North Thorne Project Area Watershed Restoration Plan

Upstream view from North Fork of the Thorne River Bridge, 3016000 road. The West Fork subwatershed verves off to the left of the picture and the East Fork subwatershed verves off to right of the picture.

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Executive Summary

The North Thorne Project Area is a set of highly valued and ecologically diverse watersheds located in the central eastern portion of Prince of Wales Island, Southeast Alaska. It is around 7 miles northwest of the community of Thorne Bay, and is 35,750 acres in size (55.7 mi^2). The Project Area includes four watersheds and includes sub watersheds. Streams within these watersheds flow into the mainstem Thorne River, which flows in an easterly direction into Clarence Strait.

All of these watersheds have had past timber harvest and road construction, which began in the 1960's. Today the Project Area is used for recreation, subsistence, timber harvest, and other resource management. The richness and diversity of resources in the North Thorne cause differing management objectives for the Project Area. This assessment reports the existing condition of the watershed resources and restoration opportunities. These opportunities are aimed at maintaining the ecological integrity and restoring the form and function of the North Thorne Project Area.

This was the first hard look at a Project Area for restoration opportunities on the Thorne Bay Ranger District, thus a rapid assessment approach was utilized to identify potential projects. Only 1 summer was allowed for field work. Special areas of concern within the Project Area were identified in consultation with Jim Beard, Fish Biologist and Steve Paustian, Tongass Forest Hydrologist, and reviewed by Ron Medel, Tongass Forest Fish Biologist, and Ann Puffer, Alaska Regional Hydrologist.

Information used in this Watershed Restoration Plan (WRP) is a product of GIS data, field surveys and information, reports, publications, and personal communication. Analysis and maps were developed using GIS, with coverages updated as of June 2008.

The underlying geology, and a maritime climate that includes relatively high precipitation and wind storms, influences landscape processes within the North Thorne Project Area. There are two ecological subsections in the Project Area, Central Prince of Wales Volcanics which dominates the area, and a smaller portion of Central Prince of Wales Till Lowlands (Nowacki et al. 2001). Broad U-shaped valleys are found in the Volcanics subsection, and shallow lakes and ponds are found in the Till Lowlands subsection. Both subsections have hemlock and hemlock-spruce forests on well-drained sites, and mixed conifers and lodgepole pine forest in wetter areas. Elevation ranges from 100 feet above sealevel at the confluence with the Thorne River, to 2,000-3,000 feet at the upper ridges of the watersheds.

Land Use Designations (LUD's) are defined areas of land to which specific management direction is applied (USFS 2008). LUD's within the Project Area include Timber Production, Modified Landscape, Scenic Viewshed, Scenic River, Recreational River, and Old Growth. Most of these LUD's allow timber harvest. Old Growth makes up a small portion (< 20%) of the Project Area and is unsuitable for timber harvest.

Key problems identified in the Project Area include:

- Fish passage problems at road crossings due to improper placement (vertical location, gradient) or size of culverts.
- Stream degradation (increased sediment loads, streambank stability, loss of fish spawning & rearing habitat, stream channel complexity) due to lack of inchannel large woody debris (LWD) and past timber harvest of riparian areas.
- Alteration of riparian vegetation due to past timber harvest of riparian areas.
- Sediment entering streams from roads due to road failures and erosion.
- Sediment entering streams due to mass wasting (landslides) caused by past timber harvest and road location.
- Loss of hydrologic connectivity and hillslope drainage problems due to roads.

Recent restoration efforts in the Project Area has included wildlife thinning, riparian thinning, proper road storage (including culvert removal and waterbar placement), landslide seeding, and fish passage remediation.

Watershed Characteristics and Conditions

The North Thorne Project Area is located in the central eastern portion of Prince of Wales Island, Southeast Alaska (Figure 1). It is around 7 miles northwest of the community of Thorne Bay, and is 35,750 acres in size (55.7 mi^2). The Project Area is bounded on the north by Manty Mountain and Ratz Peak; on the south by the Thorne River; on the west by the Thorne River and Thorne Lakes area; and on the east by the Sal Creek and Slide Creek drainages. Furthermore, location of the Project Area is found on United States Geological Survey (USGS) Quadrangle Maps, Copper River Meridan; the northwest corner of Craig C-2, the northeast corner of Craig C-3, the southwest corner of Craig D-2, and the southeast corner of Craig D-3.

There is no non-Forest Service land within the Project Area. All land within the Project Area is part of the Tongass National Forest. Project Area watersheds flow into the mainstem Thorne River, which flows in an easterly direction into Clarence Strait.

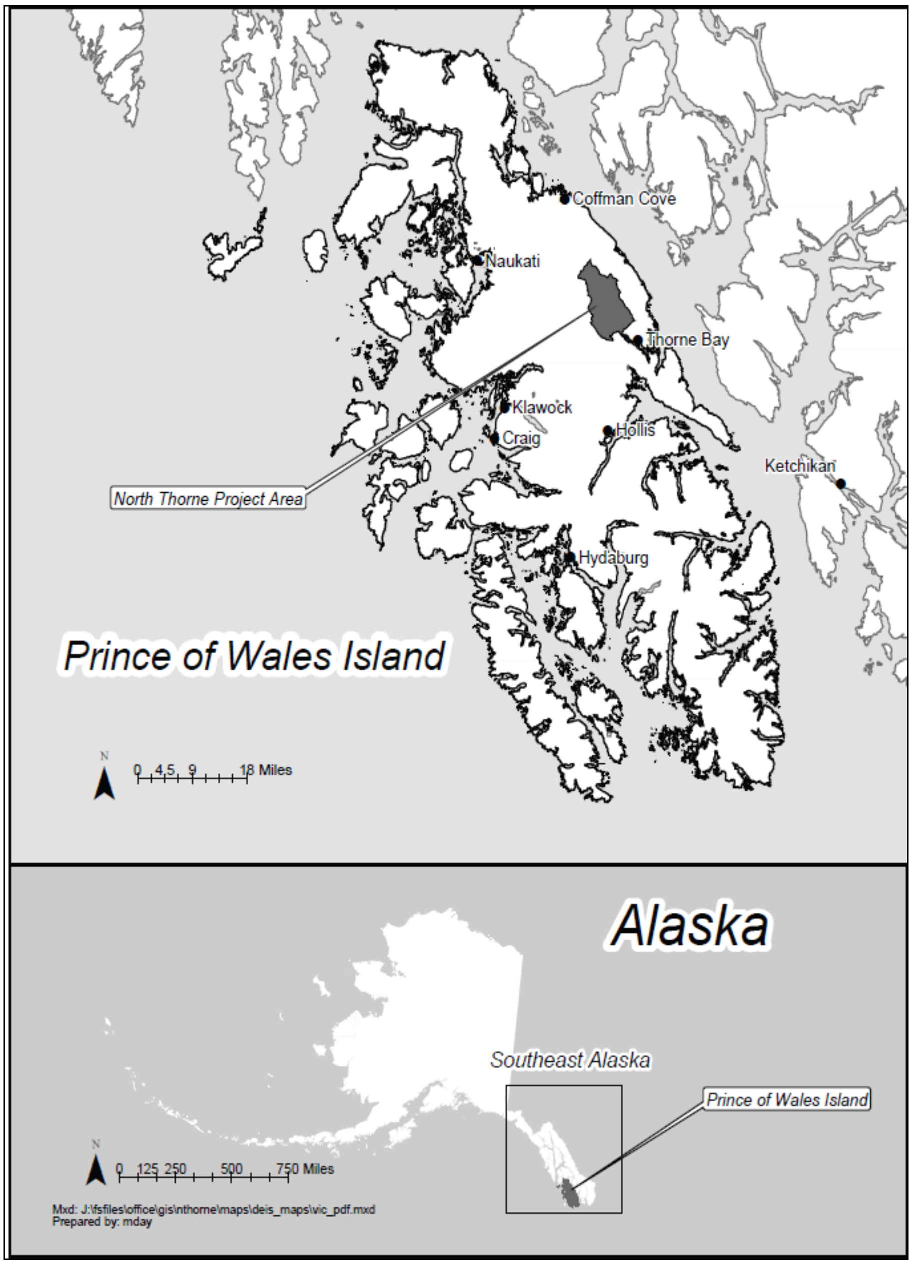

Figure 1. Location of North Thorne Project Area on Prince of Wales Island

The Desired Future Condition for the North Thorne Project Area should be to have healthy, functioning watersheds, that have hydrologic connectivity, adequately store water, functioning channel morphology, provides adequate habitat for fish and wildlife, have unimpaired passage for fish, and that can still support multiple uses including timber harvest.

Prior to 1960, the North Thorne Project Area had little man-caused disturbance. Most of the disturbance in the Project Area was naturally caused, primarily due to mass wasting (landslides) and windthrow. Some timber harvest did occur adjacent to the Thorne River, near the confluence with the Lava (Gravelly) Creek area in the early 1900's (1910-1920). Little is known about the harvest activities. It is assumed that a steam donkey was used for yarding of harvested timber to the Thorne River. Yarding down the Lava (Gravelly) Creek stream corridor is likely to have occurred (Tierney, personal communication).

In the early to mid 1960's the Ketchikan Pulp Company moved its logging camp from Hollis to Thorne Bay. In the early 1960's timber harvest began in the Lava Creek watershed. Construction of logging roads also began into the Lava Creek watershed and along the Thorne River in the early 1960's. By 1973, eighteen miles of road had been built west toward the Control Lake Area to meet the road from Klawock, and roads accessing the watersheds within the North Thorne Project Area had been constructed.

Table 1 Watersheds of the North Thorne Project Area, including watershed name, hydrologic unit (HU) field, HU code number, and size in acres and square miles. Data from USFS Tongass National Forest GIS Coverages.

Watershed Name	HU Field	HU Code	Size (acres)	Size (mi^2)	% of Prj Area
Lava Creek	7th	1901010304100800	7030.4	11	19.7
Falls Creek	7th	1901010304100900	2491	3.9	7
Unnamed Composite	7th	1901010304101000	3361.3	5.3	9
West Fork North Thorne	8th	1901010304101101	8402.4	13.1	23.5
Snakey Lakes Lowlands	8th	1901010304101102	6795.7	10.4	19
East Fork North Thorne	8th	1901010304101103	7669	12	21.5
Total			35,750	55.7	100

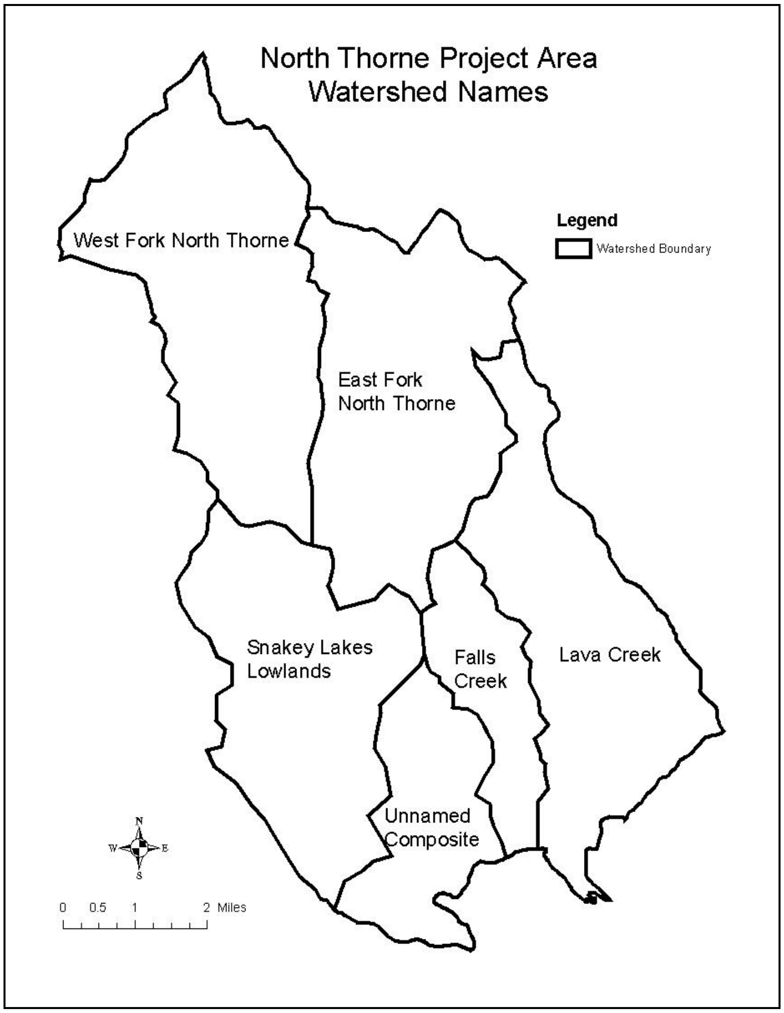

Figure 2. Names of watersheds in the North Thorne Project Area.

Project Area Watersheds

A watershed is the area in which all surface waters flow to a lowest, common point. It's boundary is the divide that separates one drainage area from another. The water moves by means of a network of drainage patterns that may be underground or on the surface. These drainage patterns connect to a stream and river system that becomes progressively larger as water flows downstream. Because water moves downstream in a watershed, any activity that affects the quality, quantity, or rate of movement at one location can change the characteristics of the watershed at locations downstream (OWEB 1999).

Watersheds within the North Thorne Project Area include Lava Creek, Falls Creek, an unnamed composite watershed, and the North Fork of the Thorne River. The North Thorne watershed is further subdivided into the West Fork, the East Fork, and the Snakey Lakes Lowlands sub watersheds. Figure 2 displays the Project Area boundary, watershed and subwatershed boundaries, and watershed names for the North Thorne Project Area.

Hydrologic Units

Hydrologic Units (HU) define the hydrological providence where a given watershed is located and follow a national standard hierarchal organization developed by the USGS and further refined by the United States Forest Service (USFS), Tongass National Forest (USFS 2000b). The USGS hierarchy uses Region, Subregion, Accounting Unit, and Catalog Code, and is typically displayed as a numeric code (eight digits), with each subsequent two digits or "field" defining Region, Subregion, etc. The USFS Tongass National Forest (TNF) further delinates HU's into Watershed Association, Watershed, Subwatershed, Drainage, Watershed Type that correspond to fifth thru ninth field watersheds. Table 1 displays HU information and size of watersheds within the Project Area.

The North Thorne Project Area is located in the Thorne River fifth field HU (1901010304), one of the Tongass National Forest's Priority Watersheds (54 total). The Thorne River fifth field HU is ranked number one among the Priority Watersheds for watershed disturbance (past harvest, road mileage, riparian area harvested), human use, and fish production (USFS 2000c). The North Thorne Watershed is listed as one of the Tongass National Forests Priority Watersheds (USFS 2008a). HU code nomenclature and numbering for this WRP is based on older USGS and TNF hierarchy

Ecological Subsection

Southeast Alaska ecosystems are greatly influenced by water and how it is processed over the land. Eighty-five ecological subsections have been described for Southeast Alaska and adjoining areas of Canada (Nowacki et al. 2001). The North Thorne Project Area includes two of these ecological subsections, Central Prince of Wales Volcanics and Central Prince of Wales Till Lowlands (Figure 3).

The Central Prince of Wales Volcanics subsection is located throughout the majority of the Project Area (76.6 %). This subsection includes the West Fork and East Fork subwatersheds, the majority of Falls Creek and Lava Creek watersheds, and small portions of the Unnamed Composite watershed and Snakey Lakes Lowlands subwatershed. Broad U-shaped valleys formed from past glaciation exist. Well-drained, moderately to highly productive, glacial till soils predominate at low elevations. At high elevations, soils are shallow over bedrock, often organic, and less productive. Hemlock and hemlock-spruce occur on well-drained sites, mixed conifers and lodgepole pine forest occupy wetter areas. Open, shrubby bogs and fens occur on the wettest spots (Nowacki et al. 2001). Erosion potential can be high on the steep slopes of this subsection

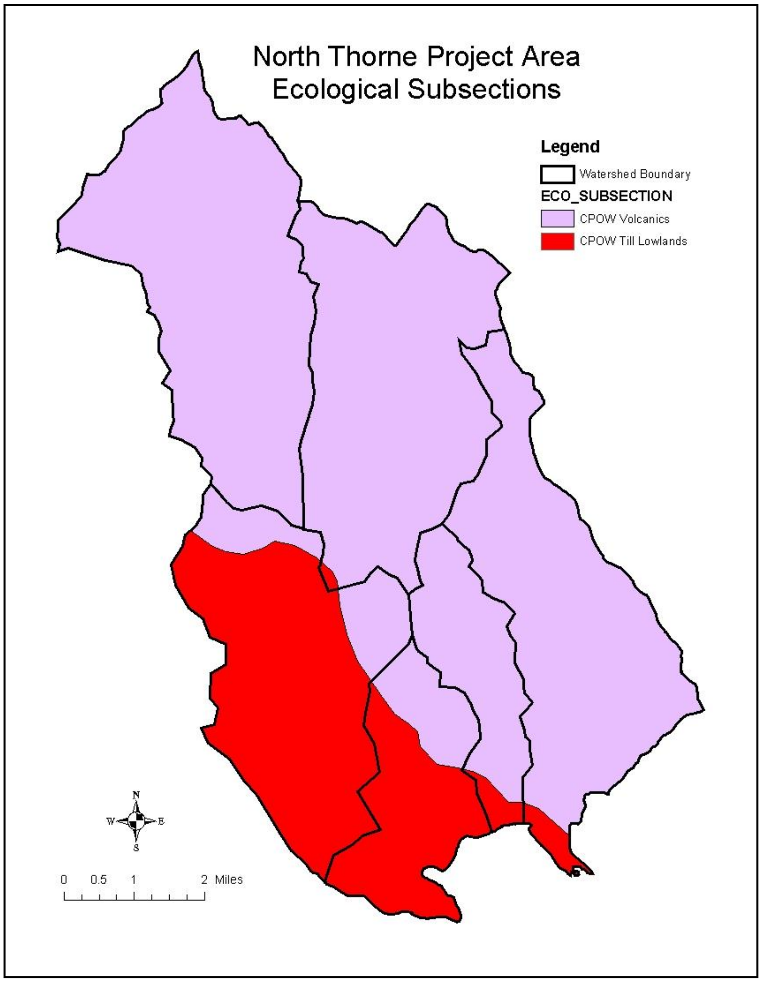

Figure 3. Ecological subsection by watershed for the North Thorne Project Area

Central Prince of Wales Till Lowlands make up about one-quarter of the land (23.4 %), and are located in the southwestern portion of the Project Area. This subsection includes the majority of the Snakey Lakes Lowlands subwatershed and the Unnamed Composite watershed, and small portions of the Falls Creek and Lava Creek watersheds. A unique drumlin field occurs within the Thorne River drainage [lower portion of the Upper Thorne River and Snakey Lakes Lowlands areas]. Organic soils formed over deep deposits of glacial till and support vast wetland complexes. Shallow lakes and ponds pockmark the till lowland landscape. The lack of bedrock control and relatively smooth topography of the till lowlands allow slow moving rivers to meander across the landscape. Again, hemlock and hemlock-spruce occur on well-drained sites, mixed conifers and lodgepole pine forest occupy poorly drained sites. (Nowacki et al. 2001).

Climate

In general, southeast Alaska possesses a maritime climate with precipitation derived from northeast moving cyclonic storms originating in the North Pacific. These storms occur throughout the year, with increased frequency and magnitude in fall and winter. Fall and winter storms, in addition to producing the greatest precipitation, also generate most of the gale force winds (greater than 32 mph). Cyclones developed from cold or occluded fronts with counterclockwise wind from the southeast result in the most damage in terms of windthrow (Harris 1989).

The Project Area receives moderately high levels of precipitation (Nowacki et al. 2001). The mean annual precipitation based on regional nomigraphs is approximately 120 inches [304.8 cm] (Jones and Fahl 1994). The nearby town of Hollis, Alaska, located about 19 miles to the south of the Project Area, had an average annual rainfall of 103 inches [261.6 cm] for May 1949 to December 2010 (WRCC 2011). The highest annual rainfall was during the month of October, and the lowest annual rainfall was during the month of June (Figure 4). Snow falls at all elevations during the winter season, with more snowfall in the higher elevations, and rain-on-snow events do occur.

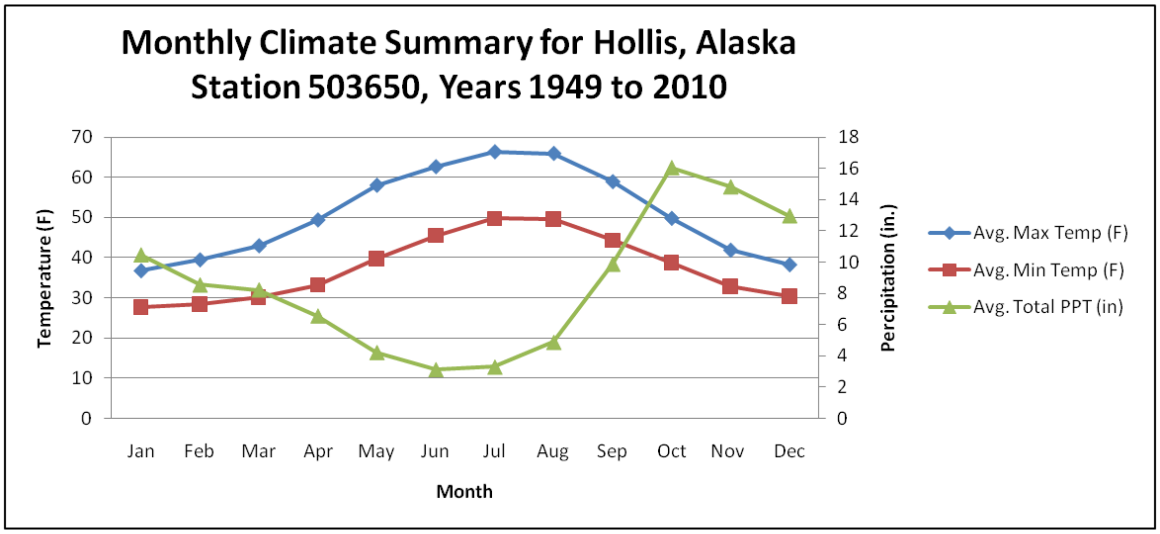

Figure 4. Monthly Climate Summary for Hollis, Alaska, Station 503650, Years 1949 to 2010. Data from WRCC 2011.

A Remote Automated Weather Station (RAWS) has been operating near the North Thorne Project Area since August 29, 2002. The station (THOA2) is located at an elevation of 600 feet above sea level, near the end of the 3015200 road, and can be view as real-time 24-hour data in 1 hour increments by day. Data includes precipitation, maximum-minimum air temperature, relative humidity, and wind speed (NOAA 2011).

<u>Air Temperature</u>

Figure 3 shows average maximum and minimum air temperatures for years 1949 to 2010 at Hollis, Alaska. Minimum average temperatures of 28°F [-2.2°C] occurred during the month of January. Maximum average temperatures of 67°F [19.4°C] occurred during the month of July (WRCC 2011).

Between 1999-2002 air temperature has been monitored at a site just downstream of the North Fork of the Thorne River bridge, on the 3016000 road (Walters and Prefontaine 2005). January's mean minimum air temperature was 31.2°F [-0.42°C], the mean maximum air temperature was 35.6°F [2°C], with the mean average being 33.4°F [0.75°C]. July's mean minimum air temperature was 50.2°F [10.13°C], the mean maximum was 59.7°F [15.39 C], and the mean average was 54.8°F [12.67]. It should be noted however that periods of low air temperatures occurred in February and March, and higher air temperatures occurred in August.

<u>Geology</u>

The southwestern portion of the North Thorne Project Area is a lowlands (Snakey Lakes sub watershed), formed where continental ice lobes eroded the present Thorne River valley from the north. Organic soils have formed over deep deposits of glacial till. Soils vary throughout the lowlands area, but are often poorly drained in the low lying areas with muskeg and low productivity (scrub) forest. In addition to vast wetland complexes, shallow lakes, and ponds, the area is intermixed with forested drumlins. The effects of past glaciation in the northern and eastern portions of the Project are complex, resulting from a mixture of continental and alpine ice flows. Numerous small steep valleys dissect the mountains and coalesce to form broad U-shaped valleys along larger drainages (West Fork and East Fork sub watersheds). Here, bedrock exposures and faults control the valley development. Well-drained, moderately to highly productive, glacial till soils predominate the valley slopes and lower elevations. Alluvial soils, formed by water transport and deposition, are found along the major stream courses and riparian areas.

The Project Area is predominately underlain by Ordovician to Silurian aged andesitic breccias, andesitic and basaltic lavas, graywacke turbidites, conglomerate, sandstone, chert, and shale that have been intruded in the east by Permian diorite (Table 2). These rocks generally outcrop as blocky, weather resistant high slopes and cliffs. These range from dark-gray, to greenish-gray, to black in color. Minor recrystallized limestone reefs are scattered throughout the volcanic breccias and flows. Younger, Tertiary sandstones and volcanic rocks are reported as small exposures along Lava Creek in the southeastern portion of the Project Area. Permian diorite has intruded these rocks to the eastern portion of the Project Area.

The andesitic breccias, andesitic and basaltic lavas and graywacke turbidites, conglomerate, sandstone, chert, and shale outcrops resisted the scouring efforts of the past glaciation and form the highlands in the eastern two-thirds of the Project Area. Of these the conglomerates, sandstones and shale locally weather to form soil. The carbonaceous shale and thin-bedded cherts weather to form fine, silty soil and are prone to erosion and mass wasting. The volcanic rocks are weather resistant and contribute little to soil development. The breccias and conglomerates are hardened and weather much like the volcanic flow rock. Beneath cliffs of these materials are colluvial deposits. Here these rock types weather to form course grained complexes with fine-grained interstitial soils. Locally metamorphosed volcanic and sedimentary rocks adjacent to the intrusion weather rapidly and are prone to erosion and mass wasting. In places, the diorite weathers to a granular soil and clays prone to erosion and mass wasting.

Table 2 Rock types, Rock Category, Rock Code, and total acres of rock type within the North Thorne Project Area. Data from USFS Tongass National Forest GIS Coverages. Rounding may adjust number totals slightly.

Rock Type	Rock Category	Rock Code	Total Acres in Project Area	Percent of Project Area
Marble	Metamorphic Carbonate	Khh	31.2	0.08
Granite Rocks undivided	Igneous/Intrusive	MzPzg	4287.4	12.0
Alluvial & Glacial deposits	Quaternary deposits	Qag	105.8	0.30
Basalts & Rhyolites	Igneous /Extrusive	QTv	364.4	1.02
Andesite Breccia	Igneous/Extrusive	Sobl	19214.5	53.7
Graywackle/mudstone/basalt	Sedimentary & Volcanic	Sod	11692.3	32.6
Conglomerate/Sandstone	Sedimentary	Ts	78.2	0.22
Total			35774	100

Karst landforms have developed within the recrystallized limestone outcrops to varying extent within the Project Area. Karst (rock code Khh) occupies less than 1% of the Project Area. The outcrops are very small, are primarily low vulnerability, and do not appear to control hydrology. Small, mapable portions occur in the Falls Creek watershed, and a section that bisects the Snakey Lakes and Unnamed Composite watersheds.

Soils

Soils are formed from weathered glacial till, both on the side slopes of valleys, and in the valley bottoms. These include not only glacial till, but glaciofluvial and glacial marine sediments. Until approximately 6,500 years ago, the Thorne River valley was an estuary/salt chuck complex that drained through the narrow gap just north of the current bridge across the Thorne River on the 30 Road. The southern project boundary represents the boundary between glacial till and drumlin development from a stagnant ice sheet to the north, and glacial outwash deposits to the south. Coarser grained glacial tills deposited on the slopes of the valley walls are prone to erosion and mass wasting. Compacted glacial tills and glacial marine sediments of the valley floors often control the down cutting of watercourses. The uncompacted till and outwash deposits on top of these layers are prone to erosion and small slope and cut bank failures.

Generally mineral soils in the Project Area have developed an "organic mat" that protects the mineral surface from extensive erosion. The buildup of organic material on the mineral surfaces is a result of the cool and moist, high precipitation maritime climate in southeast Alaska. Cool temperatures inhibit microbial decomposition at the ground surface; thus, thick (6 to 10 inches or greater) organic layers build up on the mineral surface. High precipitation leads to abundant vegetative growth in southeast Alaska, which further increases organic matter accumulation. Organic soils derived solely from organic matter accumulations vary greatly in depth depending on location. These unique soils can be less than 14 inches thick in forested wetland and can range up to 20 feet thick in muskeg areas. These organic soils are very poorly drained and typically overlie bedrock and/or glacial till deposits. Very poorly drained organic soils in the Project Area may vary greatly in their degree of decomposition from minimal to extensively decomposed. Well drained, shallow organic soils (<14 inches) are commonly found on bedrock outcrops and steep slopes in the Project Area.

The North Thorne Project Area contains 33 different soil types. The Tongass National Forest defines different soil types as soil map units (SMU's) based on National standards. The SMU is named after the major soil type within that unit. A SMU is rarely one soil type; rather it is dominated by one or two soils with inclusions of other soils of minor extent (USFS 2001). Often two soil types are so complexly intermixed within a mapping unit that no distinction can be made. These SMU's are called soil complexes. A number of soil complexes are found in the North Thorne Project Area (Table 3).

The Project Area is covered with approximately 50% poorly drained and very poorly drained soils. These soils are generally associated with forested wetlands and muskegs that are typically found on gently sloping areas, benches, flat lowlands, and depressions. The well drained and moderately well drained soils, are found on the steeper slopes of the U-shaped valleys in the Project Area, primarily the West Fork and East Fork subwatersheds. These productive soils are often shallow and can be at risk for mass wasting on steep (>72%) slopes. Tolstoi and Karta soils are the dominant well drained soils and comprise 31% of the Project Area. Additional well-drained and high productivity soils known as Tonowek and Tuxekan are generally found along floodplains in the Project Area. These soils were formed by alluvial processes and currently cover 2.6% of the Project Area.

Table 3. Soil map units (SMU), Soil name, Soil drainage Class, Mass Movement Index (MMI) and Percent Coverage of North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

SMU Number	Soil Name	Soil Drainage Class	MMI	%Coverage of Project Area
10	Tonowek and Tuxecan soils, 0 to 15% slope	well drained	1	2.58
201	Kogish-Maybeso complex, 2 to 10% slopes	very poorly and poorly drained	1	2.44
20CDX	Maybeso-Kaikli complex, 5 to 60% slopes	very poorly drained	1	2.89
21A	Kogish peat, 0 to 5% slopes	very poorly and poorly drained	1	1.77

220C	**Kina-Maybeso association, 5 to 35% slopes**	**very poorly drained**	**1**	**9.65**
23	**Kina-Kaikli association, 0 to 40% slopes**	**very poorly drained**	**1**	**0.04**
245CE	**Hydraburg-Sunnyhay association, 5 to 75% slopes**	**very poorly drained**	**1**	**9.33**
26A	**Staney Peat, 0 to 5% slopes**	**very poorly drained**	**1**	**2.22**
30C	**Karta silt loam, 5 to 35% slopes**	**moderately well and well drained**	**1**	**5.73**
81	**Rock outcrop**	**none**	**1**	**0.14**
85	**Kina peat, 0 to 35% slope**	**very poorly drained**	**1**	**3.87**
91CDX	**Maybeso peat, 5 to 60% slopes**	**very poorly drained**	**1**	**0.54**
252	**Wadleigh-Kogish association, 0 to 25% slopes**	**poorly drained**	**2**	**5.25**
28	**McGilvery and Tolstoi soils, 5 to 60% slopes**	**moderately well and well drained**	**2**	**0.24**
31C	**Wadleigh gravelly silt loam, 5 to 35% slopes**	**poorly drained**	**2**	**1.49**
540	**Tokeen-McGilvery complex, 10 to 65% slopes**	**well drained**	**2**	**0.44**
30CFX	**Karta silt loam, 5 to 100% slopes**	**moderately well and well drained**	**3**	**1.64**
30D	**Karta very fine sandy loam, 35 to 60% slopes**	**moderately well and well drained**	**3**	**3.10**
31CDX	**Wadleigh gravelly silt loam, 5 to 60% slopes**	**poorly drained**	**3**	**4.01**
320CD	**Wadleigh-Maybeso complex, 5 to 60% slopes**	**very poorly and poorly drained**	**3**	**0.11**
32CDX	**St. Nicholas very fine sandy loam, 5 to 60% slopes**	**poorly drained**	**3**	**0.32**
331CD	**Karta-Wadleigh complex, 5 to 60% slopes**	**moderately well and well drained**	**3**	**7.78**
351DE	**Karta-Tolstoi complex, 35 to 75% slopes**	**moderately well and well drained**	**3**	**10.38**
528DF	**Tolstoi-McGilvery complex, 35 to 100% slopes**	**moderately well and well drained**	**3**	**1.47**
54CEX	**Tokeen gravelly sandy loam, 5 to 75% slopes**	**well drained**	**3**	**0.89**
550CE	**St. Nicholas-Kaikli complex, 5 to 75% slopes**	**very poorly and poorly drained**	**3**	**1.38**
14DFX	**Shakan sandy loam, 35 to 100% slopes**	**moderately well and well drained**	**4**	**2.38**
15	**Cryorthents**	**moderately well and well drained**	**4**	**0.01**
32CFX	**St. Nicholas very fine sandy loam, 5 to 100% slopes**	**poorly drained**	**4**	**0.13**
32EFX	**St. Nicholas very fine sandy loam, 60 to 100% slopes**	**poorly drained**	**4**	**1.12**
33CFX	**St. Nicholas-McGilvery complex, 5 to 100% slopes**	**poorly drained**	**4**	**0.03**
34DFX	**St. Nicholas-Shakan association, 35 to 100% slopes**	**poorly drained**	**4**	**3.22**
50CFX	**Tolstoi and Karta soils, 5 to 100% slopes**	**moderately well and well drained**	**4**	**0.91**

Vegetation

The natural vegetation of the Project Area is a mosaic of coniferous forest intermixed with alpine tundra, muskeg, riparian, and shrub land plant communities. Productive forests of hemlock and hemlock-spruce occur within the Project Area and are restricted to well drained soils. These sites usually occur on steeper slopes, scoured mountains, and along streambanks. Low productive forests of mixed conifers occupy wetter areas (poorly drained sites). Open, shrubby bogs and fens occur on the wettest spots (Nowacki et al. 2001).

Table 4 displays acres of forest type by watershed. Hemlock dominated forests are prevalent in the upper slopes, above already harvested areas in the West Fork, East Fork, Falls, and Lava Creek watersheds (Figure 8). Harvested areas primarily were hemlock-spruce forests. Spruce dominated forests are in the valley bottoms along mainstem streams, primarily the Snakey Lakes lowlands. Alder often dominates the vegetation in areas harvested to the streambank, and on upland sites that have been highly disturbed. Alder dominated riparian areas are present along harvested streambank sections of Lava Creek, the West and East Fork of the North Thorne River, and in Falls Creek. Cedar dominated stands are small and isolated in the Project Area, primarily in unharvested stands.

Old Growth Forest

Old-growth forest is defined in the Forest Plan as an ecosystem distinguished by the later stages of forest stand development that differs significantly from younger stands in structure, ecological function, and species composition. Old-growth forest is characterized by a patchy, multi-layered canopy, many age classes of trees, large trees dominating the overstory, large standing dead (snags) or decadent trees, and higher accumulations of large down woody material (USFS 2008). Productive Old Growth (POG) are stands of forest capable of producing and containing enough tree volume per acre to be commercially harvestable; i.e. 20 cubic feet per acre per year with 8,000 or more board feet per acre and provide important wildlife habitat.

Table 4. Acres of forest type by watershed within the North Thorne Project Area. Other includes non-forested wetlands, lakes, rock, etc. Data from USFS, Tongass National Forest GIS Coverages.

Watershed Name	Red Alder	Cedar	Hemlock	Spruce	Hemlock - Spruce	Other
Lava Creek	18.1	0	1025.6	52.8	3756.2	2177.8
Falls Creek	0	0	442.2	2.8	984.8	1061.7
Unnamed Composite	0	17.2	860.4	16.4	1625.3	842.1
West Fork North Thorne	0	0	2149.6	0	3312	2940.8
Snakey Lakes Lowlands	0	28.3	1920.4	130.2	2866.5	1850.2
East Fork North Thorne	0	69.6	2159.3	85.9	2164.6	3189.7

Productive Old Growth

There is about 14,753 acres of Productive Old Growth (POG) within the Project Area (Table 5). POG at less than 1,500 foot elevations provides the best quality habitat for several wildlife species. Most timber harvest activity in the Project Area has occurred in these low elevation habitats (below 1,200 feet). Large scale timber harvest in the Project Area began in the 1960s, and there has been little or no retention of overstory structure in the Project Area's 8,935 acres harvested to date. High volume strata POG forest below 1,500 foot elevation is important habitat for many of the wildlife management indicator species listed in the Forest Plan FEIS (USFS 2008) and in the Project Area.

Table 5.. Productive Old Growth by volume strata and acres in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Productive Old Growth by Volume Strata	Acres in Project Area	Acres below 1500' Elevation	Acres above 1500' Elevation
High Volume Strata	6,905	6,086	819
Medium Volume Strata	4,799	3,616	1,183
Low Volume Strata	3,049	2,363	686
Total Acres	14,753	12,065	2,688

Second Growth Vegetation

The Project Area contains 8,935 acres of second growth (also referred to as young growth). Second growth is found in two stand developmental stages, stand initiation and stem exclusion (Nowacki and Kramer 1988), and represents about 26 percent of the Project Area (Table 6). Stand initiation begins after a natural disturbance to the forest or timber harvest, and usually last 25 to 35 years. During the stem exclusion stage tree density increases to a point where the canopy closes and little sunlight reaches the forest floor. This stage usually lasts from 35 to 150 years after disturbance.

Individual second growth stand size within the Project Area ranges from 0.25 acres to 801 acres, with an average size of 55 acres. The largest contiguous block of second growth is 3,682 acres. To date, 2,820 acres have been thinned; leaving 6,115 acres as young or second growth. Much of the remaining second growth is in, or near, the stem exclusion stage. As time passes, more of the second growth stands that are currently in stand initiation will move into a stem exclusion stage. The trees within these stands are crowded, and uniform in size. Stands in the stem exclusion stage exhibit a poorly developed understory, an even-aged overstory, and provide low value habitat for wildlife.

Table 6. Distribution of Stand Development Stages in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Stand Development Stages	Stand Initiation	Stem Exclusion	Understory Reinitiation	Productive Old Growth	Other Old Growth*	Non-Forest**
Acres and % of Project Area	3,379 (10%)	5,556 (16%)	0	14,753 (41%)	10,582 (29%)	1,590 (4%)
*Other Old Growth – lands having greater than 10% tree cover but not capable of producing a commercial timber crop of 8 MBF/acre/year. **Non-Forest – lands having less than 10% tree cover, and includes water.						

Wetlands

Wetlands occupy approximately 62% of the land area in the North Thorne Project Area. Forested wetland and complexes with wetland types make up approximately two-thirds of the wetlands (Table 7). Wetlands considered to be either biologically or hydrologically significant throughout the Project Area include emergent short and tall sedge fens, muskeg, and alpine muskeg. These wetlands types comprise approximately one-third of all wetland types in the Project Area.

Forested wetlands cover nearly 41% of the Project Area. Forested wetlands include a number of forested plant communities with hemlock, cedar, or mixed conifer overstories, and ground cover consisting largely of skunk cabbage and deer cabbage. Forested wetlands occur on poorly or very poorly drained mineral and organic soils. Forested wetlands are most common on gentle gradient hill slopes or benches, and support the transfer of water to downslope resources. Forested wetlands function as recharge areas for groundwater and streams, and for deposition of sediment and nutrients'

Table 7. Wetland types, Wet-Hab code, and acres by watershed in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Wetland Type	Wet-Hab Code	Lava Ck	Falls Creek	Un-named Composite	West Fork North Thorne	Snakey Lakes Lowlands	East Fork North Thorne	% of Proj Area
Alpine Muskeg	AM	355.8	453.6	0	1865.9	0	1966	13
Scrub Estuarine	E	2.3	0	0	0	0	0	0.01
Emergent Short Sedge	EM	517.8	381.1	0	226.2	25.5	229.9	3.9
Forested/Emergent Sedge (<50% Forested)	FES	1657.5	174.7	282.1	352.5	418.8	553.5	9.6
Forested Wetland/ Non-Forested Non-Wetland (>50% Forested)	FIA	28.4	0	0	0973.3	11.6	401.2	4.0
Forest Wetland/Forested Non-Wetland (>50% Forested)	FIC	0	0	760.5	380.9	1327.5	304.1	7.8
Forest Wetland/Forested Non-Wetland (>50% Wetland)	FIW	0	0	0	11.3	0	0	0.03
Forested Wetland/ Moss Muskeg (>50% Forested)	FMS	0	0	580.2	0	1290	0	5.2
Forested Wetland/ Moss Muskeg (<50% Forested)	FSS	28.2	5.36	44.3	176.2	168.5	447.9	2.4
Forested Wetland	FW	1054.1	196.1	77.4	879.9	854.5	1206.1	11.9
Sphagnum Peat Moss Muskeg	MP	28.2	7.6	153.5	144	159.4	136.6	1.8
Emergent Tall Sedge	MT	0.2	0.4	20.5	208.1	437.9	125.9	2.2
Scrub-Shrub Evergreen/Emergent Wetland (<50% Scrub-Shrub Evergreen)	SES	12.6	0	0	0	0	0	0.04
Total		3685.1	1218.9	1918.5	5218.3	4693.7	5371.2	61.9

Emergent short sedge wetlands (wet-hab code EM) include poor fens and rich bogs on moderately deep and very poorly drained organic soils. This wetland occupies approximately 4% of the Project Area and is often found on lower footslopes and on broad ridgetops. These wetlands contribute water to downslope resources and are considered to have high biological and hydrological value in the Project Area.

Emergent tall sedge fens (wet-hab code MT) are characterized by a diverse community of sedges, dominated by tall sedges such as Sitka sedge, with a variety of forbs and occasional stunted trees, usually spruce or hemlock. Soils are typically deep organic muck, often with some thin layers of alluvial mineral soil material. They occur in landscape positions where they receive some runoff from adjacent slopes resulting in somewhat richer nutrient status than bogs. These wetlands function as areas for recharge of groundwater and streams, deposition and storage of sediment and nutrients, and for waterfowl and terrestrial wildlife habitat, including black bear, mink, river otter, and beaver. Some sedge fens contain beaver ponds that often provide high quality waterfowl habitat and salmon rearing habitat. This wetland occupies approximately 2% of the Project Area.

Muskegs (wet-hab code MP) are dominated by sphagnum moss with a wide variety of other plants adapted to very wet, acidic, organic soils. They typically contain shore pine and hemlock trees less than 15 feet high. This wetland type is typically made up of raised bogs as well as sloping "poor fens" and some shrub-scrub coniferous wetlands. These wetlands function as areas for recharge of groundwater and streams and for deposition and storage of sediment, and nutrients. The wetland is a valuable source of biological and vegetative diversity and occupies approximately 2% of the Project Area, especially in the southwest corner of the Project Area.

Alpine muskegs (wet-hab code AM) occupy approximately 13% of the Project Area. They are similar to muskegs; however, they occur at higher elevations (1,200 to 2,500 feet) in the landscape, such as ridge tops and mountain summits in the West and East Fork watersheds. Vegetation is a combination of muskeg and sedge meadows on peat deposits, and low growing blueberry and heath on higher rises. Similar to muskeg, shore pine and hemlock trees less than 15 feet high are common. Alpine muskegs are important for snow storage and can be a source for snowmelt water throughout the spring and early summer months. These wetlands also provide summer habitat for terrestrial wildlife.

Value Comparison Units

Value Comparison Units (VCU's) were first developed for the 1979 Tongass Land Management Plan (TLMP) as distinct geographic areas that generally encompass a drainage basin containing one or more large stream systems. Boundries usually follow easily recognizable watershed divides (USFS 2008). On Prince of Wales Island, in many locations, VCU's often bisect a watershed or include several watersheds. The North Thorne Project Area includes large portions of VCU's 5780, 5790, 5800, and 597.1, and small fragments of 5750, 5810, 5830, 5840, 5850, 5860, and 597.2. Table 8 displays the VCU acres by watershed.

Table 8. VCU number and acres by watershed in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

VCU Number	Lava Ck	Falls Creek	Un-named Composite	West Fork North Thorne	Snakey Lakes Lowlands	East Fork North Thorne	Percent of Project Area
5750	0	0	0	394.4	461.5	0	2.4
5780	0	0.2	1076.5	0.01	5392.3	41.5	18.2
5790	6475.6	2393.6	886.2	0	655.2	256.5	29.8
5800	37.2	22.1	0	7847	57.1	7277.7	42.6
5810	0	0	0	85.7	0	0	0.2
5830	0	0	0	75.3	0	37.9	0.3
5840	0	0	0	0	0	51.1	0.1
5850	116.4	0	0	0	0	4.3	0.3
5860	401.2	15.4	0	0	0	0	1.2
597.1	0	59.9	1398.6	0	229.5	0	4.7
597.2	0	0.2	0	0	0	0	0
Total	7030.4	2491.4	3361.3	8402.4	6795.6	7669	100

Land Use Designations

Land Use Designations (LUD's) are defined areas of land to which specific management direction is applied (USFS 2008). LUD's within the Project Area include Timber Production, Modified Landscape, Scenic Viewshed, Scenic River, Recreational River, and Old Growth (Table 9).

Table 9. Land Use Designations, size (in acres), and percent of the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Land Use Designation	Size, in acres, within Project Area	Percent of Project Area
Timber Production	18898.4	52.7
Modified Landscape	4752	13.3
Scenic Viewshed	1178.4	3.3
Scenic River	3062.4	8.6
Recreational River	1132.8	3.2
Old Growth	6725.7	18.8
Total	35750	100

In Timber Production LUD's, timber management is emphasized and suitable forested land is available for harvest. The Modified Landscape and Scenic Viewshed LUD's also allow harvest of suitable forested land. The Scenic River and Recreational River LUD's allows harvest of suitable forested land if the adjacent LUD allows timber harvest (USFS 2008). Table 6 displays the acreages of LUD's within the North Thorne Project Area.

In Old Growth LUD's forested land is unsuitable for timber harvest. However, salvage of dead or down material is permitted, but limited to roadside windfall and hazard trees immediately adjacent to existing permanent roads, and catastrophic windthrow events or large insect or disease outbreaks (> 100 acs). Personal use wood harvest is also allowed (USFS 2008). The Old Growth LUD within the North Thorne Project Area is designated as a small Old Growth LUD. The Old Growth LUD occupies approximately 19% of the total Project Area acreage.

The Old Growth LUD standards and guidelines provide for further evaluation and possible adjustment of the location of small Old Growth LUD's during project level environmental analysis. This adjustment may be done through an interagency review by biologist's from the USFS, U.S. Fish and Wildlife Service (USFWS), and Alaska Department of Fish and Game (ADF&G) with line officer approval (USFS 1998). The small Old Growth LUD within the North Thorne Project Area is not static and could potentially be adjusted in the future. During 2002, an interagency review made no adjustment to the current small Old Growth LUD.

<u>Recreation</u>

The Project Areas abundant road system is used for recreational activities such as driving for pleasure, site-seeing, picnicking, fishing, canoeing, hunting, trapping, shooting, subsistence gathering, walking/hiking, mountain biking, and riding off-road vehicles (OHV). The Project Area is predominately dispersed recreation. The Gravelly Creek Picnic Ground is the only developed recreation site located in the Project Area and is adjacent to the mainstem Thorne River. Recent storage of part of the 3017000 road has created a loop road/trail near Thorne Bay that is popular with mountain biking enthusiasts. The large rock pit near the intersection of the 3000 and 3015000 road systems is a popular with gun owners for general plinking of targets and sighting in rifles. The Snakey Lakes area and lower North Thorne River is popular for canoeing. Fishing also takes place at the Gravelly Creek Picnic ground, Falls Creek confluence with Thorne River, Crabapple Tree hole, Parking Lot hole, North Thorne bridge area (3016000 road), and the North Thorne falls (off 3015000 road) by sport fisherman, subsistence fishermen, and Outfitter Guided fishermen.

Wildlife

The Project Area is located within portions of Wildlife Analysis Areas (WAAs) 1315, 1319, and 1420. Approximately 98% of the Project Area is located within WAA 1319 (34% of WAA 1319). WAAs are land divisions used by the Alaska Department of Fish and Game (ADF&G) for wildlife analysis. Further, the Project Area is found in Game Management Unit (GMU) 2, which includes all of Prince of Wales Island. There are no known terrestrial threatened or endangered species in the North Thorne Project Area.

Many wildlife species utilize the varying forest types and habitat conditions that are found in the North Thorne Project Area. The existing road system in the Project Area provides hunter access to deer, bear, wolf, martin, and beaver. Many residents of Thorne Bay use the Project Area for hunting and subsistence. The Sitka black-tailed deer is one of the most important game and subsistence species in Southeast Alaska. WAA 1319 is one of the highest used WAAs for deer on Prince of Wales Island. Black bear exist in the Project Area, and there is biological concern about bear populations in GMU 2. The Alexander Archipelago wolf is also found here, and there is a pack that dens and roams the North Thorne Area. Wolf mortality resulting from trapping and hunting harvest is directly correlated with road density in Southeast Alaska (Person et al. 1996). Marten are a medium-sized carnivore present in the Project Area. Marten represent a species using lower-elevation old-growth forest habitats during the winter. Recent increases in marten pelt values may intensify trapping pressure on this species. Beaver are also found in relative moderate numbers in the Project Area. Beaver have plugged culverts in the Project Area, creating fish passage and water flow problems. Further, they have built several dams associated with culverts. They too are also caught in trap lines.

Timber harvest has occurred in productive old growth at low elevations, especially below 1200 ft elevation. This has resulted in an unbalanced shift in the Project Area to second growth stages. For the first 25 to 35 years after timber harvest forage opportunities for deer may allow population trends of deer to increase. When these stands progress into a stem exclusion phase, a negative effect on deer populations occur as tree density increases reducing deer winter range in the Project Area. Sitka black-tail deer population trends are expected to decline as harvested stands of second growth timber move into the stem exclusion successional stage. Depending on the desired condition of a stand, selected wildlife thinning treatments can serve to maintain, or increase forage production, create more stand structure, complexity, achieve a trend toward old-growth characteristics more rapidly, while improving connectivity between remaining old-growth stands. Further, stand initiation may increase berry production, particularly blueberry, which contributes to short-term bear population growth. This forage source will be lost as the canopy closes during stem exclusion, as will habitat diversity associated with old-growth forests, accompanied by loss of bear denning trees. Thus there is a need to treat vegetation from a wildlife prespective. Without wildlife thinning deer habitat capability, especially deer winter range, will continue to decline due to stem exclusion. This undesired condition could last for 100 years or more until understory reinitiation takes place

Fisheries

Streams within the North Thorne Project Area flow into the mainstem Thorne River system. The Thorne River system is a highly productive area for salmonid fish (salmon, trout, char). Fish produced in the Thorne River system support the largest freshwater fishery on Prince of Wales Island. The fish produced in the Thorne River system are important to the subsistence, sport, guided (both freshwater and saltwater), and commercial fisheries of the area, and are a major food source for many wildlife species

Streams and lakes within the North Thorne Project Area provide salmonid habitat and contribute to the production of fish within the overall Thorne River system. These streams and lakes also contribute to the number of fish that are harvested within the lower Thorne River system, and to the culture and lifestyle of the residents of the area. ADF&G anadromous catalogued streams are found within the watersheds of the North Thorne Project Area, in addition to non-catalogued anadromous fish streams and resident fish streams.

ADF&G lists VCU's 578, 580, and 597.1 as being a primary sportfish producer on the Tongass National Forest (Flanders et al. 1998). These VCU's primarily are the West Fork, East Fork, Snakey Lakes, and Unnamed composite watersheds. ADF&G also lists VCU's 578, 580, and 597.1 as being primary producers of salmon for the Tongass National Forest. The other VCU's in the Project Area are listed as secondary producers of salmon. This is primarily the Lava Creek and Falls Creek watersheds.

The streams and lakes in the Project Area support a variety of anadromous and resident fish species. The anadromous species include: chum salmon (*Oncorhynchus keta*), coho salmon (*O. kisutch*), pink salmon (*O. gorbuscha*), sockeye salmon (*O. nerka*), cutthroat trout (*O. clarkii*), rainbow trout (steelhead) (*O. mykiss*), and Dolly Varden (*Salvelinus malma*). The Project Area also supports populations of resident cutthroat trout, rainbow trout, Dolly Varden, and non-game fish species such as sculpin (*Cottus spp.*) and three-spined stickleback (*Gasterosteus aculeatus*) [Table 10]. Chinook salmon are present in the marine waters near the Project Area, have rarely strayed into the Thorne River, but do not spawn in Project Area streams.

Table 10. Fish species use of the North Thorne Project Area streams and lakes by life stage.

	Life Stage		
Species	**Spawning**	**Rearing**	**Overwinter**
Pink Salmon[1]	**X**		
Chum Salmon[1]	**X**		
Coho Salmon	**X**	**X**	**X**
Sockeye Salmon[2]	**X**	**X**	**X**
Cutthroat Trout[3]	**X**	**X**	**X**
Rainbow Trout[3]	**X**	**X**	**X**
Dolly Varden char[3]	**X**	**X**	**X**
Sculpin	**X**	**X**	**X**
Stickleback	**X**	**X**	**X**

[1] pink and chum salmon head downstream to saltwater shortly after emergence from gravels.

[2] sockeye salmon spend 1-3 years in lakes before outmigration to saltwater.

[3] cutthroat trout, rainbow trout, and Dolly Varden char can exhibit either anadromous or resident life history (a steelhead is an anadromous rainbow trout)

There are no federally listed threatened, endangered, or sensitive fish species known to occur in streams or lakes within the Project Area. However, some fish from stocks of Federally listed salmon from Washington, Idaho, and Oregon may migrate through the marine waters of Clarence Strait, which lies to the east of the Project Area.

<u>Fishery Escapement</u>

There is virtually no known fishery escapement numbers for the North Thorne Project Area. One obscure ADF&G report (Novak 1975) documents coho and sockeye salmon adults schooling at the North Thorne falls in the West Fork subwatershed [200 coho, 2 sockeye]. It also documents 59 coho salmon observed spawning between the North Thorne falls and the upper end of the West Fork subwatershed. Steelhead are found to the upper end of the West Fork watershed. Beard et al 2008 observed about 10 adult coho in a pool just below the first crossing of the 3015640 road in the upper East Fork subwatershed.

Novak 1975 also documents adult sockeye salmon schooling in Snakey Lakes, and 118 adult sockeye salmon observed spawning in the East Fork subwatershed in the vicinity of the East Fork bridge on the 3015000 road. Beard et al 2006 observed several adult sockeye salmon immediately below the East fork bridge.

It has been thought that the falls below the Snakey Lakes area is a partial barrier to pink salmon. Beard 2006 observed several adult pink salmon schooling in deeper areas of the North Fork upstream of the North Thorne bridge on the 3016000 road. However, during the previous 5 years no adult pink salmon were observed at this location.

The Unnamed Composite watershed supports coho, chum, and pink salmon, and steelhead primarily west of the 3015000 road. The Lava Creek watershed supports coho, chum, and pink salmon. Coho salmon appear to be present to the upper end of the Lava Creek watershed. The Falls Creek watershed has the lowest mileage of Class I stream due to a waterfall that precludes upstream movement of anadromous fish. Coho, chum, and pink salmon are found to the falls.

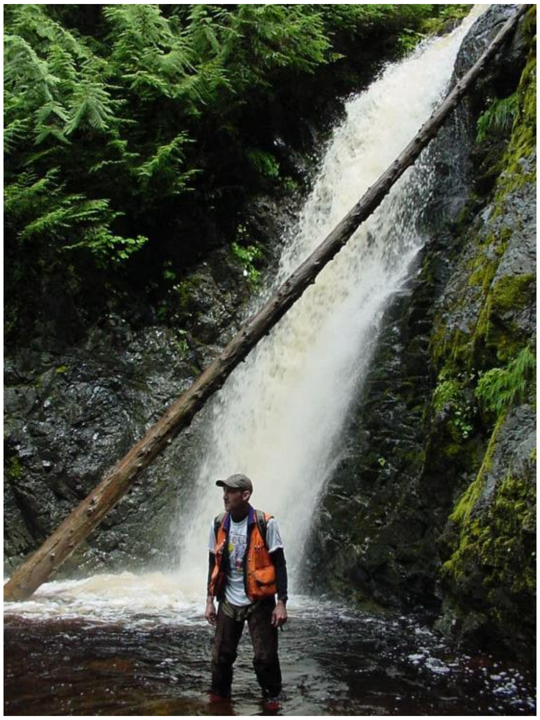

Figure 5. Photo on left is North Thorne Falls, a partial barrier to coho salmon and steelhead. Photo on right is a complete barrier falls to salmon on Falls Creek.

There is some data on peak escapement counts conducted over the lower Thorne River via aerial surveys. These are done by the Commercial Fisheries Division of the Alaska Department of Fish and Game and target only pink salmon during peak escapement timeframes (Table 11). The Thorne River is generally dark from tannins that leach into the water from surrounding vegetation and soils, making it difficult to count fish. Peak escapement numbers are therefore estimates of fish observed in the river system, and may be questionable as to accuracy (Walker 2011, personal communication).

Table 11. Peak escapement counts for pink salmon in the Thorne River, for selected years 2000 to 2010 (ADF&G 2011a).

Year	Date	Peak Escapement
2000	Sept 12	120,000
2001	Aug 19	150,000
2003	Aug 10	130,000
2004	Aug 21	75,000
2006	Aug 22	60,000
2007	Aug 17	300,000
2009	Aug 19	60,000
2010	Aug 21	61,000

The Thorne River watershed has an estimated adult steelhead escapement of greater than 1,000 fish (Harding 2008). The Thorne River system includes nine lakes and has an estimated potential to produce 56,078 sockeye salmon adults (Zadina, et al 1995). Furthermore, the Thorne River system produced more than 30,000 sockeye salmon adults in the late 1800's (Moser 1899 in Zadina, et al 1995)

Fish Use and Catch

There is no known fishery data on catch of fish in the North Thorne Project Area. Any fishery data that does exist is generally lumped into data for the Thorne River. The North Thorne falls is known to local residents of Thorne Bay and Outfitter Guides as a fishing spot for adult coho salmon. Adult coho salmon are also caught at the North Thorne bridge area on the 3016000 road. Coho, sockeye, and pink salmon, steelhead, cutthroat trout, and Dolly Varden char are harvested at the Gravelly Creek Picnic ground, Falls Creek hole, Crabapple Tree hole, and Parking Lot hole along the Thorne River. Sportfishing, Subsistence fishing, Personal Use fishing, and Outfitter Guide fishing take place at these fishing destinations.

The Alaska Department of Fish and Game (ADF&G) maintains a statewide database where sport fishing occurs, the extent of participation, and species caught and harvested. This database is called the statewide harvest survey (SWHS). The estimates generated are based on an annual survey of a subset of people who purchase Alaska sport fishing licenses. During 1997 to 2006, the highest sport fishing use on the Thorne Bay Ranger District occurred in the Thorne River System, which included Angel and Control Lakes, and Control and Goose Creek. A total of 43,448 days fished were estimated by the SWHS in addition to sportfish harvest (Table 12) [ADF&G 2007a].

Federal Subsistence uses means the customary and traditional uses by rural Alaskan residents of wild, renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible by-products of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade on Federal public lands and waters (FWS 2011). The Thorne River also had the highest number of Federal Subsistence fishing permits issued on the Thorne Bay Ranger District. A total of 86 Federal Subsistence fishing permits were issued for years 2002 to 2006 (Table 12) [USFS 2008b]. Federal Subsistence harvest is also shown in Table 9.

Personal Use fishing is defined as the taking, fishing for, or possession of finfish, shellfish, or other fishery resources, by Alaskan residents for personal use and not for sale or barter, with gill or dip net, seine, fish wheel, long line, or other means defined by the Alaskan Board of Fisheries (ADF&G 2011b). The Thorne River had a total of 147 personal use anglers for years 1997 to 2006 (Table 12) [ADF&G 2007b]. Personal Use harvest is also shown in Table 9.

Outfitter Guide Fishing Use was determined from angler day counts returned to the USFS from Outfitter Guides (Slayton 2008). This annual count is a condition of receiving a permit the following fishing season. It should be noted that an unknown percent of the Alaska Statewide Sportfish Harvest Survey may include anglers that fished with Outfitter Guides. Thus, fishing effort of anglers with Outfitter Guides is not able to be separated from the Alaska Statewide Harvest Survey, but is actually an unknown subset of that data. The Thorne River had the second highest number of angler days reported from Outfitter Guides on the Thorne Bay Ranger District for years 2002 to 2006, approximately 959 angler days. It is known that Outfitter Guides occasionally use the North Fork of the Thorne River when the mainstem Thorne River is overcrowded.

Table 12. Thorne System (streams & lakes) fishing effort and harvest by species, 1997- 2006. Data from ADF&G 2007a, ADF&G 2007b, and USFS 2008.

Year	Type Fishing	# Anglers	Days Fished	SS	RS	PS	CS	SH	RT	CT	DV
	Sportfish catch			1597	10	5479	799	410	1208	4659	6375
	Sportfish harvest	1402	3911	802	0	992	0	0	82	81	719
	Fed subsistence	0	0	0	0	0	0	0	0	0	0
1997	personal use	8	unk	0	141	0	0	0	0	0	0
	Sportfish catch			1655	76	2910	230	268	2744	6471	9011
	Sportfish harvest	844	4791	1020	76	1095	42	10	443	472	665
	Fed subsistence	0	0	0	0	0	0	0	0	0	0
1998	personal use	29	unk	30	382	3	2	0	0	0	0
	Sportfish catch			1847	0	10491	542	1306	133	1722	2810
	Sportfish harvest	1560	5264	1308	0	1952	0	8	12	378	271
	Fed subsistence	0	0	0	0	0	0	0	0	0	0
1999	personal use	9	unk	2	98	29	2	0	0	0	0
	Sportfish catch			2083	211	8343	217	841	1724	4807	11360
	Sportfish harvest	1574	5468	1323	164	525	0	0	258	527	1486
	Fed subsistence	0	0	0	0	0	0	0	0	0	0
2000	personal use	5	unk	14	17	11	1	0	0	0	0
	Sportfish catch			2843	425	7266	239	1226	439	2049	6681
	Sportfish harvest	1058	3366	999	59	263	0	26	25	238	361
	Fed subsistence	0	0	0	0	0	0	0	0	0	0
2001	personal use	1	unk	8	0	7	0	0	0	0	0
	Sportfish catch			3675	374	5683	206	114	1704	2800	6985
	Sportfish harvest	1392	5037	2224	19	921	8	0	152	193	1653
2002	Fed subsistence	6	unk	21	0	11	0	0	0	0	0

	personal use	21	unk	20	365	18	0	0	0	0	0
	Sportfish catch			3105	131	7183	427	361	635	4500	13113
	Sportfish harvest	1748	6535	1672	0	344	0	9	65	75	2196
	Fed subsistence	16	unk	16	10	0	0	10	0	0	0
2003	personal use	14	unk	41	98	26	0	0	0	0	0
	Sportfish catch			2846	135	12957	1214	95	812	2570	6393
	Sportfish harvest	1763	4303	1479	0	358	0	0	0	164	1221
	Fed subsistence	24	unk	10	68	0	0	3	0	0	0
2004	personal use	22	unk	28	427	10	0	0	0	0	0
	Sportfish catch			4932	36	6990	560	43	338	729	1291
	Sportfish harvest	1347	4234	1824	0	230	0	0	52	139	94
	Fed subsistence	14	unk	0	2	0	0	4	0	6	0
2005	personal use	29	unk	7	547	2	0	0	0	0	0
	Sportfish catch			0	0	0	0	0	0	0	0
	Sportfish harvest	0	0	0	0	0	0	0	0	0	0
	Fed subsistence	26	unk	5	6	4	2	3	0	13	0
2006	personal use	9	unk	42	51	0	0	0	0	0	0
unk=unknown; SS=silver (coho) salmon; RS=red (sockeye) salmon; PS=pink salmon; CS=chum salmon; SH=steelhead; RT=rainbow trout; CT=cutthroat trout; DV=Dolly varden char											

Watershed Conditions

Hydrologic Conditions

Only a few streams on Prince of Wales Island have been infrequently or intermittently gauged. There are no stream gauges within or adjacent to the North Thorne Project Area, therefore no discharge data is available for streams within the Project Area. The closest stream gauge is located in the Staney Creek drainage, approximately 18 to 20 miles west-northwest of the Project Area. The Staney Creek drainage is 50.6 mi^2 in size, similar to the size of the North Thorne Project Area.

Typically, October is the wettest month, and July is the driest month in Southeast Alaska. Therefore, the highest flows likely occur in the late fall and winter months, the lowest flows in the summer months. Because of the steep slopes and relatively shallow soils within the Project Area, and the generally high rainfall, it is assumed that runoff generally responds quickly to rainfall events. Discharge measurements in Staney Creek support rapid streamflow response to precipitation (USGS 2004)

Stream Classes

Stream classes are a means to categorize stream channels based on the instream habitat and fish production value.
Streams are separated into four class designations according to the Aquatic Habitat Management Handbook (USFS 2001a) and the Tongass Forest Plan (USFS 2008). In general, Class I and Class II streams are fish-bearing, whereas Class III and Class IV streams are non fish-bearing (Figure 6). There is about 253 miles of stream within the Project Area (Table 13).

Class I: Streams and lakes with anadromous or adfluvial fish habitat; or high quality resident fish waters, or habitat above fish migration barriers known to provide reasonable enhancement opportunities for anadromous fish.

Class II: Streams with resident fish or fish habitat and generally steep (often 6-25 percent or higher) gradients where no anadromous fish occur, and otherwise not meeting Class I criteria.

Class III: Perennial and intermittent streams with no fish populations or fish habitat, but have sufficient flow or sediment and debris transport to directly influence downstream water quality or fish habitat capability. These streams generally have bankfull widths greater than 1.5 meters (5 feet) and channel incision greater than 5 meters (15 feet); may be called Class III based on professional interpretation of stream characteristics.

Class IV: Other intermittent, ephemeral, and small perennial channels with insufficient flow or sediment transport capabilities to directly influence downstream water quality or fish habitat capability. These streams generally are shallowly incised into the surrounding hillslope.

Non-streams: Rills and other watercourses, generally intermittent and less than one foot in bankfull width, showing little or no incisement into the surrounding hillslope or evidence of scour.

In addition to surface water streams, there are about 286 acres of lakes in the Project Area (Table 14). These primarily support resident fish species which include Dolly Varden char, rainbow and coastal cutthroat trout. Lakes also play an important role in juvenile sockeye salmon life history, providing food in the form of phytoplankton and zooplankton and rearing habitat

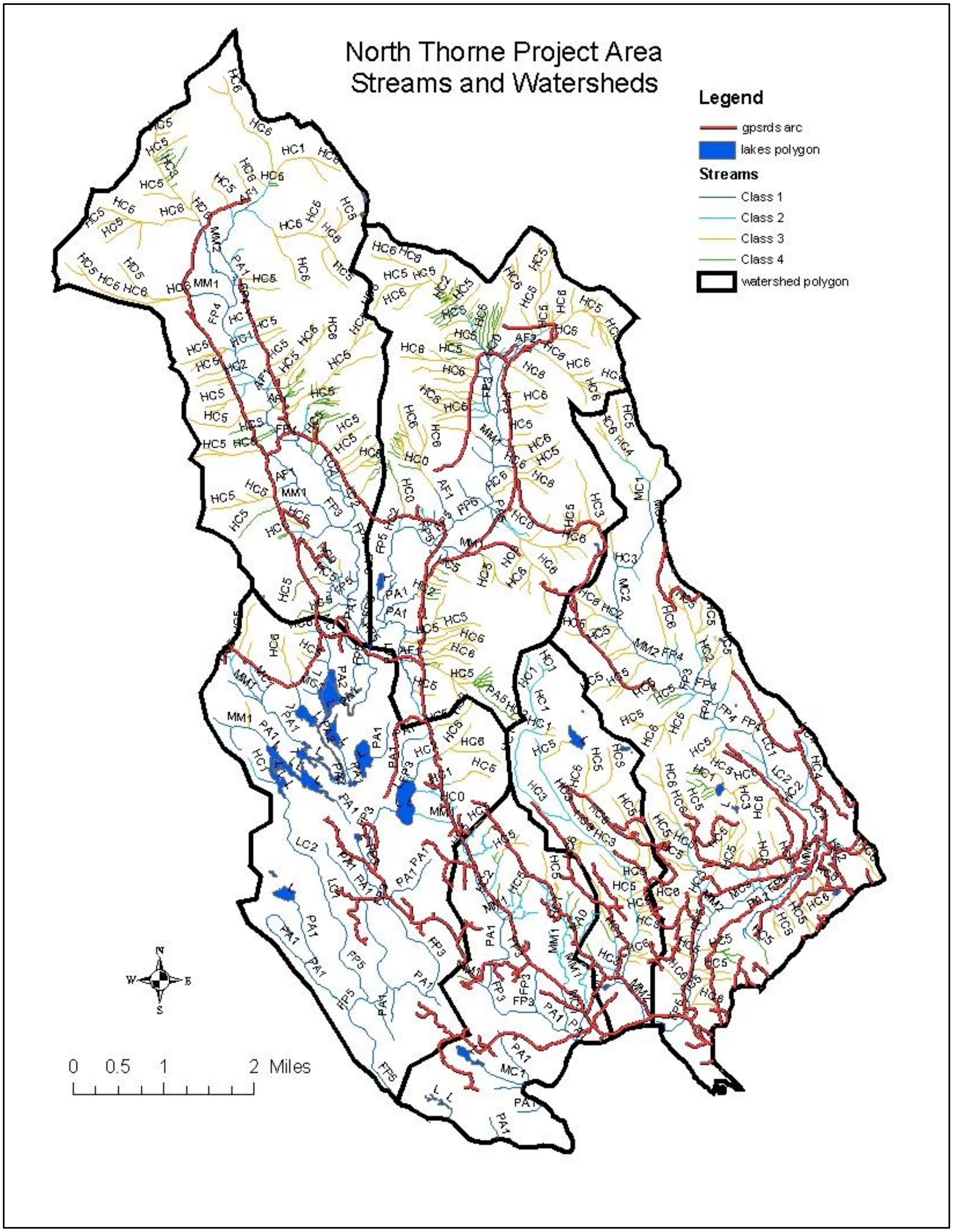

Figure 6. Stream Class and channel type of streams, and roads located within the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Table 13. Miles of stream, by watershed, stream class, and stream density in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Watershed	Class I	Class II	Class III	Class IV	Total stream miles	Stream Density (mi/mi^2)
Lava Ck	11.2	8.6	28.8	3.6	52.2	4.7
Falls Ck	1.4	6.4	8.4	0.7	16.9	4.3
Unnamed Composite	7.2	6.9	1.4	2.3	17.8	3.4
West Fk North Thorne	12.8	4.8	31.91	10.6	60.1	4.6
Snakey Lakes Lowlands	25.7	3.4	4.5	0	33.6	3.2
East Fk North Thorne	13.9	4.7	42.0	11.5	72.1	6.0
Total miles	72.2	34.6	117.0	28.7	252.7	4.4 (average)
Percent of Project Area	(29%)	(14%)	(46%)	(11%)	(100%)	

Stream Process Groups

Streams in the Project Area have been assigned a channel type (USFS 1992). Channel typing stratifies stream and lake sections within a watershed into different stream process groups. The process groups are based on physical characteristics of streams and describe the interrelationship between watershed runoff, topography, geology, and glacial or tidal influences on fluvial erosion and deposition. Channel types allow the prediction of the physical responses of streams to different management activities. For a description of stream process groups, see Appendix D of the Tongass Forest Plan (USFS 2008). There are seven process groups found within the Project Area (Table 14).

Table 14. Miles of stream by process group and acres of lake habitat, by watershed in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Process Group	Miles of Stream							% of Project Area
	Lava Creek	Falls Creekk	Unnamed Composite	W. Fk. North Thorne	Snakey Lakes	E. Fk. North Thorne	Total	
Alluvial Fan	0.9	0.3	0	2.3	0.2	4.1	7.8	(3%)
Floodplain	4.4	0	1.9	5.9	7.5	4.4	24.1	(10%)
High Gradient Contained	40.1	15.5	7.0	45.5	6.9	55.1	170.1	(67%)
Large Contained	1.3	0	0	0.7	1.8	0	3.8	(1%)
Moderate Gradient Contained	1.9	0	1.5	0	1.0	0.2	4.6	(2%)
Moderate Gradient Mixed Control	2.6	0.9	3.6	3.1	2.4	5.0	17.6	(7%)
Palustrine	0.9	0.2	3.8	2.7	13.7	3.2	24.5	(10%)
Total	52.1	16.9	17.8	60.2	33.5	72.0	252.5	(100%)
Lakes (acres)	18.7	19.5	24.2	11.2	197.1	15.5	286.2	

Stream process groups are also an indicator of the amount and quality of fish habitat within the Project Area. The amount and quality of rearing habitat predicted by the various channel types has been established through field studies within the Tongass National Forest. Floodplain, palustrine, alluvial fan, and moderate gradient mixed control channels are sediment sensitive. Floodplain channels provide the greatest amount of spawning area for salmon and much of the rearing area. Moderate gradient mixed control channels can also provide good spawning and rearing habitat in the lower gradient sections. Palustrine channels are areas with low water velocities, which are important rearing areas for juvenile coho salmon. The high gradient contained process group has the most miles of stream within a process group (Table 14).

Beneficial Water Use

Water quality affects uses by humans, fish and aquatic organisms, and wildlife. There are no known domestic or municipal water uses of streams, and no hydro projects within the North Thorne Project Area. Human use of water in the Project Area is recreational; canoeing the Snakey Lakes area and lower North Fork of the Thorne River and fishing. Water is sometimes used from nearby streams for road dust abatement, and other operations surrounding drilling or rock pit use. The main water use in the Project Area is for recreation and the propagation of trees, fish and wildlife.

Water Quality

Water quality includes the components of water chemistry, water temperature, and sediment. The natural variability of climate, geology, soils, and vegetation generally result in differing values of these components. Land use can alter the natural variability resulting in increased sediment delivery to streams, and variations in water chemistry and water temperature. Water quality affects uses by humans, fish and aquatic organisms, and other animals.

Limited water quality data exists for streams within the North Thorne Project Area. The University of Alaska Anchorage, Environmental and Natural Resources Institute (ENRI) personnel began conducting biological assessments of some streams within the North Thorne Project Area during 2002 (Major et al 2003). This survey was part of a larger effort to develop a stream condition index for Southeast Alaska. Streams were designated as either reference (watershed in pristine condition), stressed (watershed had been logged or had other land use activities), or urban a priori. Macroinvertebrate samples and water chemistry samples were collected, and visual physical habitat assessment were noted.

Water Chemistry

Water chemistry parameters collected by ENRI include conductivity, dissolved oxygen, pH, total dissolved solids, and water temperature were measured at each site in situ using a Hydrolab Surveyor 4 and Minisonde that was calibrated daily (Rinella et al 2005). This is basically a one day sample, and represents a one day "snapshot" of data. Table 15 displays results of data collect by ENRI. Stressed streams within the North Thorne Project Area are compared to streams in a nearby pristine watershed. Results do not appear to show major differences between the stressed and pristine streams.

Table 15. Conductivity, dissolved oxygen percent and mg/l, pH, total dissolved solids ppm, and water temperature for streams within the North Thorne Project Area (NTPA). Additional data is also shown for pristine streams outside the NTPA for comparison. na=not assessed. Data from Rinella et al 2005.

Stream Name	Stream Type	Water Color	Date sampled	Conductivity (us/cm)	D.O. (% sat)	D.O. (mg/l)	pH	TDS (ppm)	Temp (^{o}C)
Falls Ck (NTPA)	stressed	stained	4/25/2002	23	na	na	7.4	0.0144	3.8
Lava Ck (NTPA)	stressed	stained	4/25/2002	23	na	na	7.4	0.0143	4.7
West Fk North Thorne(NTPA)	stressed	stained	4/25/2002	36	92	12.0	7.6	na	3.8
East Fk North Thorne (NTPA)	stressed	stained	5/4/2003	28	88	11.0	7.0	na	5.9
Anderson Ck Karta River	reference	stained	4/27/2002	22	79	12.3	7.5	0.0139	5.6
Unnamed trib lower Karta River	reference	stained	4/28/2002	8	95	12.7	6.3	0.0053	3.2

Unnamed trib to Salmon Lk. Karta River	**reference**	**stained**	**4/27/2002**	**20**	**96**	**12.6**	**6.8**	**0.0127**	**3.6**

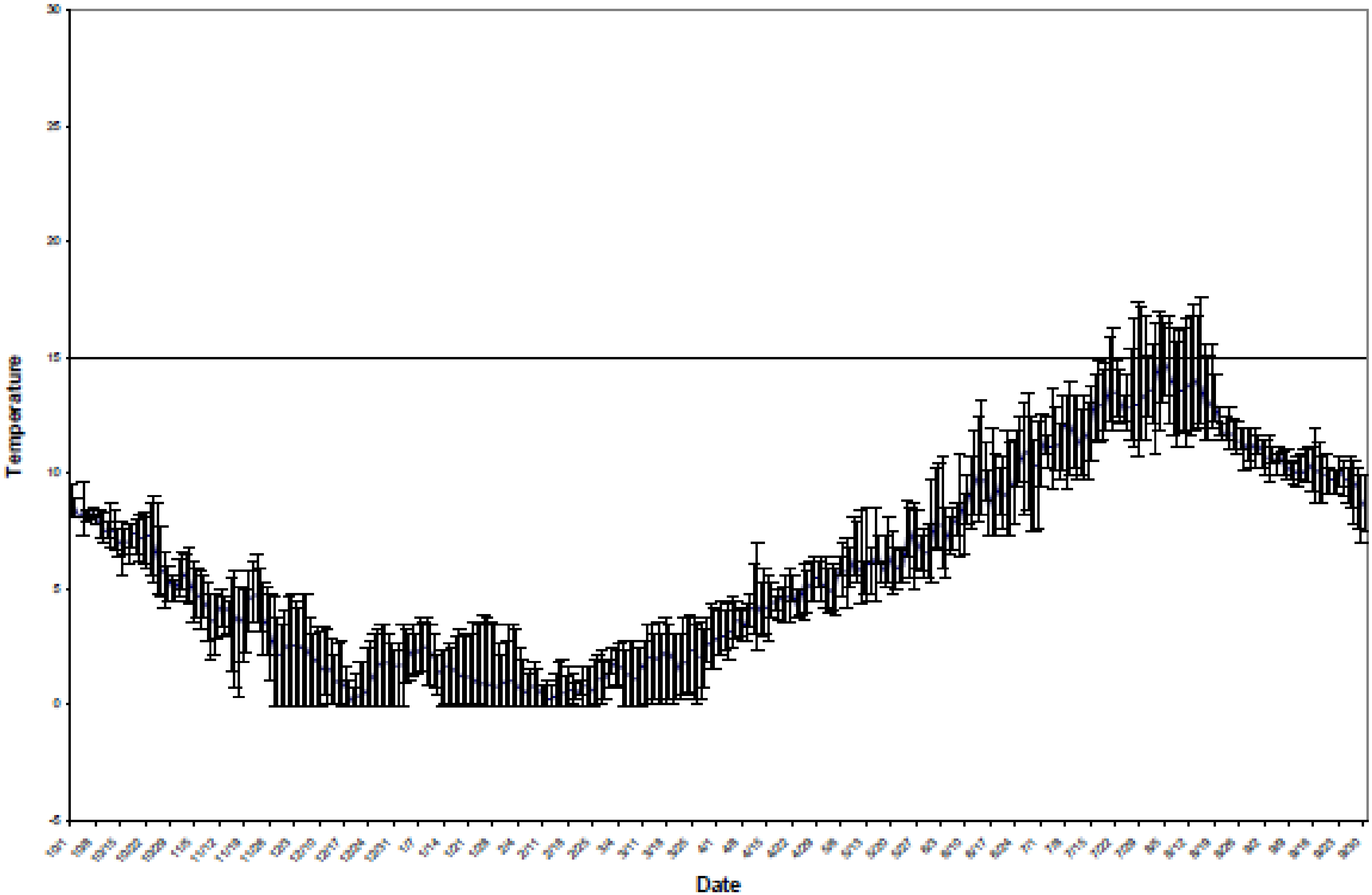

Figure 5. Mean dialy water temperature for the North Fork of the Thorne River. Error bars represent daily high and low maximum water temperatures (Walters and Prefontaine 2005).

Water Temperature

The purpose of water temperature monitoring is to evaluate one of the many indicators of watershed health. Steam temperature can increase due to a number of circumstances such as a change in vegetation adjacent to the stream, change in vegetation in the watershed, and below average rainfall associated with warm weather. Stream temperature has an inverse relationship with the dissolved oxygen (D.O.) holding capacity of water and each has a lethal threshold for fish. The lethal water temperature limit for salmon (adult and fry) is considered to be 24^{o}C (75^{o} F). Ideal water temperatures for salmon are between 10 and 18^{o}C (50 and 65^{o}F). According to the Alaska State Water Quality Standards (DEC 2011) stream temperatures "may not exceed 20^{o}F at any time" and "the following maximum temperatures may not be exceeded, where applicable: Migration Routes 15^{o}C, Spawning Areas 13^{o}C,Rearing Areas 15^{o}C, Egg and Fry Incubation 13^{o}C. For all other waters, the weekly average temperatures may not exceed site-specific requirements needed to preserve normal species diversity or to prevent appearance of nuisance organisms.

Water Temperature has been monitored on the North Fork of the Thorne River since 1998. The site is located just downstream of the North Fork of the Thorne River bridge on the 3016000 road. Water temperatures taken between 1998 and 2002 ranged from a low of –0.1^{o}C to a high of 17.61^{o}C (Figure 6) [Walters and Prefontaine 2005]. Maximum daily water temperatures exceeding Alaska State Water Quality Standards for spawning areas, and egg and fry incubation (13^{o}C) have taken place from June through August. Average maximum daily water temperatures exceeding 13^{o}C occurred during mid-July to mid-August. Maximum daily water temperatures exceeding Alaska State Water Quality Standards for migration routes and rearing areas (15^{o}C) also occurred during mid-July to mid-August.

Sediment

Sediment is water transported materials such as gravel, sand, and silt. Gravel and sand generally are transported along the stream bottom as bedload. Silt is generally transported within the water column and is measured in nephelometric turbidity units (NTU’s) [turbidity]. According to the Alaska State Water Quality Standards (DEC 2011) for growth and propagation of fish, shellfish, other aquatic life, and wildlife, turbidity "may not exceed 25 NTU above natural conditions. For all lake waters, turbidity may not exceed 5 NTU above natural conditions. Turbidity measurements do not exist for any streams or lakes within the Project Area.

Stream sediment originates from natural geological processes and from land use activities. Within the Project Area the primary processes that input sediment to streams are landslides, streambank erosion, erosion from roads, and bedload scour. Fine sediment can reduce stream habitat quality, abraid the gills of fish, and fill in the pores in gravels thus smothering incubating fish eggs.

Sediment Risk Assessment

A sediment risk assessment model (Gier 1998) was run on the watersheds in the North Thorne Project Area. The model evaluates multiple, independent watersheds using a coarse-scale screening process based on percent disturbance, mass movement potential, drainage efficiency, and other watershed characteristics.

Two risk indices are developed for each watershed, which evaluate characteristics related to sediment supply and transport, and the extent of storage (depositional) streams. Generally, watersheds with high transport potential have steeper slopes, more unstable soils, and higher stream densities. High gradient contained, moderate gradient contained, and large contained channels are stream process groups that have high sediment transport capacity due to steeper stream gradients.

Transitional stream process groups include moderate gradient mixed control and alluvial fan channels. Transitional stream process groups have moderate sediment retention capacity and are considered lower risk than depositional channels because they tend to retain less amount of fine sediment and gravel, and have higher proportions of stable substrate. Moderate gradient mixed control channels can also provide good spawning and rearing habitat in the lower gradient sections.

Watersheds with high storage potential (depositional) have higher densities of low gradient depositional streams for medium and long-term sediment storage. Depositional stream process groups include floodplain, palustrine, and alluvial fan channels. Depositional stream process groups have a high sediment retention capacity and have higher impact risk due to low gradients.

The transport and storage indices are combined into an overall Sediment Risk Index (SRI) under the assumption that watersheds with high combinations of storage potential and transport potential represent the highest level of concern for management activities. Watersheds with a high SRI usually have steep, unstable valley walls which drain into well developed, low gradient valley bottom channels.

Watershed morphology and disturbance history help identify and rank areas according to potential for sediment production and deposition. The SRI does not provide yield estimates, sediment discharge estimates, nor identify impact thresholds. It can indicate the location and potential significance of sediment sources and depositional areas within the watershed on measured characteristics known to correlate with sediment transport and deposition. The SRI calculations for watersheds in the North Thorne Project are displayed in Table 16.

Table 16. Selected Sediment Risk Index values for watersheds in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

	Lava Ck	Falls Ck	Unnamed Composite	West Fk North Thorne	Snakey Lakes Lowlands	East Fk North Thorne
Sediment Risk Index value	81	40	89	88	100	97
Sediment Risk Index rank	5th	6th	3rd	4th	1st	2nd
Potential Impact Index value	35	34	100	75	2	74
Potential Impact Index rank	4th	5th	1st	2nd	6th	3rd
Depositional Stream Index	26	6	54	38	100	44
Transitional Stream Index	43	35	100	45	36	75
Drainage Efficiency Index	79	73	58	76	60	100
Transport Potential Index	100	76	57	83	43	84
Storage Potential Index	29	9	61	40	100	49

The Snakey Lakes Lowlands, East Fork, Unnamed Composite, West Fork, Lava Creek, and Falls Creek watersheds ranked one through six respectively for sediment risk. This makes sense since the topography of the West Fork, East Fork, Unnamed Composite, and Snakey Lakes Lowlands do contain steep slopes that transport sediment, but also contain valley bottoms that capture and store that sediment.

Uplands/Hillslope Condition

Hillslopes in North Thorne Project Area are source areas for stream energy, large wood, and sediment. As the headwater areas in North Thorne Project Area erode, the streams evolve and supply varying sizes of sediment to the mid-slope and valley bottoms. The upper elevations capture precipitation and transfer it downslope with stream power along high gradient, moderately incised stream channels. Shallow soils overlying glacially compacted till have low permeability, thus during heavy rainfall water is shed downslope over the compacted soil layer. Heavy watering in low permeable soils causes saturation resulting in increased shear stress and decreased shear resistance. Overland surface flow may occur if the soil is completely saturated or if gravity moves the water faster downslope than it can permeate through the top layers of the soil. These topographic and hydrologic characteristics contribute to the erosions processes in the watershed such as landslides and soil creep. In many places streams become blocked by debris moving downstream and redirect the stream overland, crossing roads were no culvert exists, or plugging up culverts downstream and inboard road ditches with high volumes of debris and bedload.

A dominate feature in the coastal temperate rainforests of Southeast Alaska is the natural disturbance regime. In steep forested terrain with high soil water levels, mass wasting (landslides) is the dominant erosional process (Swanston 1991). Topographic, geologic, and soil conditions in combination with high rainfall events are the major factors that contribute to landslide events in Southeast Alaska. Steep forested terrain occurs throughout the northern portion of North Thorne Project Area. This results in landslides along hillslopes and headwater streams in North Thorne Project Area.

This Project Area has a history of unstable slopes and high frequency of landslides. Landslides can transport large amounts of sediment into streams. Increased landslide frequencies can overwhelm a stream system with sediment and alter the sediment regime. The effects of these slides on the mainstem reaches of streams in the Project Area vary depending on location. Nine hundred-thirty acres of landslides have occurred in North Thorne Project Area, and 160 streams have been impacted by those landslides. Landslides that reach streams are able to transport wood and sediment directly to the mainstem streams, those that do not reach the creek tend to deposit on the foot slopes and result in secondary pulses of sedimentation downslope.

Mass movement index (MMI) hazard classes are used to group soil map units (SMU's) that have similar properties relative to the stability of natural slopes. Slope gradient is the primary site factor determining the stability of slopes; however, soil type and soil drainage class may also play a role in specific locations. Four categories of MMI soils hazard classes exist, MMI 1 (most stable) through MMI 4 (least stable). Table 17 displays acres of MMI hazard soils by watershed.

Table 17. Mass Movement Index (MMI) hazard soil acres, landslide acres, and landslide acres impacting streams by watershed for the North Thorne Project Area, Prince of Wales Island, Alaska. . Data from USFS, Tongass National Forest GIS Coverages.

Watershed Name	MMI 1	MMI 2	MMI 3	MMI 4	Landslide acres	No. streams impacted by landslides	Landslide acres impacting streams
Lava Creek	**3533.6**	**288.6**	**3028.5**	**160.2**	**71**	**27**	**54**
Falls Creek	**1333**	**87.5**	**1036.7**	**9.3**	**17**	**7**	**13**

Unnamed Composite	**1442.4**	**641.5**	**1180**	**0**	**3**	**3**	**0**
West Fork North Thorne	**3443.1**	**0**	**3232.6**	**1725.9**	**657**	**65**	**249**
Snakey Lakes Lowlands	**2569.8**	**1473.4**	**2283.4**	**40.8**	**4**	**0**	**3**
East Fork North Thorne	**4104.2**	**150.6**	**2278.4**	**1125.7**	**178**	**58**	**121**
Total	**16426.1**	**2641.6**	**13039.6**	**3061.9**	**930**	**160**	**440**

SMU's in the very high class (MMI 4) are the least stable and have the greatest probability of slope failure. These slope gradients are generally greater than 75%, but includes some poorly and very poorly drained soils on 60% slopes.. These areas may have visible indications of instability and past failures such as slide scarps, tension cracks, jack-strawed trees, and/or mixed soil horizons. Nearly all naturally occurring landslides are found on very high class soils (USFS 2001). The risk of management induced slope failure is so high on these areas that they are generally precluded from forest harvest and roading activities (USFS 2008).MMI 4 soils cover 8% of the Project Area and are located on the steep slopes of the U-shaped valleys primarily in the northern portion of the Project Area. A total of 67 landslides were found to originate in MMI 4 soils.

The West and East Fork watersheds contain the highest amount of MMI 4 soils and therefore have the highest risk for landslide activity. Currently, the West and East Fork watersheds contain 835 acres of landslides, approximately 90% of all the landslides in the Project Area (Figure 6; Table 17). A total of 370 acres of landslides have deposited sediment and debris into streams of the West and East Fork watersheds.

SMU's in the high class (MMI 3) have a lower probability of failure than a very high mass movement hazard class soil. These soils are mostly well drained and have slope gradients that are generally greater than 60%, but may include some soils on slopes greater than 50%that are poorly drained. These areas show visible indications of instability and past failures similar to the very high class soils (USFS 2001). The risk of management induced slope failure is high on these areas, but they are generally not precluded from normal forest harvest and roading activities (USFS 2008). MMI 3 soils cover approximately 31% of the Project Area. A total of 76 landslides were found to originate in MMI 3 soils.

In addition to hazard soils and steep slopes, landslides can be triggered by heavy precipitation during storm events, problems associated with road construction on steep slopes, and harvest activities on steep slopes. Landslide activity was monitored during heavy precipitation events in October 1993. Approximately 33 acres of landslides in the Project Area are associated with these October 1993 storm events.

Landslides and windthrow dominate the natural disturbance regime in the North Thorne Project Area. Figure 6 shows locations of landslides, potential areas susceptible to medium and high storm damage from wind, and MMI hazard 3 and 4 soils. As previously mentioned, the Project Area is orientated in a north-south direction and generally receives storm winds from a south-southeast direction.

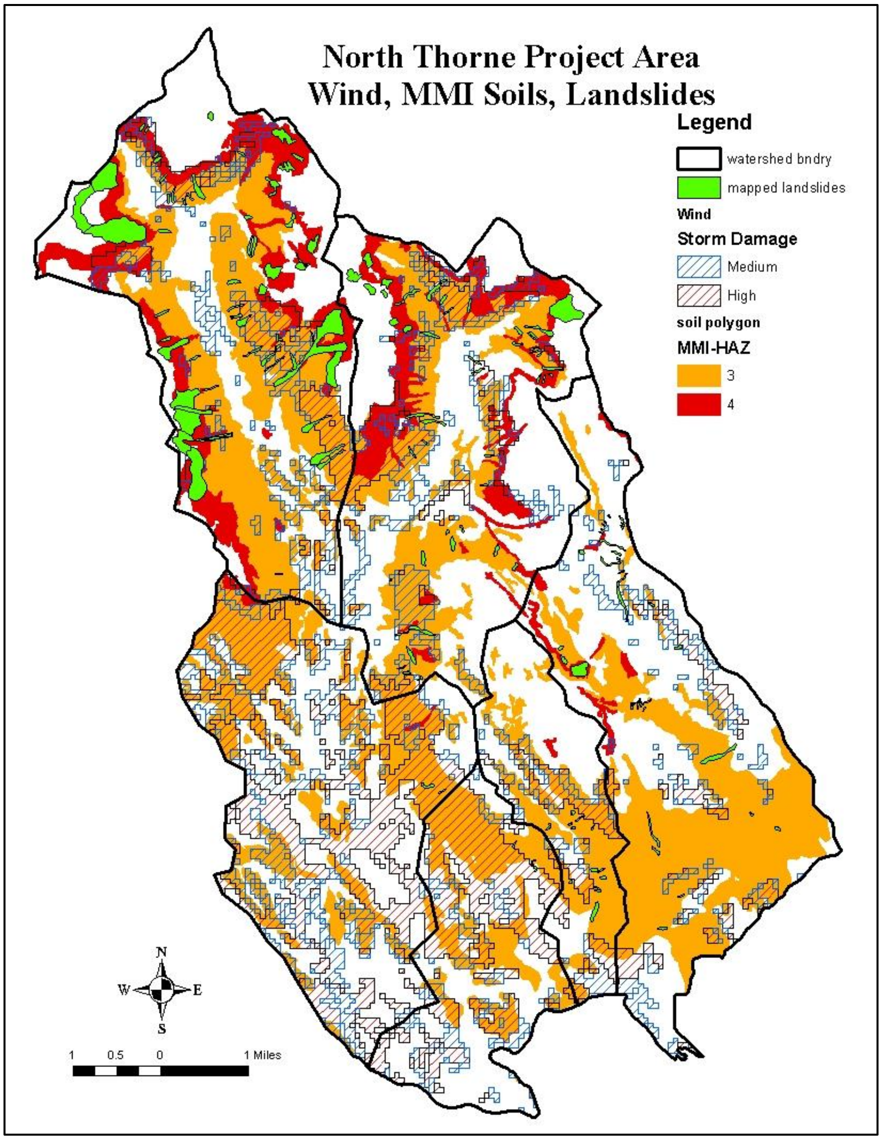

Figure 7. Mapped landslides, areas susceptible to medium and high storm damage from wind, and location of mass movement index (MMI) hazard soils in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Problems associated with road design and drainage initiated 10 landslides that have impacted 12 acres. The majority of these landslides are located on the 3018250 road.

A total of 52 landslides have initiated in previously harvested areas. While landslides in these harvested areas may have occurred regardless of management, data collected from landslide activity across the Tongass has indicated that landslide risk can be increased as much as three times by timber harvest (TLMP 1997). The stress of timber harvest on unstable soils can affect fluvial and geomorphic processes in stream channels and riparian zones of headwater systems (Gomi et al 2001). Swanston and Marion (1991) found a 3.5 fold increase in landslides in harvested areas versus unharvested areas. They also noted that landslides in harvested areas tend to be smaller than landslides in unharvested areas. This information would suggest that increased sedimentation may be an issue following timber harvest in landslide prone areas.

<u>Timber Harvest</u>

Large-scale timber harvest in the Project Area has changed the historic natural disturbance regime to reflect low frequency but high magnitude disturbances. Past harvest in the Project Area amounts to 8,935 acres. Table 18 shows harvest acres by decade in the Project Area. Timber harvest has occurred on hillslopes, in valley bottoms, and in riparian areas.

Since the early 1960s, much of the low elevation (<1,500' elevation) productive old growth in the Project Area has been harvested, with most disturbance concentrated along the valley bottoms. This has resulted in an unbalanced shift to young forest, a development stage which does not reflect the desired condition of the LUDs in the Project Area. Clearcutting differs from natural disturbances in that it often results in concentrated large-scale openings (typically up to 100 acres), rather than small, dispersed patches (20 acres or less). In natural disturbances, many trees usually remain standing and windthrow patches have erratic boundaries. Because nearly all trees are felled during clearcutting, stands that develop after harvest of old growth are even-aged.

Table 18. Acres of Timber Harvest by decade in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Year	1960s	1970s	11980s	1990s	2000s
Acres Harvested	2,212	3,369	1,723	1,549	82

Table 19. Acres of Timber Harvest by watershed, harvested acres less than 30 yrs old, and percentages in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

	Lava Ck	Falls Ck	Unnamed Composite	West Fk North Thorne	Snakey Lakes Lowlands	East Fk North Thorne
Total Harvested (ac)	3117	808	1169	1577	1075	1190
Total Harvested (%)	44%	32%	35%	19%	16%	16%
Wshed Harvested (ac) less than 30 yrs	977	216	730	1577	1011	1190
Wshed Harvested less than 30 yrs (%)	14%	9%	22%	19%	15%	16%

Figure 8. View looking south from the north end of the East Fork of North Thorne subwatershed, showing timber harvest to mid slope.

Roads

The Project Area has been extensively roaded, primarily in support of past timber harvest. There are 96 miles of existing road within the Project Area, 93 miles of which are Forest Service roads. Further, there is an average road density of 1.9 miles of road per square mile of watershed (Table 20). The road system connects the Project Area to Thorne Bay, Craig, Klawock, and Hollis in the south and Coffman Cove, Naukati, and Whale Pass in the north.

Table 20. Road Mileage and Road Density in the North Thorne Project Area. Data from USFS, Tongass National Forest GIS Coverages.

Watershed	Lava Ck	Falls Ck	Unnamed Composite	West Fk North Thorne	Snakey Lakes Lowlands	East Fk North Thorne	
Road Mileage	30.8	9.8	14.4	11.7	15.1	14.3	96.1 (Total)
Road Density (mi/mi^2)	2.8	2.5	2.7	0.9	1.4	1.2	1.92 (Average)

Timber harvest and road construction can accelerate sediment production (USFS 2008b). Roads have been found to contribute more sediment to streams than any other land management activity (Gucinski, and others 2001), and pose the greatest potential risk to watershed resources and fish habitat capabilities (Furniss and others 1991, Ziemer 1997). The effects of roads on aquatic habitat and populations are well documented and overwhelmingly negative. Fine-sediment, a common consequence of road-derived sediments entering streams, has been linked to decreased fry emergence, decreased juvenile fish densities, loss of winter carrying capacity, increased predation of fishes, and can reduce aquatic insect populations and algal production (Gucinski, and others 2001).

Table 21. Number of Stream Crossings by Stream Class in the Project Area. *= Data from RCS surveys; **= Data from USFS, Tongass National Forest GIS Coverages.

Stream Class	Number
Class I	37*
Class II	69*
Class III	107**
Class IV	24**

Roads can affect watershed processes, modifying natural hillslope drainage and accelerate erosion (Furniss et al. 1991; Ziemer 1997). The disruption of stream flow connectivity can continue even after road storage and culvert removal, it also may be corrected through culvert removal and proper road storage. Road construction also has the potential to block fish migration and affect upstream fish passage through improper placement or sizing of culverts. There are at least 237 stream crossings by road in the Project Area (Table 21).

Valley/Floodplain Conditions

Large Wood Dependent Channels

Large wood dependent channels (AF, FP, MM channel types) make up 20% of the channel types in the Project Area, and total 49.5 miles of stream (Table 14). These channel types have the ability to capture and hold legacy large wood and are mainly located in the Lava Creek watershed, and the West Fork, East Fork, and Snakey Lakes subwatersheds.

Of all riparian areas, floodplains are some of the most productive sites for lowland timber, wildlife and fish on the Tongass National Forest (USFS 2008b). Floodplains are composed of nutrient-rich sediments and are typically found in broad, flat, alluvial U-shaped valleys. About 10% (24 miles) of the stream mileage in the project area is floodplain channel, and 12% (596 acres) of riparian management area (RMA) is floodplain. About 114 acres (19%) of floodplain RMA has been previously harvested. About 0.39 acres of landslides has dispersed onto floodplain RMAs. Currently, 0.6 miles of road crosses floodplain channels, at the North Fork Thorne River bridge (3016000), the Upper North Fork of Thorne River (3015000, two logs spanning stream, undrivable), and at the East Fork bridge on the East Fork of North Fork Thorne River (3015000).

Riparian Vegetation

An important part of watershed health and function are the riparian areas. The Forest Plan (USFS 2008) defines riparian areas as "…areas [which] encompass the zone of interaction between the aquatic and terrestrial ecosystems, and include riparian stream sides, lakes, and floodplains with distinctive resource values and characteristics." Riparian areas have distinctive resource values and characteristics, and can be geographically delineated. The vegetation condition plays a key role in the function of riparian management areas. Riparian areas provide a source of large wood for input into streams. This is important in maintaining habitat complexity for anadromous and resident fish in the form of pool habitat, spawning habitat and escape cover. The vegetation in riparian areas provides stream bank stabilization via root masses. Trees in riparian areas also help provide a broader shade canopy along streams, which is important for maintaining water quality, including optimum water temperatures for the production of fish species.

Figure 9. Alder dominated riparian area due to harvest of Old Growth trees up to the streambank in the upper West Fork subwatershed. Note also bedload aggregation due to lack of a stable channel.

The North Thorne Project Area has 5,020 acres of RMA along Class I, II, and III streams Past timber harvest practices removed 1,311 acres (26%) of riparian vegetation to the stream bank within the Project Area. Fish habitat has been most adversely affected in the streams where timber was harvested without leaving riparian buffers. Generally, these areas lack large instream woody debris that is necessary for pool formation and other fish habitat. Loss of trees along stream banks also leads to a loss of the roots that hold the banks together, because roots decay after three to five years following harvest (Hartman et al 1996). The affected streams then show signs of becoming wider and shallower, because the banks and channels have become unstable. Past removal of riparian vegetation has affected sediment delivery, fish habitat, and stream productivity. Current riparian Standards and Guidelines require no-harvest buffers along all Class I, II, and III streams.

In the 1980's it was a common practice to remove LWD from stream channels as logjams were thought to cause barriers to upstream movement of fish. While there is no direct documentation of LWD removal from streams in the Project Area, LWD may have been removed from Falls Creek in particular (200 m segment of old road in and adjacent to stream). LWD is important for capturing sediment and releasing slowly over time, rather than in a "large burst". LWD also sorts out bedload, creating spawning gravels for fish. LWD deflects flows, helping to protect streambanks from excessive erosion, and forms low flow velocities along channel margins. LWD helps create pools, and form off channel and channel margin habitat thus creating fish rearing habitat.

Total riparian thinning completed to date for Class I streams is 80 acres, and for Class II streams is 60 acres (Table 22). Along Class III streams the total riparian thinning to date is 60 acres (Table 23).

Table 22. Stand number, Year originally harvested, and approximate acres of Class I and II stream riparian thinning completed, and year thinned within the North Thorne Project Area (based on one side of stream, 100 ft wide riparian area).

Stand Number	Year Harvested	Watershed Location	Acres Class I stream (100 ft wide, 1 side only)	Acres Class II stream (100 ft wide, 1 side only)	Year Thinned
580010172	1976	West Fork	4.32	3.62	2009
580010501	1976	West Fork	6.01	0	2008
580010505	1976	West Fork	7.59	1.72	2005
580020511	1976	East Fork	12.62	0	2005
578010501	1977	West Fork	1.48	0	2008
579020506	1966	Lava & Falls Creek	7.33	23.81	2004
579020507	1971	Lava Creek	0	10.54	2004
580010508	1977	West Fork	2.48	0	2005
580010509	1977	West Fork	14.97	0	2002
580010502	1979	West Fork	0	5.99	2008
580010511	1987	West Fork	0	3.66	2009
580010512	1986	East Fork	0	1.92	2009
580010521	1979	West Fork	4.32	8.59	2008
578010506	1987	Snakey Lks & Unnamed Composite	14.13	0	2007
578010511	1988	Snakey Lakes	4.33	0	2007
Total			80	60	

Table 23. Stand number, Year originally harvested, and approximate acres of Class III stream riparian thinning completed, and year thinned within the North Thorne Project Area (based on one side of stream, 100 ft wide riparian area).

Stand Number	Year Harvested	Watershed Location	Acres Class III stream (100 ft wide, 1 side only)	Year Thinned
579020506	1966	Lava & Falls Creek	114.46	2004
579020507	1971	Lava Creek	64.72	2004

580010172	**1976**	**West Fork**	**8.75**	**2009**
580010501	**1976**	**West Fork**	**1.48**	**2008**
580010505	**1976**	**West Fork**	**7.69**	**2005**
580010512	**1986**	**East Fork**	**5.75**	**2009**
580010511	**1987**	**West Fork**	**3.49**	**2009**
580020511	**1976**	**East Fork**	**19.73**	**2005**
580010508	**1977**	**West Fork**	**3.47**	**2005**
580010502	**1979**	**West Fork**	**36.94**	**2008**
Total			**60**	

Inchannel Conditions

The inchannel conditions found in the Project Area are varying in function and condition. The channels are dependent upon the location within the watershed, amount of surrounding timber harvest and road building, and the hillslope and valley/floodplain processes and conditions. Quantification of inchannel conditions can be described using proper functioning condition and tier II surveys.

Proper Functioning Condition (PFC) Surveys

One measure of good watershed health is the proper functioning condition (PFC) survey, which examines the hydrology, vegetation, and erosion/deposition characteristics of a stream and its riparian area. PFC surveys are a qualitative assessment of the on-the-ground condition of riparian areas. The survey includes questions about channel stability, the presence of large woody debris or other structure to create pools and dissipate stream energy, and the ability of the riparian vegetation to control bank erosion. An interdisciplinary team consisting of at least a fish biologist, hydrologist, and fisheries technician conducted the assessment. Table 24 displays the status of the PFC sites surveyed.

Judging from the Proper Functioning Condition surveys and general observations, the areas where fish habitat has been most adversely impacted has been in the streams where timber was harvested without leaving riparian buffers. Generally, these areas lack the large woody debris that is necessary for pool formation and other fish habitat. The affected streams show signs of having become wider and shallower as the banks and channels have become unstable. Streams with these characteristics include much of lower Falls Creek, lower Lava Creek, and the upper portions of the East and West forks of the North Thorne River

Table 24. Summary of proper functioning condition surveys within the North Thorne Project Area. PFC= proper functioning condition, FAR = functioning at risk, NF = not functioning.

Watershed	Channel type	Status	Riparian harvest	Problems, risks
Upper E Fk W Fk N Thorne (near end 3015 rd)	**MM**	**FAR**	**Yes**	**Channel aggradation, lack of future LWD, channel braiding.**
Upper E Fk W Fk N Thorne (near end 3015 rd)	**FP**	**PFC**	**No**	**Concern with harvested area upstream (MM Channel)**
Upper W Fk W. Fk N Thorne (dwn strm 3015 rd)	**MM1**	**FAR**	**Yes**	**Vertically unstable (downcutting), lack of future LWD. Recommend LWD, boulder placement.**

Upper W Fk W Fk N Thorne (dwn strm 3015 rd)	**FP4**	**FAR**	**Yes**	**Lack of future LWD, primarily alder. Sediment aggregation, disturbances and additional input could overload system. Recommend LWD placement.**
Lower W Fk N Thorne (upstrm NThorne bridge 3015 rd)	**FP4**	**FAR**	**One bank, less on 2nd**	**Sediment aggregation. LWD low, most piled up in two jams on meander. Future LWD sources somewhat limited by harvested bank.**
Lower W Fk N Thorne (upstrm NThorne bridge 3016 rd)	**FP4**	**PFC**	**One bank, less on 2nd**	**LWD low, future sources somewhat limited.**
Upper W Fk E Fk N Thorne (below 3015640 rd)	**FP4**	**PFC**	**No**	**Minor downcutting. Lateral movement from some deposition, but most deposition is upstream. This stream segment is functioning properly.**
Upper W Fk E Fk N Thorne (below 3015640 rd)	**MM1**	**FAR**	**Yes**	**Limited sources of future LWD, except some in upstream area. Downcutting in area above road where sediment loading occurred. Some raw banks. Some conifer release, thinning opportunities.**
Upper E Fk N Thorne (above 3015640 rd)	**MM1**	**PFC**	**Yes**	**This stream segment is functioning properly, but concerns with limited sources of future LWD. Minor channel constriction at road crossing. Downcutting channel suggests some LWD would capture bedload and distribute less bedload to stream segment below 3015640 road.**
Upper E Fk N Thorne (below 3015640 rd)	**FP3**	**FAR**	**Yes, part of**	**Concerns with limited sources of future LWD. Sever bedload aggregation. Some LWD placement.**
Upper E Fk N Thorne (below 3015640 rd)	**FP3**	**PFC**	**Yes, part of**	**This stream segment is functioning properly, but concerns with limited sources of future LWD.**
Lower E Fk N Thorne (above E Fk bridge 3015 rd)	**FP5**	**PFC**	**No**	**This stream segment is functioning properly**
Lower E Fk N Thorne (above/below E Fk bridge 3015 rd)	**FP5**	**PFC**	**One bank**	**This stream segment is functioning properly, but concerns with limited sources of future LWD from harvested bank.**
Lower E Fk N Thorne (below E Fk bridge 3015 rd)	**FP5**	**PFC**	**No**	**This stream segment is functioning properly**
Lower Lava	**FP4**	**FAR**	**Yes**	**Lack of future LWD. Sediment**

Ck (Thorne River upstrm to no harv)				**aggradation. Channel constrictions from roadfill. Unstable banks and channels. Recommend removal of fill, LWD and boulder addition.**
Lower Lava Ck (no harv area below 3017 rd)	**MC3**	**PFC**	**No**	**This stream segment is functioning properly. Unknown effects from harvest in rest of watershed.**
Lower Lava Ck (below 3017 rd)	**MM2**	**FAR**	**Yes**	**Little LWD in stream, lack of future sources. Some downcutting, undercutting of banks. Few pools or spawning gravels. Recommend riparian thinning.**
Upper Lava Ck (above 3017 rd)	**LC2**	**PFC**	**No**	**Adequate LWD. Geologic containment leads to stable channel.**
Lower Falls Ck (Thorne River to falls)	**Primarily MM1, with small sections FP4, MC1**	**NF**	**Yes**	**No LWD or future sources on harvested section. Unstable, downcutting channels in section. Sinuosity, width/depth out of balance. Some past LWD placement, could use more LWD.**

Figure 10. Aggregrated bedload surrounding conifers in a side channel in the upper East Fork subwatershed below the 3015640 road crossing

Figure 11. Wide width-to-depth ratio in upper East Fork subwatershed below 3015640 road crossing.

Figure 12. Down-cut channel in upper East Fork subwatershed above 3015640 road crossing.

Tier II Surveys

Tier II surveys provide quantitative habitat measurements necessary to evaluate the condition of a stream relative to riparian habitat management objectives. Measurements include macro pool frequency, total count of large woody debris (LWD), average width and depth, substrate type, channel cross sectional, and fish species observed for each channel type.Stream parameter measurements from Tier II surveys of over 100 streams on the Tongass National Forest are summarize in Table 25.

Table 25. Mean and the 25th, 50th, and 75th percentiles for total LWD/m, total key pieces LWD/m, and number of pools/km for streams on the Tongass National Forest (USFS 2007).

Habitat Attribute	Percentile	Non Harvested FP Process Group	Non Harvested MM Process Group
Total LWD/m			
	25th	0.26	0.27
	50th	0.36	0.38
	75th	0.50	0.50
Total Key Pieces LWD/m			
	25th	0.04	0.05
	50th	0.10	0.12
	75th	0.15	0.14
Number Pools/km			
	25th	30	40
	50th	45	60
	75th	70	70

Table 26. Stream parameter measurements for Tier II surveys conducted on streams in the North Thorne Project Area. Data based on field surveys. Grayed cells are below the 75th percentile for a given parameter.

Habitat Attribute	E Fk N Thorne near 3015640 rd	E Fk N Thorne below E Fk bridge (reach 1)	E Fk N Thorne near E Fk bridge (reach 2)	E Fk N Thorne above E Fk bridge (reach 3)	Upper W Fk N Thorne near 3015000	Lower Falls Ck	Lower Lava Ck
Harvested	Yes	No	Yes, 1 bank	No	Yes	No	Yes
Stream Process Group	FP	FP	FP	FP	FP	MM	FP
Stream Reach Length	135.6m	301m	300m	436m	290m	540m	374m
Total LWD/m	0.75	0.64	0.447	0.729	0.39	0.376	0.294
Total Key Pieces LWD/m	0.22	0.050	0.063	0.075	0.045	0.024	0.019
Number Pools/km	132.7	73.1	53.3	78	55.2	25.9	13.36

Table 26 shows results of tier II surveys. The tier II site on the East Fork of North Thorne near the 3015640 road crossing exceeded the 75^{th} percentiles for Total LWD/m, Total Key Pieces LWD/m, and Number of Pools/km. Reach 1 of the East Fork of North Thorne below the East Fork Bridge was below the 50^{th} percentile for Total Key Pieces LWD/m. Reach 2 of the East Fork of North Thorne near the East Fork Bridge was below the50^{th} percentile for Total Key Pieces LWD/m, and below the 75^{th} percentile for Total LWD/m and Number of Pools/km. Reach 3 of the East Fork of North Thorne above the East Fork Bridge was below the 50^{th} percentile for Total Key Pieces LWD/m. The tier II site on the upper West Fork of North Thorne near the 3015000 bridge road crossing (MP 11.94) was at the 50^{th} percentile for Total LWD/m, at the 25^{th} percentile for Total Key Pieces LWD/m, and below the 75^{th} percentile for Number of Pools/km. The tier II site on Lower Falls Creek was at the 50^{th} percentile for Total LWD/m, and below the 25^{th} percentile for Total Key Pieces LWD/m and Number of Pools/km. The tier II site on Lower Lava Creek was at the 25^{th} percentile for Total LWD/m, and below the 25^{th} percentile for Total Key Pieces LWD/m and Number of Pools/km.

<u>Road Condition Surveys (RCS)</u>

RCS is an inventory of roads and their associated stream crossing structures. The survey can be utilized to determine the status of roads, fish passage problems, sources of sediment, future potential for road failures, and restoration opportunities.

The Project Area's extensive road network is an important source of sediment delivery to streams. Roads modify the natural hillslope drainage and accelerate erosion. Common causes of accelerated erosion from roads include unstable road fills, over-steepened road cuts, intercepted and rerouted surface and subsurface water, undersized and poorly placed culverts, and the diversion of streams at road crossings.

Abandoned or unmaintained roads in the Project Area have been shown consistently to pose long-term problems. These roads are subject to fail during large storm events because road drainage features no longer function as designed and culverts deteriorate or become clogged with debris. This results either in failure of the road fill at the stream crossing or diversion of water from the stream channel and down the road to areas unaccustomed to increased water discharge (Ziemer 1997)

<u>Road Storage</u>

Existing roads in the Project Area are eroding and generating sediment input into streams, thereby adversely affecting fish and fish habitat. Not maintaining and properly storing roads has had negative impacts to fish and fish habitat. Due to road storage opportunities, 16 miles of road has been properly stored in the Project Area (Table 27). This has removed 14 red or gray fish crossings, allowing fish unimpeded access to upstream habitat. Further, at least 145 other culverts (pipes) where removed and 107 waterbars where constructed, restoring hydrologic connectivity and reducing sedimentation entering streams.

Table 27. Roads that have been currently stored in the North Thorne Project Area.

Road No.	Begin MP	End MP	Total Miles	Year Stored	Comments
3015000	**9.16**	**12.6**	**3.44**	**2008**	**Removed 2 red pipes, landslide (2007), remove 58 other pipes, add 8 waterbars.**
3015200	**0.5**	**2.7**	**2.2**	**2008**	**Removed 2 red pipes, 1 green pipe, remove 23 other pipes, add 31 waterbars**
3015208	**0**	**0.4**	**0.4**	**2008**	**Remove 3 pipes, add 4 waterbars**
3015225	**0**	**0.72**	**0.72**	**2008**	**Add 7 waterbars**
3015230	**0**	**1.2**	**1.2**	**2008**	**Remove 2 red pipes, 1 gray pipe, 6 other pipes, add 15 waterbars**
3016100	**0**	**0.23**	**0.23**	**2005**	**Remove 1 red pipe, add 10 waterbars**

3017000	**1.029**	**2.959**	**1.93**	**2005**	**Remove 1 red xing, 1gray crossing, 1 green xing, other log culverts (unknown #), add waterbars (unknown #)**
3017170	**0**	**1.24**	**1.24**	**2007**	**Remove 22 pipes**
3017350	**0**	**1.514**	**1.514**	**2005/2008**	**Remove 4 red xings, 16 log culverts, add 3 waterbars**
3015000_2.91R	**0**	**0.37**	**0.37**	**2005**	**Remove 1 red pipe, add 17 waterbars**
3015105_0.96L	**0**	**0.43**	**0.43**	**2005**	**Removed 1 red pipe.**
3015017_0.44L	**0**	**0.26**	**0.26**	**2005**	**Remove 1 red pipe, 1 other pipe, add 6 waterbars**
3015230_0.33R	**0**	**0.97**	**0.97**	**2008**	**Remove 2 pipes, add 3 waterbars**
3015208_0.26R	**0**	**0.04**	**0.04**	**2008**	**Add 1 waterbar**
3015200_1.28R	**0**	**0.55**	**0.55**	**2008**	**Remove 3 pipes, add 3 waterbars**
3015200_1.85L	**0**	**0.21**	**0.21**	**2008**	**Add 2 waterbars**
3015200_1.96R	**0**	**0.312**	**0.312**	**2008**	**Add 2 waterbars**
Total			**16.016**		

Fish Passage

Fish require unhampered access up and down streams for access to appropriate spawning and rearing habitat, available food, and adequate shelter. Providing for fish passage at stream and road intersections is an important consideration when constructing or reconstructing forest roads. Road crossings commonly act as barriers to the movement of fishes and other aquatic organisms (Furniss et al. 1991). Improperly located, installed, or maintained stream crossing structures can restrict fish movement, thereby adversely affecting fish populations. Culverts in the Project Area that are obstacles to upstream fish migration are characterized by vertical barriers, debris blockages, and excessive water velocity caused by increased gradient during culvert installing and/or constricting the stream channel through installing undersized culverts.

Guidelines for fish passage through culverts are specified in the Aquatic Habitat Management Handbook (USFS 2001, sect. 34.2: 22 to 31). These guidelines should be used in all proposed road storage, reconstruction, and new road construction in this Project Area from this point in time forward. The guiding criteria for culvert design is to allow for natural migration by adult and juvenile fish through the culvert during flows equal to or less than the discharge predicted to occur two days before or after the mean annual flood flow.

A culvert is determined to be a blockage to fish passage if it fails to allow passage of a designated species and life stage at or below a designated stream flow. The designated species, or design fish, for Class I (anadromous) fish streams is a 55 mm juvenile coho salmon. The design species for a Class II (resident) fish streams is a juvenile Dolly Varden char, rainbow trout, or cutthroat trout.

The Tongass National Forest has developed a juvenile fish passage evaluation criteria matrix with an interagency group of interdisciplinary professionals. The evaluation matrix stratifies culverts by type, and establishes criteria thresholds for culvert gradient, stream channel constriction, debris blockages, and vertical barrier (or perch) at culvert outlet. The categories are:

Green: conditions that have a high certainty of meeting juvenile fish passage at all desired stream flows,

Gray: conditions are such that additional or more detailed analysis is required to determine their juvenile fish passage ability. This additional analysis includes use of the FishXing analytical model developed by the USFS and others (USFS 2003), and

Red: conditions that have a high certainty of not providing juvenile fish passage at all desired stream flows.

About 112 stream crossings on Class I and II streams (fish streams) have been identified in the Project Area using RCS, 63 green and 49 red (Table 28).

Table 28. Number of existing Green and Red fish stream crossings (Class I and II) in the North Thorne Project Area. Data from USFS, Tongass National Forest Road Condition Survey database.

Stream Class	Green Fish Stream Crossing	Red Fish Stream Crossing
Class I	26	16
Class II	37	33
Total	63	49

Many culverts installed in the past within the Project Area do not meet current standards for fish passage. Consequently, some culverts will not pass all life stages of fish species that are present in the Project Area (see Table 29). This undesired condition is causing approximately 9 miles of fish habitat to be disconnected from fish production in the Project Area. Forty-eight culverts have been identified as not meeting fish passage standards. Because of these conditions, access to fish habitat is limited by several road crossings, and fish production is reduced. Consequently, there is a need to correct this undesired condition and reestablish the fish habitat connectivity.

Table 29. Locations of red pipes impassable to various life stages of resident and anadromous fish species in the Project Area. Data from USFS, Tongass National Forest Road Condition Survey database.

Road No.	MP	Current Culvert Size (in)	Fish barrier problem description	Amt of Habitat upstream (ft)	Species Present
Culvert types: LC=log culvert, WC=wood culvert. Fish Species: SS= Coho salmon, CT=cutthroat trout, DV=Dolly Varden char, SH=steelhead, PS=pink salmon, SC=sculpin, SB=three-spined stickleback					
3015000	0.739	48	Gradient, Perch	19054+	CT, SH
3015000	1.773	18	Gradient, Perch	2641	DV
3015000	1.826	18	Gradient	2356	SS, CT, DV
3015000	1.892	18	Gradient, Perch	358	CT
3015000	2.166	18	Perch	82	DV
3015000	2.496	24	Gradient, Constriction, Perch	1640	DV
3015000	2.752	24	Gradient	1919	CT
3015000	2.920	24	Gradient	675*	CT, DV
3015000	3.275	24	Gradient, Perch	692	CT, DV
3015000	3.292	18	Gradient, Constriction. Blockage	591	CT, DV
3015000	3.496	36	Gradient, Perch	984	DV
3015000	3.893	84	Gradient, Constriction. Perch	328	DV
3015000	5.079	60	Gradient	345	CT
3015000	6.234	18	Gradient, Perch	48	DV

Road No.	MP	Current Culvert Size (in)	Fish barrier problem description	Amt of Habitat upstream (ft)	Species Present
Culvert types: LC=log culvert, WC=wood culvert. Fish Species: SS= Coho salmon, CT=cutthroat trout, DV=Dolly Varden char, SH=steelhead, PS=pink salmon, SC=sculpin, SB=three-spined stickleback					
3015000	6.750	18	Gradient, Constriction	692	SS, CT, DV
3015000	6.823	36	Constriction	302	CT, DV
3015000	8.743	24	Gradient, Constriction. Perch	2133	CT
3015000	8.789	18	Gradient, Constriction. Perch	131	DV
3015050	0.476	18	Gradient	131	SS, DV
3015105	0.570	24	Gradient	66	CT
3015105	0.600	18	Gradient, Perch	3274	CT
3015105	0.840	24	Perch	279	CT
3015105	0.860	18	Gradient, Perch	279	CT
3015105	0.910	36	Gradient, Perch	2927	CT, DV
3015300	0.040	36	Gradient	420	CT, DV
3015600	0.210	24	Gradient, Perch	354	DV
3015600	0.950	36	Gradient, Perch	194	DV, SB
3015600	1.170	48	Constriction	2382	SS, CT, DV
3015600	1.240	36	Gradient, Perch	581	CT, DV
3015600	2.110	18	Gradient, Constriction	200	DV
3015600	2.890	36	Blockage	272	SS, DV
3015640	0.132	24	Perch, Constriction	3018	DV, SC
3015640	0.385	18	Gradient	328	DV
3016000	0.070	36	Gradient, Constriction, Perch	unknown	SS, DV
3016000	0.140	36	Constriction, Blockage	unknown	SS, DV
3016000	1.020	24	Blockage	394	SS, DV
301600	1.021	18	Unknown	unknown	SS, DV
3016000	1.480	18	Gradient, Perch	187	CT, DV
3016000	1.900	36	Gradient, Perch	315	DV

Road No.	MP	Current Culvert Size (in)	Fish barrier problem description	Amt of Habitat upstream (ft)	Species Present
Culvert types: LC=log culvert, WC=wood culvert. Fish Species: SS= Coho salmon, CT=cutthroat trout, DV=Dolly Varden char, SH=steelhead, PS=pink salmon, SC=sculpin, SB=three-spined stickleback					
3016000	2.580	30	Gradient, Constriction, Perch	164	DV
3016000	2.750	48	Gradient, Perch	82	DV
3017000	3.089	18	Gradient, Constriction, Perch, Blockage	459	DV
3017000	3.209	18	Gradient, Perch	240	DV
3017000	3.479	24	Gradient	633**	DV
3017000	3.529	72	Constriction	1611	DV
3017000	3.639	18	Gradient, Constriction, Perch	423	DV
3017300	0.020	18	Gradient	187	DV
3017300	0.990	48	Gradient, Perch	243	CT, DV
3017400	0.060	18	Gradient, Constriction, Perch	354++	DV
Amount of upstream habitat in Project Area for which fish passage is a problem for juveniles and/or adult life stages of fish.			Total	9 miles	
*=includes habitat upstream of 3015000_2.19R - at MP 0.044; ++=includes habitat upstream of 3017300 - at MP 0.020; **= includes habitat upstream of 3017400 - at MP 0.060 ; +=includes sum of habitat upstream of red culverts at 3015105 MP's 0.570, 0.600, 0.840, 0.860, 0.910.					

Remediated Red Pipes

Twenty-three red pipes have been remediated in the Project Area through replacement or removal due to road storage opportunities and available funding sources. This has reopened approximately 7.4 miles of fish habitat to unrestricted access for fish to spawning and rearing habitat, adequate shelter and cover, and available food resources (Table 30).

Table 30. Remediated Red Pipes (replacement or removal for road storage) in the North Thorne Project Area.

Road No.	MP	Previous Culvert Size (in)	New Culvert Size or Total Removal due to road storage	Amt of Habitat upstream (ft)	Species Present
3015000	0.344	36	96x96 in.	4158	CT
3015000	2.641	36	79x117 in. arch	2986	SS, CT, DV

3015000	**6.335**	**36**	**40 ft bridge**	**2973**	**SS, DV**
3015000	**6.830**	**18**	**72x72 in.**	**1631**	**SS, CT**
3015000	**11.090**	**48**	**Removal**	**23**	**DV**
3015000	**11.130**	**72**	**Removal**	**26**	**DV**
3015000_2.91R	**0.044**	**24**	**Removal**	**410**	**DV**
3015105_0.96L	**0.038**	**36**	**Removal**	**3281**	**CT, DV**
3015200	**2.336**	**36**	**Removal**	**4101**	**SS, CT, DV**
3015200	**2.404**	**78X109**	**Removal**	**2972**	**SS, CT, DV, PS, SB**
3015200	**2.620**	**24**	**Removal**	**3773**	**SS, SH, SB**
3015230	**0.484**	**48**	**Removal**	**1627**	**CT, SB**
3015230	**0.520**	**36**	**Removal**	**115**	**SS, DV**
3015230_0.33R	**0.571**	**24**	**Removal**	**374**	**SS**
3015250	**0.030**	**48**	**91x142 in arch**	**3251**	**SS, CT, DV**
3016015_0.44L	**0.047**	**18**	**Removal**	**256**	**DV**
3016100	**0.18**	**24**	**Removal**	**591**	**DV**
3017000	**2.471**	**LC**	**Removal**	**2962**	**DV**
3017000	**2.512**	**LC**	**Removal**	**948**	**DV**
3017350	**0.477**	**LC**	**Removal**	**1834**	**SS, DV**
3017350	**0.825**	**WC**	**Removal**	**177**	**DV**
3017350	**0.931**	**WC**	**Removal**	**400**	**DV**
3017350	**1.023**	**WC**	**Removal**	**404**	**DV**
Total				**39273 ft (7.4 miles)**	

Figure 13. A remediated red pipe at 3015000 MP 0.344. Before photo (left) shows a 36 inch pipe that is perched and is installed at a steep gradient. After photo (right) shows a 96 inch pipe that has had bedload placed inside the pipe simulating a stream bottom.

Figure 14. A red pipe removed at 3015105_0.96L MP 0.038. Before photo (left) shows 36 in pipe that is crushed and buried in the road prism. After photo (right) shows downstream view of removed crossing due to proper road storage.

Restoration Goals, Objectives, and Opportunities

Restoration Goals

- Improve and/or restore riparian function and condition by thinning previously harvested riparian areas along streams.
- Reduce erosion entering streams from degrading roads by stormproofing, storing, and decommissioning roads.

- Improve and or restore hillslope hydrologic connectivity from roads by stormproofing, storing, and decommissioning roads.
- Improve, and/or restore fish passage at road crossings

Restoration Objectives

Improve and/or restore riparian function and condition by thinning previously harvested riparian areas along streams.

- Improve 75 acres of harvest riparian areas along Class I and Class II streams, and 81 acres of harvest of riparian areas along Class III streams by riparian thinning.

Reduce erosion entering streams from degrading roads by stormproofing, storing, and decommissioning roads.

- Stormproof, store, and decommission 38 miles of road.

Improve and or restore hillslope hydrologic connectivity from roads by stormproofing, storing, and decommissioning roads.

- Stormproof, store, and decommission 38 miles of road.

Improve, and/or restore fish passage at road crossings.

- Restore access to about 5 miles of upstream fish habitat by replacing or removing MR1, MR2, and MR3 red pipes.

Improve, and/or restore instream large wood debris (LWD) and/or restore channel stability.

- Install LWD and boulders into streams.

Restoration Opportunities

The National Research Council (NRC, 1992) defines restoration as a holistic process. It is "the return of an ecosystem to a close approximation of its condition prior to disturbance. In restoration, ecological damage to the resource is repaired. Both the structure and the functions of the ecosystem are recreated .... The goal is to emulate a natural, functioning, self-regulating system that is integrated with the ecological landscape in which it occurs."

Restoration has also been defined as the reestablishment of the structure and function of an ecosystem, including its natural diversity. A restored ecosystem is much more than just an assemblage of its components of soil, water, air, and biota. Rather, a restored ecosystem displays the interactions among all these components. Rehabilitation, reclamation, habitat creation, or mitigation can be achieved through manipulation of site-specific or isolated elements of ecosystems, but restoration is a more complex process. Successful restoration means that ecosystem structure and function are recreated or repaired and that natural ecosystem processes can operate unimpeded. (Williams et al. 1997)

Restoration is an integral part of comprehensive watershed management and is used to recover fish habitat, stabilize deteriorating watershed conditions, and speed recovery of the watershed towards healthy conditions. Effective restoration has a watershed-level approach and includes upland, riparian, and instream components. In other words, from the ridge top to the valley bottom. The upland component is used to control erosion, stabilize roads, upgrade culverts for fish passage, maintain hydrologic connectivity, and manage watershed uses. The riparian component restores functions of riparian vegetation by establishing mature conifers or other appropriate vegetation. The instream component uses woody debris and other structures to retain spawning gravels and create pools or other fish habitat features, and stabilize stream banks.

Restoration projects provide not only ecological benefits, but also human health, recreation, and economic benefits. Close involvement and cooperation of communities, landholders, and partners [help] address issues throughout entire watersheds (USFS 2005). A recent framework for setting watershed-scale priorities on Prince of Wales Island was developed in partnership with the USFS, USFWS, Nature Conservancy, and Klawock Watershed Council (Albert et al 2005). The framework lists the North Thorne River as a very high value watershed based on its freshwater ecosystem (Ranked #3). Lava (Gravelly) Creek is high priority watershed for terrestrial ecosystem restoration based on most modification (Rank #2).

Restoration opportunities within the North Thorne Project Area include riparian thinning, maintaining adequate fish passage through stream crossing structures, and road maintenance in the form of stormproofing, storage, and decommissioning, and installing LWD and/or boulders instream.

Riparian Thinning

The Tongass Forest Plan (USFS 2008) defines riparian areas as "…areas [which] encompass the zone of interaction between the aquatic and terrestrial ecosystems, and include riparian streamsides, lakes, and floodplains with distinctive resource values and characteristics. Timber harvest has actively occurred within the North Thorne Project Area since the early 1960's. Past timber harvest practices removed riparian vegetation to the streambank within the Project Area along Class I, II, and III streams.

Fish resource objectives are to maintain fish habitat. This includes the management of riparian areas for the maintenance of stream banks and channel processes, water quality, and large woody debris (LWD) for resident and anadromous fish species (USFS 2008—FISH112, IVB, C, D, E).

Riparian resource objectives are to maintain riparian areas in mostly natural (assumed late-serial, old growth) conditions. This includes maintenance of stream banks and channel processes, LWD, and water quality (USFS 2008—RIP 1, IIA).

Riparian thinning in areas previously harvested provides an opportunity to meet these resource objectives more rapidly than natural processes would allow. Thinning will increase the diameter growth of riparian trees by distributing the growing potential over fewer trees. Larger trees have larger root masses for stream bank stabilization. Larger trees also help provide a broader shade canopy along streams which is important for maintaining water quality, including water temperature. More rapid growth will lessen the timeframe needed to re-establish the natural (late-serial, old growth) conditions of riparian areas lost through past timber harvest practices. An adequate and continual source of LWD available for input into streams is important in maintaining habitat complexity for anadromous and resident fish in the form of pool habitat, spawning habitat and escape cover. .

Riparian thinning opportunities exist along 75 acres of Class I and II streams within the North Thorne Project Area are displayed in Table 31. The opportunities focus on the first 100 feet (horizontal distance) from the stream bank. This is the minimum typical height of trees in late-serial and old growth stands along streambanks. Hence, this is the area where trees might enter the stream channel and become a source of LWD.

Table 31. Stand number, Year originally harvested, and approximate acres of Class I and II stream riparian thinning opportunity within the North Thorne Project Area (based on one side of stream, 100 ft wide riparian area). Total riparian thinning opportunity for Class I streams is 34 acres, for Class II streams is 41 acres.

Stand Number	Year Harvested	Watershed Location	Acres Class I stream (100 ft wide, 1 side	Acres Class II stream (100 ft wide, 1 side	Priority

			only)	only)	
579010044	1966	Falls Creek	0	5.51	1
579010045	1966	Falls Creek & Unnamed Composite	2.66	8.16	1
579010046	1966	Unnamed Composite	5.53	3.25	1
579020512	1973	Lava Creek	7.78	9.5	1
586010504	1973	Lava Creek	5.4	0	1
597110503	1975	Unnamed Composite	4.95	0	1
580020516	1986	East Fork	0	3.18	2
580020517	1986	East Fork	0	5.82	2
580020520	1987	East Fork	3.01	0	2
579010506	1988	Unnamed Composite	4.25	5.59	2
Total			34	41	

Riparian Thinning costs for75acres along Class I and Class II streams are estimated at $29,836 (Table 32). Additional cost estimates for field review, contract preparation and inspection, and overhead are estimated at $22,000.

Table 32. Estimated costs for riparian thinning along Class I and Class II streams in the North Thorne Project Area.

Stand Number	Total Acres on Class I & II stream	Thinning Cost/acre @ $400/acre	Fish/Hydro field review @ $500/day	Fish/Hydro overhead @ $350/day	Silviculture Inspection/Contract Prep @ $500/day	Silviculture Overhead @ $350/day
579010044	5.51	$2,204	$500	$350	$1,000	$350
579010045	10.82	$4,328	$500	$350	$1,000	$350
579010046	8.78	$3,512	$500	$350	$1,000	$350
579020512	17.28	$6,912	$500	$350	$1,000	$350
586010504	5.4	$2,160	$500	$350	$1,000	$350
597110503	4.95	$1,980	$500	$350	$1,000	$350
580020516	3.18	$1,272	$500	$350	$1,000	$350
580020517	5.82	$2,328	$500	$350	$1,000	$350
580020520	3.01	$1,204	$500	$350	$1,000	$350
579010506	9.84	$3,936	$500	$350	$1,000	$350
Total	75	$29,836	$5000	$3500	$10,000	$3500

Riparian thinning opportunities along Class III streams within the North Thorne Project Area total 81acres (Table 33). The opportunities focus on the first 100 feet (horizontal distance) from the stream bank. Again, this is the typical height of trees in late-serial and old growth stands along streambanks. No riparian thinning opportunities are proposed for Class IV streams as the Tongass Forest Plan treats these streams as part of the hillslope process (USFS 2008).

Table 33. Stand number, Year originally harvested, and approximate acres of Class III stream riparian thinning opportunity within the North Thorne Project Area (based on one side of stream, 100 ft wide riparian area).

Stand Number	Year Harvested	Watershed Location	Acres Class III stream (100 ft wide, 1 side only)	Priority
579020516	1962	Lava Creek	5.36	2
579010042	1966	Unnamed	5.71	2

		Composite		
579010046	1966	Unnamed Composite	15.35	1
579020512	1973	Lava Creek	0.85	1
586010504	1973	Lava Creek	8.55	1
580020027	1975	East Fork	2.96	1
580020029	1976	East Fork	0.15	1
580010507	1980	West Fork	3.00	1
580020516	1986	East Fork	7.51	2
580020517	1986	East Fork	13.66	2
580020520	1987	East Fork	8.72	2
579010506	1988	Unnamed Composite	6.81	2
580020531	1988	East Fork	2.46	2
Total			81	

Riparian thinning costs for 81 acres along Class III streams is estimated at $58,324 (Table 34). Additional cost estimates for field review, contract preparation and inspection, and overhead are estimated at $24,600.

Table 34. Estimated costs for riparian thinning along Class III streams in the North Thorne Project Area.

Stand Number	Total acres along Class III stream	Thinning Cost/acre @ $400/acre	Fish/Hydro field review @ $500/day	Fish/Hydro overhead @ $350/day	Silviculture Inspection/Contract Prep @ $500/day	Silviculture Overhead @ $350/day
579020516	5.36	$2,144	$500	$350	$1,000	$350
579010042	5.71	$2,284	$500	$350	$1,000	$350
579010046	15.35	$6,140	$500	$350	$1,000	$350
579020512	0.85	$340	$500	$350	$1,000	$350
586010504	8.55	$3,420	$500	$350	$1,000	$350
580020027	2.96	$1,184	$500	$350	$1,000	$350
580020029	0.15	$60	$200		$200	
580010507	3.00	$1,200	$500	$350	$1,000	$350
580020516	7.51	$3,004	$500	$350	$1,000	$350
580020517	13.66	$5,464	$500	$350	$1,000	$350
580020520	8.72	$3,488	$500	$350	$1,000	$350
579010506	6.81	$2,724	$500	$350	$1,000	$350
580020531	2.46	$984	$500	$350	$1,000	$350
Total	81	$58,324	$7200	$2100	$13,200	$2100

Road Storage

Roads pose a significant effect on water and stream quality, particularly if they are not maintained at stream crossings. Existing roads in the Project Area are eroding and generating sediment input into streams, thereby adversely affecting fish and fish habitat. Not maintaining and properly storing roads has had negative impacts to fish and fish habitat.

Road condition surveys have identified that sediment generated from roads in the Project Area has been caused by plugged culverts, road washouts, poor water drainage due to plugged ditch lines, and lack of adequate water bars to direct water off the road prism. Placing currently open roads in storage would effectively reduce potential erosion and sedimentation. Further, roads that have not been previously properly stored (culverts left in place behind pulled bridges, culverts, tank traps, or vegetatively overgrown roads) need to be, so that sedimentation into streams can be minimized. Roads placed into storage would reduce erosion, fill failure, and diversion potential while restoring hydrologic connectivity. Removing red pipes would allow for adequate fish passage upstream to available spawning and rearing habitat, food sources, and shelter. The overall effects would be beneficial because erosion and sedimentation would be reduced from current levels, and fish passage would be restored.

Removal of bridges and culverts and construction of waterbars on roads slated for storage or decommissioning would introduce some sediment into streams. This can be minimized depending on how the road structures are removed or constructed, conducting this work during prescribed instream work timing windows, and following Best Management Practices (BMPs).

Table 35. Road storage opportunities and priority in the North Thorne Project Area. Road storage opportunities are based on POW ATM (USFS 2009)

Road Number	BMP	EMP	Segment Length	Comments	Priority
3000100	0.00	2.44	2.44	Convert to OHV trail 2011 Rd Storage Contract. Stormproof by adding drivable waterbars at culvert sites and leaving most culverts in place.	3
3000100_0.46R	0.00	0.26	0.26	2011 Rd Storage Contract. Remove culvert install waterbars	3
3000110	0.00	1.39	1.39	Convert to OHV trail 2011 Rd Storage Contract. Stormproof by adding drivable waterbars at culvert sites and leaving culverts in place.	3
3000124	0.00	1.05	1.05	POW ATM Storage. Remove 10 culverts, install waterbars, fix erosion	3
3015000	8.84	9.06	0.22	POW ATM Storage. Remove 2 logs spanning West Fork N Thorne (put in stream). Remove bridge abutments (put in stream)and recontour slopes	3
3015000_4.29L	0.00	1.26	1.26	2011 Rd Storage Contract. Remove 7 culverts, construct/improve waterbars	2
3015100_0.87R	0.00	0.60	0.60	Falls Creek Loop Rd. Remove bridge abutments (put in stream), recontour slopes, remove log culvert, install waterbars	2
3015105	0.00	2.70	2.70	POW ATM Storage. Remove 5 red pipes, 43 culverts, fix hole in road, install waterbars, fix erosion,	1
3015108	0.00	0.4	0.4	2011 Rd Storage Contract. Remove 9 culverts, install waterbars	3
3015255	0.00	0.36	0.36	POW ATM Storage. Remove 2 culverts, construct/improve waterbars	3
3015300	0.00	0.22	0.22	2011 Rd Storage Contract. Remove 1 red pipe, install waterbars	1
3015600	1.61	2.95	1.34	POW ATM Storage. Foot-slope road, road erosion, plugged culverts. Remove 2 red pipes, 10 culverts, install waterbars, fix erosion	2
3015600	2.95	3.52	0.57	POW ATM Storage. 1 fish pipe, log bridge constricting channel. Remove culverts, install waterbars. Intersection w/ 3015640 Rd at MP 2.95	2
3015600	3.52	4.30	0.78	POW ATM Storage. Landslide on road, pulled bridge, road prism washout, buried culverts. Remove 17 culverts, install waterbars, fix erosion.	1
3015630	0.00	0.73	0.73	2011 Rd Storage Contract. Remove 16 culverts, install waterbars, fix erosion	2
3015635	2.32	4.00	1.68	POW ATM Storage. Remove 40 culverts, install waterbars, fix erosion,	3
3015639	0.00	0.41	0.41	POW ATM Storage. Remove 11 culverts, deep fill one culvert, install waterbars, fix erosion,	2
3015640	0.00	1.88	1.88	2011 Rd Storage Contract. Part of road is on foot slope, road prism erosion, buried culverts. Remove 2 red pipes, remove 16 culverts, install waterbars, fix	1

				erosion	
3015700	0.00	1.81	1.81	POW ATM Storage. Road is on foot slope, slides on road, blownout culverts, buried culverts. Remove 17 culverts, install waterbars, recontour slopes, fix erosion	1
3015700_0.14L	0.00	0.13	0.13	2011 Rd Storage Contract. Remove 1 culvert, install waterbars	2
3016000	5.25	6.34	1.09	2011 Rd Storage Contract (Honker Divide). Remove 8 culverts, install waterbars.	3
3016300	0.00	0.36	0.36	2011 Rd Storage Contract (Honker Divide). Remove 1 culvert, install waterbars.	3
3016350	0.00	0.74	0.74	2011 Rd Storage Contract (Honker Divide). Remove 5 culverts, install waterbars.	3
3016400	0.00	1.36	1.36	2011 Rd Storage Contract (Honker Divide). Remove 16 culverts, install waterbars	3
3017000_0.05R	0.00	0.29	0.29	2011 Rd Storage Contract (Lava Loop Rd). Remove bridge abutments (put in stream), Remove log culvert and log bridge	2
3017100	2.94	3.42	0.48	2011 Rd Storage Contract. Remove 6 culverts, install waterbars	3
3017100_0.28R	0.00	0.20	0.20	2011 Rd Storage Contract. Remove log culvert, install waterbars	3
3017100_1.28L	0.00	0.59	0.59	2011 Rd Storage Contract. Slide on road. Remove 4 log culverts, install waterbars	3
3017200	0.00	2.20	2.20	2011 Rd Storage Contract. Remove 37 culverts, install waterbars	3
3017210	0.00	0.67	0.67	POW ATM Storage. Install waterbars, fix erosion	3
3017300	0.00	1.60	1.60	2011 Rd Storage Contract. Remove 2 red pipes, remove 19 culverts, 1 log culvert, install waterbars	1
3017400	0.00	0.81	0.81	2011 Rd Storage Contract. Remove 1 red pipes, remove 12 culverts, install waterbars	1
3017420	0.00	1.74	1.74	2011 Rd Storage Contract. Remove 35 culverts, install waterbars	1
3017422	0.00	0.82	0.82	2011 Rd Storage Contract. Remove 12 culverts, install waterbars	1
3018130	0.00	1.31	1.31	POW ATM Storage. Remove 16 culverts, install waterbars, fix erosion	2
3018250	0.00	3.07	3.07	2011 Rd Storage Contract. Majority of road outside N Thorne PA. Remove 1 red pipe, remove 36 culverts, install waterbars	2
3018258	0.00	0.17	0.17	2011 Rd Storage Contract. Install waterbars	3
Total			37.73		

Table 35 shows road storage opportunities in the North Thorne Project Area. The road storage opportunities are based on the POW ATM (USFS 2009). Approximately 38 miles of road could be stored or properly stored. Road storage estimates at $18,000 per road mile would total approximately $679,000 [$18,000 x 37.73] for all roads listed in Table 36. This would include removing culverts, constructing waterbars, endhaul of culverts, and seeding and fertilizing road prism, cutbanks, and at culvert removal/waterbar construction sites. Additional cost of mobilization to the sites is estimated at $10,000 per site for a total of $90,000. Fish Biologist/Hydrologist field prep is estimated at $11,500. Fish Biologist/Hydrologist presence during implementation is estimated at $18,500. Fish Biologist/Hydrologist overhead is estimated at $5,250.

Table 36. Estimated costs for road storage by road segment in the North Thorne Project Area.

<table>
<tr><th>Road Number</th><th>Segment Length</th><th>Road Storage Estimate@ $18,000/mi</th><th>Mobilization Estimate @$10,000/ rd group location</th><th>Fish/Hydro field prep (stake/flag sites) @$500/day</th><th>Fish/Hydro implementation presence @$500/day</th><th>Fish/Hydro Overhead costs@$350/day</th></tr>
<tr><td>3000100</td><td>2.44</td><td>$43,920</td><td rowspan="4">$10,000</td><td rowspan="2">$500</td><td rowspan="2">$1,000</td><td rowspan="2">$350</td></tr>
<tr><td>3000100_0.46R</td><td>0.26</td><td>$4,680</td></tr>
<tr><td>3000110</td><td>1.39</td><td>$25,020</td><td>$500</td><td>$500</td><td rowspan="2">$350</td></tr>
<tr><td>3000124</td><td>1.05</td><td>$18,900</td><td>$500</td><td>$500</td></tr>
<tr><td>3015000</td><td>0.22</td><td>$3,960</td><td rowspan="7">$10,000</td><td rowspan="3">$500</td><td rowspan="3">$1,000</td><td rowspan="3">$350</td></tr>
<tr><td>3015000_4.29L</td><td>1.26</td><td>$22,680</td></tr>
<tr><td>3015100_0.87R</td><td>0.6</td><td>$10,800</td></tr>
<tr><td>3015105</td><td>2.7</td><td>$48,600</td><td rowspan="2">$500</td><td rowspan="2">$1,000</td><td rowspan="2">$350</td></tr>
<tr><td>3015108</td><td>0.4</td><td>$7,200</td></tr>
<tr><td>3015255</td><td>0.36</td><td>$6,480</td><td rowspan="2">$500</td><td rowspan="2">$500</td><td rowspan="2">$350</td></tr>
<tr><td>3015300</td><td>0.22</td><td>$3,960</td></tr>
<tr><td>3015600</td><td>1.34</td><td>$24,120</td><td rowspan="7">$10,000</td><td rowspan="3">$1,000</td><td rowspan="3">$2,000</td><td rowspan="3">$350</td></tr>
<tr><td>3015600</td><td>0.57</td><td>$10,260</td></tr>
<tr><td>3015600</td><td>0.78</td><td>$14,040</td></tr>
<tr><td>3015630</td><td>0.73</td><td>$13,140</td><td rowspan="3">$1,000</td><td rowspan="3">$1,500</td><td rowspan="3">$350</td></tr>
<tr><td>3015635</td><td>1.68</td><td>$30,240</td></tr>
<tr><td>3015639</td><td>0.41</td><td>$7,380</td></tr>
<tr><td>3015640</td><td>1.88</td><td>$33,840</td><td>$500</td><td>$1,000</td><td>$350</td></tr>
<tr><td>3015700</td><td>1.81</td><td>$32,580</td><td rowspan="2">$10,000</td><td rowspan="2">$500</td><td rowspan="2">$1,000</td><td rowspan="2">$350</td></tr>
<tr><td>3015700_0.14L</td><td>0.13</td><td>$2,340</td></tr>
<tr><td>3016000</td><td>1.09</td><td>$19,620</td><td rowspan="2">$10,000</td><td rowspan="2">$1,000</td><td rowspan="2">$1,500</td><td rowspan="2">$350</td></tr>
<tr><td>3016300</td><td>0.36</td><td>$6,480</td></tr>
</table>

<table>
<tr><td>3016350</td><td>0.74</td><td>$13,320</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td></tr>
<tr><td>3016400</td><td>1.36</td><td>$24,480</td></tr>
<tr><td>3017000_0.05R</td><td>0.29</td><td>$5,220</td><td rowspan="4">$10,000</td><td rowspan="4">$1,000</td><td rowspan="4">$1,000</td><td rowspan="4">$350</td></tr>
<tr><td>3017100</td><td>0.48</td><td>$8,640</td></tr>
<tr><td>3017100_0.28R</td><td>0.2</td><td>$3,600</td></tr>
<tr><td>3017100_1.28L</td><td>0.59</td><td>$10,620</td></tr>
<tr><td>3017200</td><td>2.2</td><td>$39,600</td><td rowspan="6">$10,000</td><td rowspan="3">$1,000</td><td rowspan="3">$1,500</td><td rowspan="3">$350</td></tr>
<tr><td>3017210</td><td>0.67</td><td>$12,060</td></tr>
<tr><td>3017300</td><td>1.6</td><td>$28,800</td></tr>
<tr><td>3017400</td><td>0.81</td><td>$14,580</td><td rowspan="3">$1,000</td><td rowspan="3">$1,500</td><td rowspan="3">$350</td></tr>
<tr><td>3017420</td><td>1.74</td><td>$31,320</td></tr>
<tr><td>3017422</td><td>0.82</td><td>$14,760</td></tr>
<tr><td>3018130</td><td>1.31</td><td>$23,580</td><td>$10,000</td><td>$500</td><td>$1,000</td><td>$350</td></tr>
<tr><td>3018250</td><td>3.07</td><td>$55,260</td><td rowspan="2">$10,000</td><td rowspan="2">$1,000</td><td rowspan="2">$2,000</td><td rowspan="2">$350</td></tr>
<tr><td>3018258</td><td>0.17</td><td>$3,060</td></tr>
<tr><td>Total</td><td>37.73</td><td>$679,140</td><td>$90,000</td><td>$11,500</td><td>$18,500</td><td>$5,250</td></tr>
</table>

Fish Passage

Providing for fish passage at stream and road intersections is an important consideration when constructing or reconstructing forest roads. Improperly located, installed, or maintained stream crossing structures, primarily culverts, can restrict fish movement, thereby adversely affecting fish populations. These structures may present a variety of obstacles to fish migration. The most common obstacles are culvert outlet barriers, debris blockages, and excessive water velocities.

The requirement and direction to provide fish passage at road crossings can be found in several documents.

The Clean Water Act Section 33, Code of Federal Regulations 323.3 (B) states: “the design, construction, and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the waterbody.”

One of the riparian area objectives of the Tongass Forest Plan (USFS 2008) is to “design and coordinate road management activities to provide [for] passage of fish at road crossings (RIP1, II-9).” Furthermore, a fish habitat objective is to “maintain fish passage through stream crossing structures (FISH 112, IV-G).”

Additionally, in a Supplemental Memorandum of Understanding between the U. S. Forest Service and the Alaska Department of Fish and Game, both agencies agreed to "[provide] efficient fish passage (SMOU 1998)."

Red Pipe Remediation Prioritization

RCS inventory of culverts on the Tongass National Forest has identified many cuverts that do not meet the current fish passage standards. An interagency group developed a process to categorize culverts for repair or replacement. Two teams were assembled to prioritize culverts for repair or replacement in the North Thorne Project Area to test this process (Aho et al 2006). Each team consisted of a U.S. Forest Service fish biologist, hydrologist, and road engineer, and at least one representative from an outside agency (ADF&G, NMFS, and USFWS). The two teams were asked to assign one of five alternative management recommendations to each culvert ranging from replace the culvert to acceptable to be a permanent barrier to fish passage. Table 37 summarizes the two teams recommendations for replacement or not. The recommendation shown is a combination of the two teams input showing the most liberal interpretation of the two recommendations.

Table 37. Team Recommendation for remediation of red pipes impassable to various life stages of resident and anadromous fish species in the North Thorne Project Area (see also Table 26). Upstrm Hab= Upstream Habitat.

Road No.	MP	Management Recommendation	Estimated Cost To Replace	Comments
3015000	0.739	5	$109,560	10 ft waterfall short distance upstream. Downstream of 5 red culverts on 3015105. Upstrm Hab=19,054+ ft
3015000	1.773	3	$58,340	Upstrm Hab=2,641 ft
3015000	1.826	1	$44,715	Upstrm Hab=2,356 ft
3015000	1.892	5	$86,320	Upstrm Hab=358 ft
3015000	2.166	5	$86,320	Upstrm Hab=82 ft
3015000	2.496	3	$109,560	Upstrm Hab=1,640 ft
3015000	2.752	3	$39,480	Upstrm Habitat=1,919 ft
3015000	2.920	3	$44,715	Upstrm Hab=675 ft
3015000	3.275	4	$86,320	Upstrm Hab=692 ft
3015000	3.292	3	$39,480	Upstrm Hab=591 ft
3015000	3.496	5	$109,560	Upstrm Hab=984 ft
3015000	3.893	5	$135,000	Upstrm Hab=328 ft
3015000	5.079	5	$62,724	Upstrm Hab=345 ft
3015000	6.234	5	$58,340	Upstrm Hab=48 ft
3015000	6.750	1	$39,480	Upstrm Hab=692 ft
3015000	6.823	5	Unknown	Upstrm Hab=302 ft
3015000	8.743	1	$44,715	Upstrm Hab=2,133 ft
3015000	8.789	5	Unknown	Upstrm Hab=131 ft
3015050	0.476	2	$34,252	Upstrm Hab=131 ft
3015105	0.570	4	Unknown	Upstream of 301500 MP 0.739 unique CT pop'n above waterfall ?? Upstrm Hab=66 ft

Road No.	MP	Management Recommendation	Estimated Cost To Replace	Comments
3015105	0.600	1	$34,252	Upstream of 301500 MP 0.739 unique CT pop'n above waterfall ?? Upstrm Hab=3,274 ft
3015105	0.840	5	$86,320	Upstream of 301500 MP 0.739 unique CT pop'n above waterfall ?? Upstrm Hab=279 ft
3015105	0.860	5	Unknown	Upstream of 301500 MP 0.739 unique CT pop'n above waterfall ?? Upstrm Hab=279 ft
3015105	0.910	1	$90,000	Upstream of 301500 MP 0.739 unique CT pop'n above waterfall ?? Upstrm Hab=2,927 ft
3015300	0.040	1	$39,480	Upstrm Hab=420 ft
3015600	0.210	5	$44,715	Upstrm Hab=354 ft
3015600	0.950	4	$43,354	Upstrm Hab=194 ft
3015600	1.170	1	$60,395	Upstrm Hab=2,382 ft
3015600	1.240	5	$34,252	Upstrm Hab=581 ft
3015600	2.110	5	Unknown	Upstrm Hab=200 ft
3015600	2.890	4	$54,976	Upstrm Hab=272 ft
3015640	0.132	1	$43,354	Remove during Road Storage est. cost <$1500 Upstrm Hab=3,018 ft
3015640	0.385	1	$34,252	Remove during Road Storage est. cost <$1500 Upstrm Hab=328 ft
3016000	0.070	1	$58,340	Upstrm Hab=unknown
3016000	0.140	1	$60,395	Upstrm Hab=unknown
3016000	1.020	1	$63,531	Upstrm Hab=394 ft
301600	1.021	3	Unknown	Upstrm Hab=unknown
3016000	1.480	5	$34,252	Upstrm Hab=187 ft
3016000	1.900	5	$132,800	Upstrm Hab=315 ft
3016000	2.580	5	$58,340	Upstrm Hab=164 ft
3016000	2.750	5	$132,800	Upstrm Hab=82 ft
3017000	3.089	5	$58,340	Upstrm Hab=459 ft
3017000	3.209	5	$58,340	Downstream of 3017300 MP 0.020 Upstrm Hab=240 ft (includes hab from 3017300 MP 0.020
3017000	3.479	4	Unknown	Downstream of 3017000 MP 0.060 Upstrm Hab=633 ft (includes hab from 3017000 MP 0.060
3017000	3.529	2	Unknown	Upstrm Hab=1,611 ft
3017000	3.639	5	$86,320	Upstrm Hab=423 ft
3017300	0.020	1	$34,252	Remove during Road Storage est.

Road No.	MP	Management Recommendation	Estimated Cost To Replace	Comments
				cost <$1500 Upstrm Hab=187 ft
3017300	0.990	1	$132,800	Remove during Road Storage est. cost <$1500 Upstrm Hab=243 ft
3017400	0.060	1	$58,340	Remove during Road Storage est. cost <$1500 Upstrm Hab=354 ft
Total			≥$2,723,081	
1.—Achieve full aquatic passage as soon as practicable.				
2.—Temporary partial barrier acceptable until end of culvert's life then full passage. Will require action if culvert is currently a complete barrier. These culverts have a lower priority for action than Management Recommendation 1 culverts.				
3.—Temporary complete barrier acceptable until end of culvert's life then full passage.				
4.—Permanent partial barrier acceptable with mitigation and 404 permit. Will require action if culvert is currently a complete barrier. These culverts have lower priority for action than Management Recommendation 1 and Management Recommendation 2 culverts.				
5.—Permanent complete barrier acceptable with mitigation and 404 permit.				
Partial barrier implies that some fish are able to achieve passage at some stream flow conditions. Complete barrier implies that no fish are able to achieve passage at any stream flow conditions				

The total cost to replace all 49 known culverts that do not meet fish passage standards (red pipes) exceeds 2.72 million dollars (Table 37). The cost to replace 15 red pipes designed as Management Recommendation (MR) 1 is approximately $838,301. The mileage of fish habitat upstream of these red pipes is at least 3.5 miles (18,708 ft). MR1 red pipes are slated to achieve full aquatic passage as soon as practicable. This cost could be reduced to $551,803 [($838,301-$293,998)+(5x$1,500)] if the 3015640, 3017300, and 3017400 roads are stored and the red pipes removed. These would be the author's priority 1 to replace or remove.

MR2 red pipes are slated to be temporary partial barriers to fish passage acceptable until end of culvert's life then require full passage. The cost to replace 2 red pipes designed as MR2 is at least $34,252. The mileage of fish habitat upstream of these red pipes is at least 0.33 miles (1,742 ft). These would be the author's priority 2 to replace.

MR3 red pipes are slated to be a temporary complete barrier acceptable until end of culvert's life then full passage. The cost to replace 6 red pipes designed as MR3 is at least $291,575. The mileage of fish habitat upstream of these red pipes is at least 1.4 miles (7,466 ft). The red pipes at 301500 MPs 1.773, 2.496, and 2.752 would also be the author's priority 2 to replace as the mileage of fish habitat upstream of these red pipes is 1.2 miles (6,200 ft). The red pipes at 301500 MPs 2.920 and 3.29 would be the author's priority 3 to replace as the mileage of fish habitat upstream of these red pipes is at least 0.24 miles (1,266ft).

MR4 red pipes are slated to be permanent partial barriers acceptable with mitigation and 404 permit. The cost to replace 5 red pipes designed as MR4 is at least $184,650. The mileage of fish habitat upstream of these red pipes is 0.35 miles (1,857 ft).

MR5 red pipes are slated to be permanent complete barriers acceptable with mitigation and 404 permit. The cost to replace 21 red pipes designed as MR5 is at least $1.37 million dollars. The mileage of fish habitat upstream of these red pipes is 4.8 miles (25,195 ft). The mileage of upstream fish habitat above the MR5 red pipe at 3015000 MP 0.739 is over 3.6 miles (19,054 ft). While the distance upstream from the pipe accounts for 75% of the mileage, there is a 10 ft waterfall a short distance upstream of the pipe. Also, there may be a unique population of cutthroat trout upstream of this waterfall (Kim Hastings, USFWS Biologist, personal communication), but this is instantiated. Trying to remediate this red pipe plus the cost of fish passage over the 10 foot falls (by blasting or steeppass) is probably cost prohibitive. The two MR5 red pipes at 3015105 MPs 0.84 and 0.86, upstream of 3015000 MP 0.739, account for only 558 ft of upstream fish habitat. In fact, 20 of the MR5 pipes (not including 3015000 MP 0.739, but including the two just mentioned) only accounts for 1.2 miles (6141 ft) of upstream habitat.

Instream structures

Instream problems that were observed in the North Thorne Project Area focused on areas where much of the riparian area has been harvested. These areas offers little potential recruitment for LWD and hence have streambank stability and bank erosion problems within floodplain channels. While conducting PFC surveys, the need for instream structures at some sites was identified. Introduction of LWD and boulders was suggested to help create pools and protect bank erosion. Table 38 displays the locations and actions proposed. Costs are not estimated for these projects, as extensive field review and instream structure planning did not take place.

Table 38. Location, Action Proposed, Priority, and Access for instream structures in the North Thorne Project Area.

Location	Action Proposed	Priority	Access
Upper W Fk of W Fk N Thorne (below 3015 rd)	Add LWD, some boulder structures	3	Poor, Road Stored
Upper W. Fk N. Thorne (adjacent to 3015700, above 3015000 intersection	Add LWD above meander channel	2	Fair
Upper E Fk (above 3015640 rd)	Add LWD, capture bedload	1	Good
Upper E Fk (below 3015640 rd)	Add LWD, reestablish channel	1	Good
Lower Lava Ck (below 3017000 rd)	Add LWD, bank stabilization, some boulder structures	1	Good
Lower Lava Ck (above 30 rd)	Add LWD, stabilize bank, some boulder structures	2	Poor
Lower Falls Ck (above 30 rd)	Add LWD, stabilize bank	2	Fair

Attempted restoration in part of Lower Falls Creek occurred in the late 1980's by cabling wood, primarily alder bundles, to the streambank. Many of the cabled alders have washed parallel to the streambank or out of water during all but high flows. The 200m stretch of stream above the old road crossing could use some LWD, as well as bank stablization as it appears that the channel was use as a corridor to haul wood by a steam donkey.

Project Sequencing

Implementation and sequencing time of projects identified in this document depends on funding, accessibility, spatial distribution across the landscape, and management direction. Roads are key to access to a given area proposed for restoration. Thus, road storage should take place after proposed timber harvest, riparian thinning, or in-stream structures if that road provides access to these sites. Ranger and USFS Staff approval is essential for all road projects that result in road storage. In other cases, the road may be cleared by all resource personnel for storage immediately if no restoration projects are access from that road. All road storage opportunities in this WRP are consistent with the POW ATM (USFS 2009). Remediation of red pipes would depend on available funding. Riparian thinning should be combined with wildlife thinning and timber thinning in the same stand. In-stream projects would benefit most from being done in a 'top-down' manner, ie store roads in the headwaters, and then improve stream condition from headwaters down to the mainstem spatially across the Project Area.

Project Monitoring and Evaluation

The North Thorne restoration effort supplements other restoration projects going on Prince of Wales Island and elsewhere across the Tongass National Forest. These projects range from removal of stream crossing structures along roads (road storage), replacing red pipes, riparian thinning, to addition of LWD instream to improve stream and habitat conditions. All these efforts aim to improve watershed form and function, and increase existing fish populations. While the effectiveness of hydrologic recovery may be simpler to monitor, increased fish populations are far more difficult monitor. Oceanographic conditions and global climate change can influence the presence, absence, or populations of salmonids in an area where watershed restoration takes place. Thus, monitoring the effectiveness of restoration projects properly, and an expectation of direct results can be a difficult challenge.

North Thorne restoration efforts should include project implementation monitoring and simple effectiveness monitoring. The finer details of project effectiveness on fish populations will be tiered to previously established efforts. The simple effectiveness monitoring should occur at varying intensities depending upon the project objectives. The projects proposed in this restoration plan have one or multiple specific objectives. Simple objectives such as hydrologic connectivity and large wood additions can be measured on a project by project basis. For example, large wood additions can be monitored by sampling pieces of large wood prior to restoration, then immediately following restoration and multiple years beyond. Hydrologic connectivity can be measured immediately post restoration. For example, removing plugged structures along a road would result in immediate restoration of hydrologic connectivity. As individual in-stream projects are proposed, specific variables will be recommended for measuring success depending upon the funding available, the timeframe, and level of effort, available to accomplish the work.

All restoration projects in this plan will include specific objectives and associated monitoring efforts to measure project success. Road projects will be successful in terms of hydrologic connectivity if surface water flow downslope and the risk of inhibited flow is eliminated at the road crossing. Fish passage would be evaluated by evaluating for fish habitat access. For example, if the road storage project intended to store X miles of road and improve access to Y miles of fish habitat, then post project monitoring would evaluate for these objectives.

Young growth riparian area objectives could be monitored by measuring diameter and height growth metrics and utilizing the stand simulation models suggested in the Tongass Forest Riparian Thinning Strategy. This information could be used to help predict the response to thinning and approximation of the desired future condition.

In-stream projects will include project specific monitoring as mentioned above and will be tiered to the objectives of the larger restoration working group. All in-stream projects should include pre and post photo points, and Tier II monitoring. The information from the Tier II surveys will be used to evaluate the in-stream success by comparison with the Region 10 physical channel metrics.

Project implementation should be summarized each fall in year-end project reports. Additional monitoring should be documented in individual monitoring reports that will follow project implementation. The results of specific project monitoring, and the results of the larger restoration picture across the Tongass National Forest, should be used to improve restoration methods and prescriptions in future projects.

Recommendations

- This WRP needs to be a “living” document, with the option to continually add to it in the future.

- Need to avoid, if possible, additional harvest in the valley bottoms near Class I streams, especially the North Fork of the Thorne River drainage (West Fork, East Fork, and Snakey Lakes). This area is a prime producer of sportfish and salmon on the Tongass (ADF&G) and in the Project Area.
- The West and East Fork watersheds contain the highest amount of MMI 4 soils and nearly 90% of the landslides in the Project Area. There is high risk for landslides with additional harvest and road building upslope of currently harvested areas. These areas should be avoided , if possible, for future harvest consideration. Also, need to protect upper stream reaches of West and East Fork watersheds, lots of bedload aggregation in floodplains downstream of these areas.
- Need to be aggressive about storage and decommissioning roads in the Project Area. Need to properly store roads, which includes removing all structures and providing necessary drainage.
- Need to carefully design and properly construct roads, if truly needed, on mid to upper slopes.

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APPENDIX A

8.5” x 14” Maps of Riparian Thinning Opportunities in the North Thorne Project Area

APPENDIX B

8.5" x 14" Maps of Roads and Road Storage Opportunities

in the North Thorne Project Area

APPENDIX C

8.5" x 14" Maps of PFC and Tier II Sites

in the North Thorne Project Area

APPENDIX D

8.5" x 14" Maps of Potential Instream LWD Opportunities

in the North Thorne Project Area