1999) found that there is a potential risk to aquatic life from snowmobile emissions but that the risk could not be quantified because of a current lack of water quality data. Adams (1975) showed that high concentrations of lead and hydrocarbons were found in pond water adjacent to snowmobile trails during the weeks following ice melt. The study also found that juvenile brook trout had increased hydrocarbon intake and reduced stamina, from surface water and food chain feeding and hydrocarbon uptake.

Some of the unburned hydrocarbons would accumulate on the snow surface and eventually wash into streams and lakes. This could cause localized degradation of the high water quality of the waters of the Chugach National Forest. Concentrated snowmobile use areas, primarily around Turnagain Pass where the potential impact to water quality exists. Turnagain Pass has the highest use concentrations on the Forest (Skustad 2001). Maximum use counts indicated a peak of 100 vehicles per day associated with snowmobile users. Generally, use was less than 50 vehicles on weekend days. Weekday numbers averaged around 10. The area around Upper Granite Creek would be the area most prone to accumulations of hydrocarbons. The aquatic ecological communities do not appear threatened by these concentrations, and this diminishment to water quality would be below the federal standards for pollution, but additional monitoring is needed to establish that standards are not being exceeded.

Effects from Dams and Water Diversions

Dams and water diversions can change channel dimensions, alter aquatic and riparian habitat, and obstruct fish migration in streams. When they occur, these impacts can be both local (directly below the reservoir or diversion) and far reaching. Such projects can cause downstream dewatering with adverse effects to aquatic species. Future permits and licenses are required to be consistent with the Forest Plan. As permits are amended, renewed, or issued, the Forest will analyze environmental effects and ascertain if additional mitigation or new terms and conditions are required for the permit to meet the Revised Forest Plan standards and guidelines.

Beneficial use of water in the form of water diversions from existing streams would not vary by alternative. Potential adverse effects of future uses would increase with each water rights application. These effects are common to all alternatives.

Effects from Mining Operations

Current mining occurring on the Forest is limited primarily to small-scale placer mining operations for gold, and a few gravel pits and rock quarries. The placer gold operations mostly use small suction dredges that work instream to separate gold from stream gravels. These operations can cause some alteration of substrates within the stream channel. Gold operations working outside stream channels are required to use settling ponds for process waters, and to rehabilitate and revegetate mined areas on completion of mining. Historic placer operations on the Forest have caused large-scale disturbance of several streams and their associated floodplains. Disturbance and stream sedimentation effects of current operations are small in comparison. The Forest Service currently requires use of minerals BMPs for mining operations on the Forest. Gravel and rock extraction operations will use BMPs and are generally situated away from streams and riparian areas so as to have minimal effects on water quality or aquatic habitats. Several past gravel operations have in fact been used in creating ponds for fisheries enhancement.

Numbers of mining operations do not vary by alternatives, and basically the same level of mining would be expected under all alternatives.

Cumulative Effects

Potential cumulative effects on water resources resulting from past, current, and future management are based on the total amount of disturbance. Past management activities have been concentrated within certain watersheds. These are the watersheds where most activities under any of the alternative would continue. Most watershed associations on the Forest are virtually untouched by roads or large-scale management activities, and retain pristine watershed characteristics (see Affected Environment, this section). Reductions in connected disturbed area resulting from soil and water improvements could reduce the potential for adverse cumulative effects.

With increases in recreation users Forestwide, potential impacts to streams, riparian vegetation and overall watershed potential could increase. Riparian settings receive protection under all alternatives through the application of the Forestwide standards and guidelines and BMPs. The possibility for damage to the riparian system is greater in those alternatives with more activities such as road building. Nevertheless, identification and protection of riparian areas during project planning and monitoring prevent widespread or long-term deterioration of riparian resources.

Potential cumulative effects as a result of water put to beneficial use through diversions of surface water would depend on future water rights applicants. Substantial diversions from Forest streams at this time occur for two hydroelectric power projects and several fish hatcheries. Some adverse impacts to native aquatic species and their habitat have occurred at these sites, and additional diversions would generally increase these effects.

Of the alternatives analyzed, implementation of Alternative A has the highest risk of adverse cumulative effects to the water resource. Alternative B, the No Action Alternative, Alternative C, the Preferred Alternative, and Alternatives D, E and F each follow with successively less impacts. The use of Forestwide standards and guidelines and BMPs will reduce the potential for adverse cumulative effects.

A consumptive water use that has not been tested on the Forest but may be of interest in the future is the ocean transport of domestic (drinking) water to cities on the Pacific Rim. Several companies have tested transporting water in ocean-going tankers or even towing in large barges. As good quality drinking water becomes more difficult and expensive to obtain locally in some coastal cities, Alaska's abundant coastal waters may become of increasing interest. Undertaking large-scale marine transport of Forest water in the next 10 to 15 years appears unlikely, but is worthy of note and consideration. Depending on where water was taken from, and how much, water withdrawals could adversely impact some aquatic species.