Kadake Creek
Watershed Restoration Plan

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Executive Summary

The Kadake Creek watershed (Hydrologic Unit Code 190102020100) lies within the North Kuiu priority watershed in the north central portion of Kuiu Island on the Petersburg Ranger District of the Tongass National Forest (Figure 1). Kadake Creek (ADF&G #109-44-10390) drains a 32,270 acre watershed and lies partially in three different ecological subsections including the Rowan Sediments, Sumner Straight Volcanics, and the North POW-Kuiu Carbonates subsections (USDA Forest Service, 2001). Sixty nine percent of the area in this watershed lies in the Timber Production land use designation (LUD), but also includes the Modified Landscape, Old Growth Habitat, Recreational River, and Semi-Remote Recreation LUDs.

Kadake Creek Watershed is important for commercial fisheries production, subsistence and recreation activities. Users from the nearby communities of Kake, Point Baker, Port Protection, Kupreanof, and Petersburg as well as approximately 25 outfitters and guides use this watershed for fishing, hunting, trapping, sightseeing, kayaking, camping and hiking. Recent changes in the physical conditions of the watershed have been driven primarily by timber harvest and road building, with natural and management-induced landslides also contributing to physical changes within the watershed. Commercial riparian harvest has altered forest stand conditions along some of Kadake Creek and its tributaries, possibly altering patterns of wood recruitment and wood function in streams. Temporary and unused National Forest System (NFS) roads contribute sediment to streams and alter drainage patterns. Restoration projects are aimed at improving fisheries habitat through placement of large woody debris (LWD) structures, reducing the negative impacts of roads on watershed resources through decommissioning and storing temporary and NFS roads, lowering sediment input to a Kadake Creek tributary from a highly used fishing access trail, improving access to the Kadake Bay cabin and slowing or stabilizing streambank erosion occurring at the site, and expanding stream, road, and invasive weed surveys to better characterize the watershed.

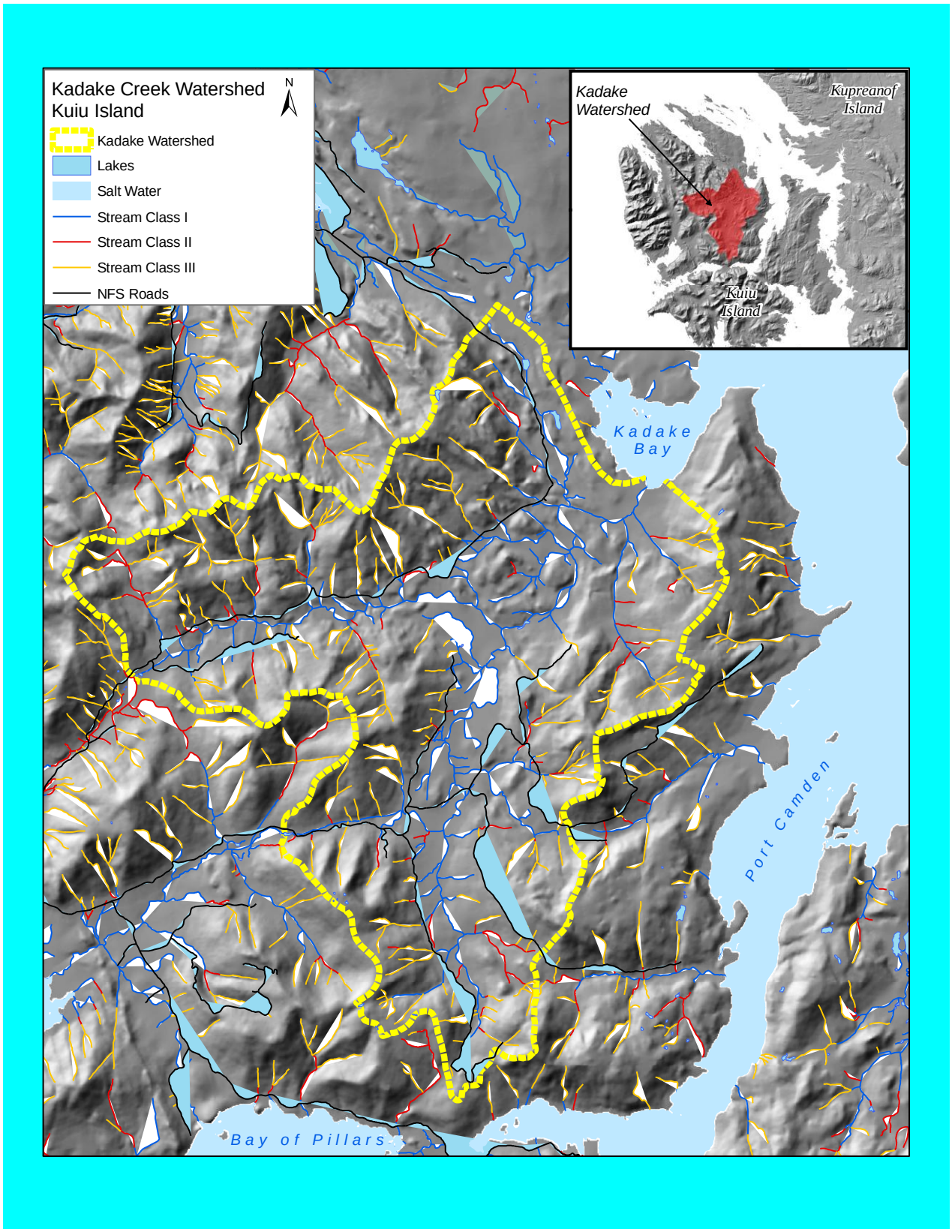

Figure 1. Kadake Creek Watershed on North Kuiu Island.

The key problems in this watershed include road drainage/erosion concerns, altered streamflow and sediment transport regime, and degraded aquatic habitat.

Opportunity exists to decommission 1.6 miles of temporary roads, store 15.9 miles of NFS roads, re-establish natural drainage patterns on 15.3 miles of Class I stream channels and 1.1 miles of Class II stream channels, enhance stream habitat through LWD placements on 0.6 miles of stream, control sediment input while improving sport fishing access to Kadake Creek, survey up to 30 miles for invasive weeds, expand Tier II stream surveys for improved assessment of instream and riparian condition, and expand NFS and temporary road surveys for input into the Tongass Watershed Improvement Tracking (WIT) database for subsequent decommissioning / storage contract development. Implementing these restoration objectives will improve watershed function and health by enhancing fisheries habitat through placement of large woody debris (LWD) structures, reducing the negative impacts of roads on watershed resources, and improving management decisions and restoration project development through expanded inventories and updated GIS.

Watershed Characteristics and Conditions

General

Climate

Climatic conditions in the Kadake Creek watershed are typical of Southeast Alaska temperate rainforest, cool and wet. The climate in this region is moderated by maritime exposure, with a greater proportion of winter precipitation falling as rain, especially at lower elevations. Kadake Creek watershed is strongly influenced by a nearly constant procession of storms originating from a semi-permanent low-pressure system called the Aleutian Low (USDA Forest Service, 2001). Maritime air masses originate over the warm waters of the Pacific Ocean, where heat and moisture are transferred to the atmosphere. The northward movement of warm ocean currents and air masses transports warm moist air into the coastal mountain ranges of the Alexander Archipelago. As the moisture-laden air rises into the mountains, it cools causing heavy precipitation. Annual precipitation ranges from near 100 inches at the mouth of Kadake Creek to around 130 inches in the headwaters of the watershed (USDA Forest Service, 1979). Most precipitation falls from September to January, and snow is common from October through March. Rainfall dominates the streamflow regimes, with streams also responding to late spring snowmelt. Peak stream flows are typically associated with heavy fall rains or winter rain-on-snow events, with dry weather in early to mid-summer leading to low flows by late summer.

Basin Geology

The watersheds in north Kuiu Island are formed from the Alexander terrane, and are characterized by interbedded ocean trench sediments, shallow water limestone, sedimentary rocks (primarily mudstone, graywacke, and turbidites), volcanic rocks, and

chert (USDA Forest Service, 2001). The Kadake watershed lies partially in three different ecological subsections. The Rowan Sediments subsection comprises 48 percent of the watershed and is predominant in the West Fork of Kadake Creek, but also makes up the western portion of the South Fork. This subsection is characterized by rounded hills and broad U-shaped valleys altered through time by repeated glaciations. Hillslopes contain silty- or loamy-textured soils resulting from weathered mudstone, greywacke, and turbidite bedrock. These deep residual soils are well drained and support highly productive hemlock and spruce forests. Valleys are typically composed of thick deposits of glacial till, with poorly drained organic soils supporting a mix of forested and nonforested muskegs and fens. The Sumner Strait Volcanics subsection in the southeastern portion of the watershed comprises 33 percent of the watershed, and is characterized by benched hills and lava plateaus resulting from young, somewhat impermeable volcanic flows rising from lowland glacial till. Glacial activity has eroded prominent features in this landscape, with landforms characterized by long gentle slopes or short, steep, and stair-stepped slopes, depending on orientation relative to the direction of volcanic flow (USDA Forest Service, 2001). Precipitation actively erodes gullies on this volcanic bedrock, contributing a large amount of bedload sediments to streams. The northern portion of Kadake watershed is characterized by a karst landscape that comprises the North Prince of Wales Kuiu Carbonate subsection. Karst is a result of dissolving carbonate (limestone and marble) bedrock that results in unique topographic features including cone-shaped pits, vertical shafts, cliffs and caves (USDA Forest Service, 2001). This type of geology is heavily fractured, and water flows freely underground along conduits that do not necessarily follow watershed boundaries. The open, wetland areas in the valleys in this portion of the watershed suggest deposition of glacial till over the karst bedrock, effectively sealing the porous bedrock. The Kadake watershed ranges from sea level to 1975 feet in elevation.

Vegetation

Vegetation patterns in Kadake and other North Kuiu watersheds are similarly influenced by climate and soils. Approximately 61 percent of this watershed is forested non-wetland, and is generally dominated by Western hemlock (*Tsuga heterophylla*) and Sitka spruce (*Picea sitchensis*) (Table 1). Other tree species include Mountain hemlock (*Tsuga mertensiana*), Alaska yellow cedar (*Chamacyparis nootkatensis*), shore pine (*Pinus contorta*), and red alder (*Alnus rubra*), depending on the site. Understory shrubs typically include blueberry (*Vaccinium ovalifolium*), red huckleberry (*Vaccinium parvifolium*), rusty menziesia (*Menziesia ferruginea*), and devil's club (*Oplopanax horridus*) (USDA Forest Service, 1994).

Table 1. Vegetation cover in the Kadake Creek watershed

Vegetation Cover	Acres	% of Total
Lakes	26	0
Forested Non-Wetland/Alpine Shrub-Emergent Short Sedge Wetland, > 50 Percent Forested	315	1
Alpine Dwarf Evergreen/Alpine Shrub Complex, < 50 Percent Dwarf Evergreen	897	3
Alder/Salmonberry Shrublands on Mountain Slopes	284	1

Scrub/Estuarine	15	0
Emergent Short Sedge Wetland	1,533	5
Forested Wetland/Moss Muskeg Complex, > 50 Percent Forested	5,713	18
Forested Non-Wetland	19,828	61
Forested Wetland	1,173	4
Moss Muskeg (Sphagnum Peat Muskeg)	910	3
Forested Non-Wetland/Non-Forested Non-Wetland Complex, > 50 Percent Forested	664	2
Rockland	23	0
Unknown	888	3
Total	32,270	

Fisheries

The Kadake Creek watershed is important for fisheries production relative to other watersheds in Southeast Alaska, with large populations of coho (*O. kisutch*), pink (*O. gorbuscha*), and chum (*O. keta*) salmon, cutthroat trout (*Salmo clarki*), and Dolly Varden char (*Salvelinus malma*). Kadake Creek is the largest producer of pink salmon on Kuiu Island and is also recognized locally as one of the top steelhead trout (*O. mykiss*) fisheries in the area. Fisheries values are particularly high for pink and chum salmon spawning in the mainstem from a point below the confluence of the South and West Forks to the mouth; coho salmon and steelhead spawning and rearing in the South Fork, lower West Fork, and lower reaches of tributaries to these streams; and coho salmon overwintering habitat in the beaver ponds and palustrine channels primarily west of the confluence of the West and South Forks, and in the similar habitats off the lower mainstem in the north-central portion of the watershed.

Peak escapement estimates for Kadake Creek are not available through the Alaska Department of Fish and Game "Fish Count" database, and little historical data is available. Kadake Creek is known to contain a strong run of steelhead and is one of two federally managed steelhead fisheries on the Petersburg Ranger District. Federally qualified users were able to harvest steelhead (Oncorhynchus mykiss >22 inches) in Kadake and Hamilton Creeks of any length for subsistence in 2003 and 2004. This rule was expanded in 2005 to include all fresh water. Petersburg district biologists have conducted an annual adult and redd count on Kadake Creek for 13 of the last 15 years since 1993. The counts are made between May 12 and May 17 along a 5.6 mile reach, from the bridge crossing on Forest Service road 6437 to a downstream log jam about one mile upstream from the mouth (Figure 2).

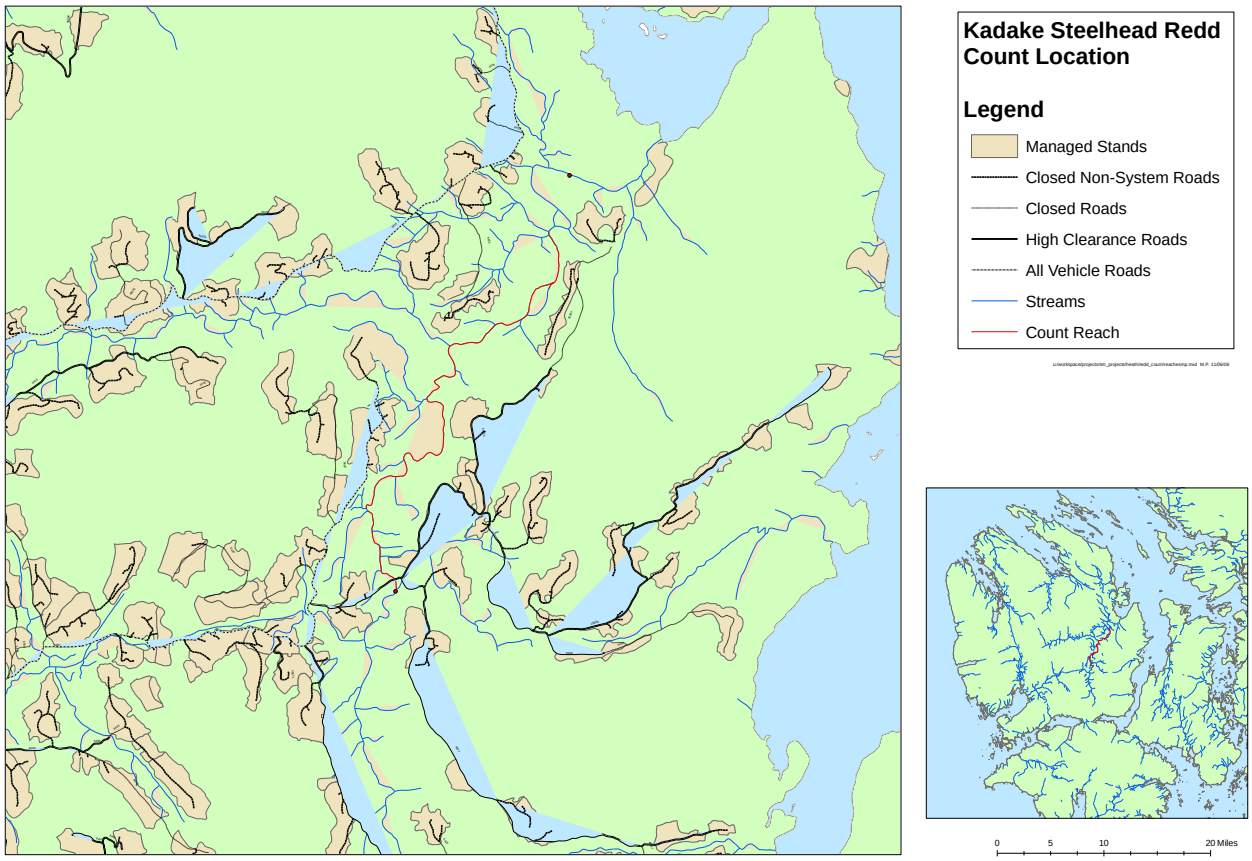

Figure 2. Location of study reach for Kadake Creek steelhead redd count.

Counts and observation conditions continue in order to gather an index of spawning activity from year to year and track changes in the riffle areas preferred by the spawning steelhead (Figure 3). This information will help better manage steelhead populations and the subsequent fishing use patterns along Kadake Creek. Currently, sport fishing use along well-known portions of the mainstem has created spur trails needing maintenance to prevent resource damage. Residents of Kake and other nearby communities harvest Kadake Creek fish for subsistence use, but little data is available concerning this fishery.

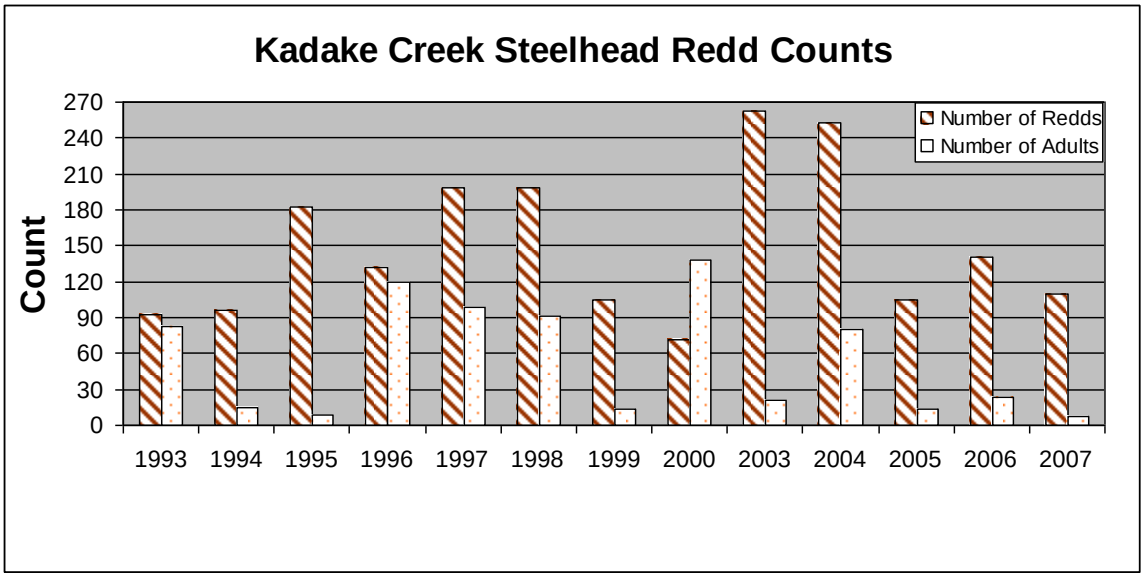

Figure 3. Index counts for steelhead redds and adult steelhead in Kadake Creek.

Recreation

Areas commonly used for recreation in Kadake watershed include Kadake Bay, a portion of Kadake Creek, and Gil Harbor. Several outfitters/guides do business in North Kuiu watersheds, including Kadake. Black bear hunting, sightseeing, and fishing are the primary guided activities. Since 2004, eight to ten outfitters and guides had special use permits for this area. Actual Use Reports show the number of black bear hunts in north Kuiu watersheds ranged from 59-69 during the 2004-2006 seasons, although it is difficult to determine specific use in the Kadake Creek watershed. A few outfitters and guides with special use permits for North Kuiu watersheds rely exclusively on sightseeing, freshwater fishing and hiking for their clients. Also, two kayak outfitters and guides have used the shoreline of North Kuiu for their trips.

Recreational values of Kadake Creek are enhanced by the Recreational River designation and the presence of a recreational cabin in Kadake Bay managed by the USFS, which draws both local and out-of-state steelhead fishermen. The most recent cabin use data indicates there were 104 total days fished at the cabin in 2002, with visitors fishing an estimated 584 hours for steelhead, Dolly Varden, and cutthroat trout (ADFG, 2007).

Watershed Conditions

Hydrology

The Kadake Creek hydrograph was estimated using the USGS gage on nearby Hamilton Creek, corrected for watershed area (Figure 4). The hydrograph is similar to other north Kuiu watersheds and is driven by rainfall and snowmelt, with annual maximum flows controlled by fall and winter rainstorms. Snowmelt augments stream flows in the spring

and early summer months (Figure 5). Annual minimum flows occur during periods of drought in June, July or August. The northern portion of the watershed is characterized by karst topography in which water can flow freely through fractures in the carbonate bedrock, likely concentrated on the hillslopes and toeslopes. The high proportion of wetlands in this watershed suggests an increased ability to moderate storm runoff and provide a more stable baseflow during the summer months.

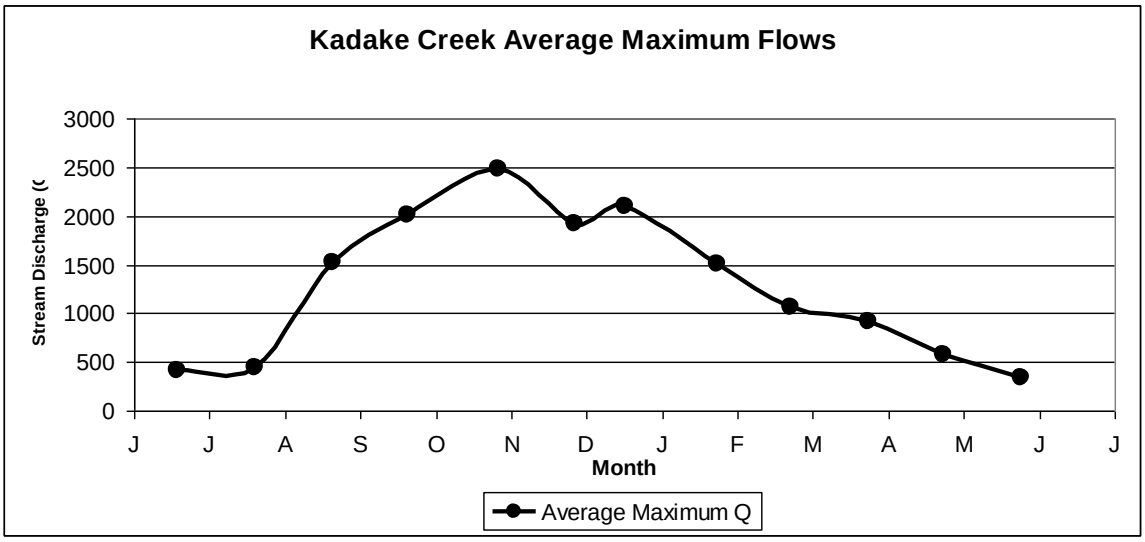

Figure 4. Hydrograph of average maximum flows (cfs) on Kadake Creek.

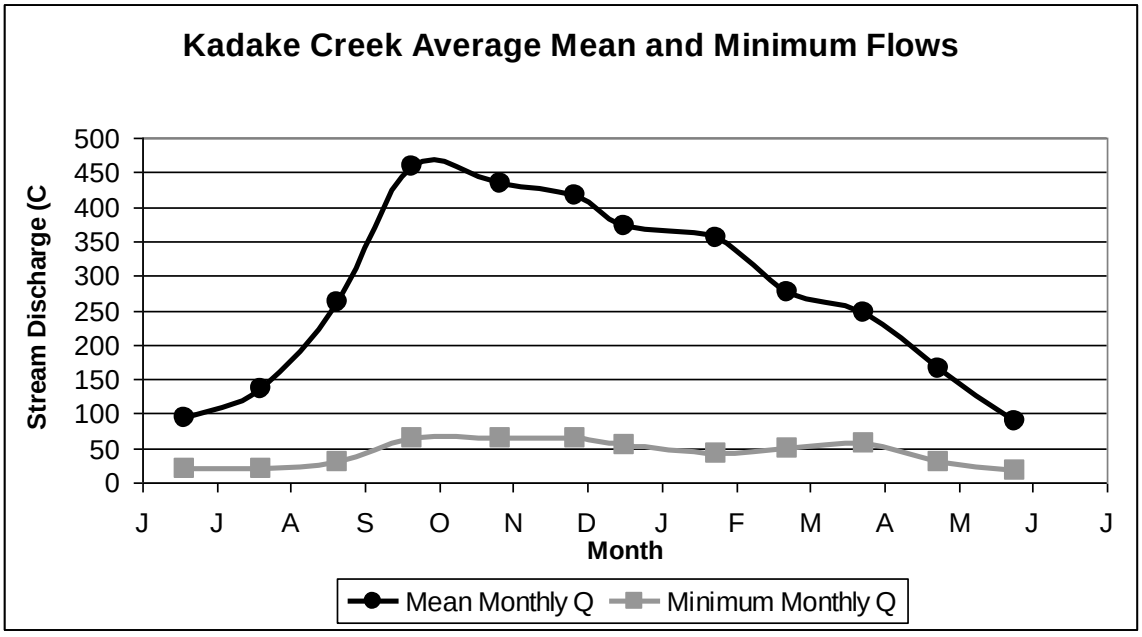

Figure 5. Average mean and minimum flows on Kadake Creek.

Wetlands

There are seven wetland habitat types in the Kadake watershed, from the valley bottoms to the mountain tops. The "Estuary" habitat type is considered a high value wetland, which is a determination largely dependant on human use or the perceived benefit of the wetland. Because perceptions change over time, the values placed on wetlands or upland ecosystems also changes. Resource values associated with these wetlands vary, depending on biological qualities, proximity to water bodies, and position on the landscape. Based on the Soil Resource Inventory (1992), approximately 30 percent of this watershed is classified as wetlands (Table 2). Most occur in the broad valleys of the West and South Forks of Kadake Creek.

Table 2. Wetland habitat types in Kadake watershed.

Wetland Type	Acres	% of Total
Lakes	21	0
Subalpine Forest/muskeg mosaic	315	1
Estuarine Wetlands	15	0
Forested Wetland	1,173	4
Muskeg	910	3
Muskeg/forested wetland mosaic	5,713	18
Sedge Fen	1,533	5
Non-wetland uplands	20,800	64
Unknown	888	3
Other	902	3
Total	32,270	100

Stream Channels

The Kadake Creek watershed contains eight of nine process groups defined in the Aquatic Habitat Management Handbook for the Tongass National Forest (USDA Forest Service, 2001b) (Figure 6). This watershed has a relatively large proportion, mile per mile, of streams in the Moderate-gradient Mixed-control (MM) and Flood Plain (FP) process groups compared to other Kuiu watersheds. The high proportion of Class I streams reflects the high value of anadromous fish habitat in this watershed (Figure 7). With a drainage density of 3.4, the Kadake watershed lies between the 75^{th} and the 90^{th} percentile for drainage density amongst Kuiu watersheds, indicating the watershed is efficient at routing water and sediment from headwater areas to low gradient streams in valley bottoms.

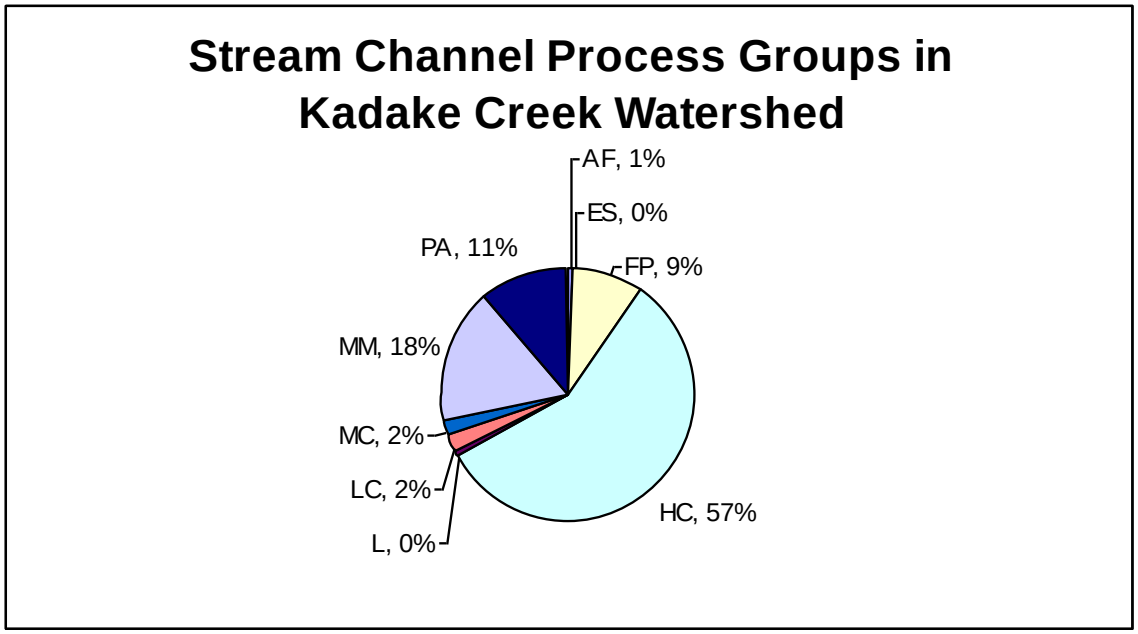

Figure 6. Stream channel type by length in the Kadake Creek watershed

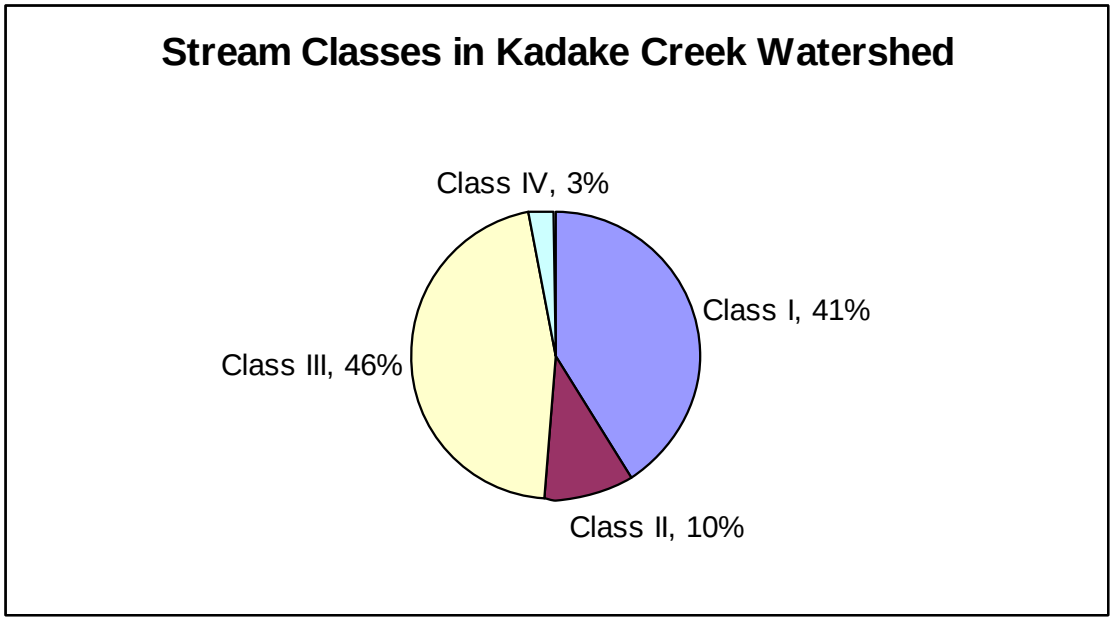

Figure 7. Stream classes in the Kadake Creek watershed

Water Quality

The desired condition for water quality in Kadake Creek watershed is for maintaining State-designated beneficial uses, which include the growth and propagation of fish, shellfish, other aquatic life, and wildlife. The criteria used to ensure beneficial uses are being met include standards for stream temperature, dissolved oxygen, pH, turbidity, total dissolved solids, and sediment (ADEC, 2006). Water quality has been assessed periodically on smaller scales in Kadake Creek, but a series of fish kills in the late 1980s reported by the Alaska Department of Fish and Game (ADFG) initiated a study by Pentec Environmental Inc. (1991). The authors surmised the pre-spawning mortalities of pink salmon were likely caused by low streamflows combined with large numbers of fish in holding pools depleting dissolved oxygen concentrations.

Low water conditions, warm stream temperatures, and low levels of dissolved oxygen are the primary concerns for salmonid species. Low rainfall in mid-to-late summer is directly responsible for low streamflows in August and September in Kadake Creek (USDA Forest Service, 1994). Water temperatures are affected by climatic factors including solar radiation, air temperature, and wind; basin characteristics such as elevation, aspect, and snow accumulation; and channel characteristics including width, discharge, and the effects of tributaries (Beschta et al., 1987). Warm air temperatures, decreased pool sizes at low flow levels, and increased numbers of fish during the same time period combine to further deplete available oxygen supplies. The fish kills in the late 1980s demonstrate these conditions occur periodically on Kadake Creek.

Upland Hillslope Conditions

Soils

Mineral soils in the Kadake Creek watershed originate from weathered bedrock, glacial till, alluvium, and colluvium and are typically overlain with a thick organic layer. Soil depth beneath a 6 to 10 inch layer of organic matter ranges from 10 inches to more than 20 feet. Drainage in mineral soils ranges from poorly drained to extremely well-drained. Organic soils such as sphagnum peat and sedge muskegs are derived from highly decomposed plant material, typically found on slopes with low gradient (0-35 percent), and are very poorly drained. The Kushneahin-Maybeso complex is composed of 50 percent Sphagnum peat muskeg and accounts for approximately 18 percent of the soils in this watershed. Kwatahein silt loam is derived from siltstone or mudstone and is the most common soil in this watershed, comprising 22 percent of the overall area (Table 3). This soil type is associated with mountainslopes and hills, is considered well drained with moderate permeability, and is very deep.

Table 3. Soil types in the Kadake Creek watershed.

Soil Type	Acres	% of Total
Ulloa-Sarker complex, 35 to 75% slopes	734	2
Kupreanof-Tolstoi association, 5 to 35% slopes	1,515	5
Kupreanof-Mitkof complex, 5 to 35% slopes	1,576	5

Mitkof-Mosman complex, 35 to 75% slopes		675	2
Mitkof sandy loam, 5 to 35% slopes		1,173	4
Kushneahin mucky peat, 0 to 15% slopes		1,533	5
Kushneahin-Maybeso complex, 3 to 35 percent slopes		5,713	18
Kwatahein Mitkof complex, 0 to 35% slopes		882	3
Kwatahein Mitkof complex, 35 to 60% slopes		883	3
Kwatahein silt loam, 35 to 75% slopes		7,012	22
Maybeso peat, 5 to 35% slopes		663	2
Sunnyhay-Tolstoi complex, 15 to 120% slopes		897	3
Unknown		888	3
Other		8,125	25
	Total	32,270	100

Natural Processes

Natural events related to changes in watershed hydrology and sediment delivery through the channel network include long-term erosion processes, mass wasting, and windthrow. Erosion processes including geologic weathering and channel adjustments produce sediment at low rates over long periods of time. Episodic events including natural and management induced landslides can deliver high amounts of sediment in short time frames, and are the largest contributor to stream sediment in the Kadake Creek watershed (USDA Forest Service, 1994). The GIS landslide inventory layer identified 17 landslides in the Kadake watershed totaling 27.5 acres. However, an earlier assessment using aerial photographs from 1977, 1979, 1985, and 1989, aerial surveys, and ground surveys resulted in and inventory of 57 landslides totaling 113 acres, with sizes ranging from ½ acre to 12 acres (USDA Forest Service, 1994). Forty of these landslides totaling 88.5 acres terminated in streams.

Mass movement potential is evaluated using the mass-movement index (MMI) for soils within the watershed, and is based on the steepness and soil drainage characteristics of each soil series (USDA Forest Service, 1997). Areas of high and very high mass movement potential are assumed to be potential sediment sources for input to stream networks. The Kadake Creek watershed is comprised of 54% MMI-1, 34% MMI-2, 8% MMI-3, and 4% MMI-4 soil classes, which places it between the 25th and 50th percentile for the proportion of the watershed lying on slopes in the high or very high MMI category compared to other Kuiu watersheds. A sediment risk assessment (SRA) for Kuiu Island (USDA Forest Service, 2005) identified the Kadake Creek watershed as having a high inherent risk for sediment related changes in stream channel characteristics compared to other Kuiu watersheds. The SRA considers drainage efficiency, steepness of the topography, time elapsed since timber harvest, road density, and percent of the watershed with high and very high Mass Movement potential. These factors are considered in terms of potential sediment source and deposition areas, and the efficiency of sediment transport within the watershed. After accounting for harvest and road-building proposed in the Kuiu Timber Sale FEIS (USDA Forest Service, 2007), the risk rating for Kadake watershed increased to very high. This indicates the inherent characteristics of the stream channel network may make it susceptible to changes in stream channel condition if

sediment supply is increased. Since timber harvest and road building have increased the area of potential sediment sources within the watershed, the risk of sediment-related changes to stream channels has increased.

Windthrow is also a source of natural disturbance in the Kadake Creek watershed. The 2005 Tongass Monitoring and Evaluation Report states that riparian buffers on south facing slopes were more prone to increased windthrow, while windthrow on slopes oriented other than to the south was negligible. An aerial photo and field survey of historic windthrow in Kadake watershed indicated that natural riparian windthrow is probably not a significant stream disturbing process, although individual tree windthrow is probably an important source of large woody debris to stream channels (USDA Forest Service, 1994).

Harvest History

Timber harvest began in 1972 in this watershed, with 19% percent (6,151 acres) of the total area harvested (including road clearings), and 17% harvested within the last 30 years Timber harvest that has been approved but not implemented would bring the cumulative harvest level to 17.3%. Early harvest was concentrated in valley bottoms and toe slopes, including 160 acres of harvest in riparian areas in which commercial timber harvest is prohibited under current standards and guidelines.

The degree to which logging in riparian areas may have altered watershed processes in the Kadake Creek watershed is not known. Riparian harvest in the Kadake Creek watershed may have directly altered wood loading in streams, wood recruitment, stream shading, and wildlife habitat quality. Riparian harvest may have indirectly affected stream channel morphology, fish habitat quality, stream temperature, and summer low flows. Extensive stream channel surveys on main-stem Kadake Creek in 1993 determined that wood loading was at the 50^{th} percentile for streams of similar size on the Tongass. With less large wood available for recruitment into the stream it may be expected that wood loading in Kadake Creek will decline over time. This WRP proposes to continue Tier II stream surveys on approximately 80 acres to assess wood loading in previously harvested RMAs. Thinning and pruning treatments for riparian stands would speed the development of mature stand characteristics. Mature riparian stands are expected to function in a way that benefits fish and wildlife, including the recruitment of key pieces of large wood into streams, providing cover, shading, channel complexity, and bank stability. Benefits for wildlife include increased understory forage production and maintenance of travel corridors. The guiding philosophy is that maximum benefits for fish and wildlife will be provided by a multi-aged stand that once established will be maintained into perpetuity by natural disturbance processes.

Roads

There are a total of 47.2 miles of National Forest System (NFS) and 33.0 miles of temporary roads in the Kadake Creek watershed, with road building dating to the 1960s. The Draft 2005 Access and Travel Management Plan for Petersburg Ranger District

responds to a national mandate to reduce road maintenance needs on US Forest System roads by recommending closing 174 miles of road, including 12.6 miles of NFS roads (plus an additional 3.3 miles constructed for the Kuiu Timber Sale), and 1.6 miles of temporary road in the Kadake Creek watershed (Figure 8).

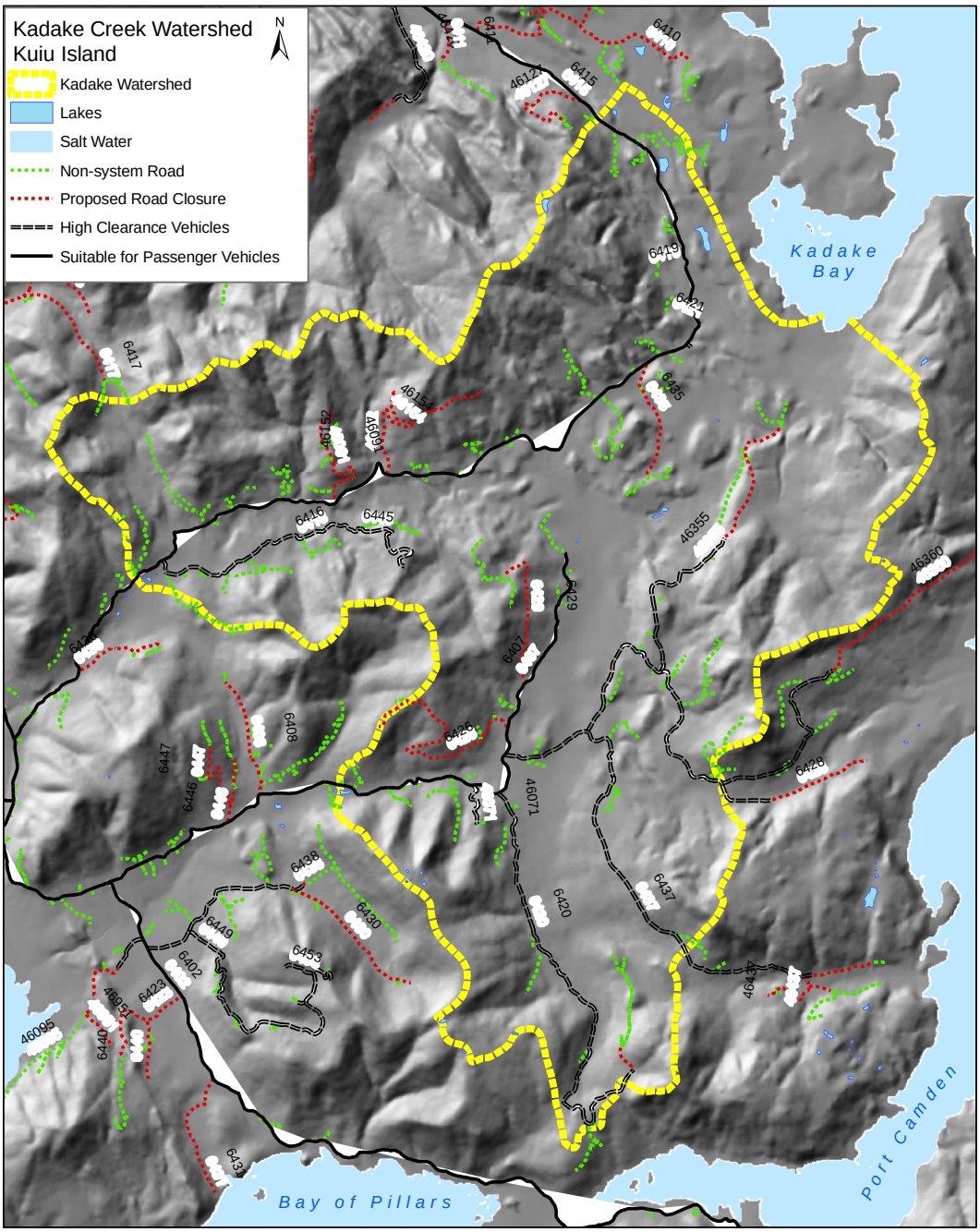

Figure 8. Routing and management objectives of roads in the Kadake watershed.

Closing NFS roads and decommissioning temporary roads involves removing drainage structures, installing additional water bars as needed for drainage, blocking the road entrance, and allowing natural revegetation of the road surface. These actions restore natural streamflow, improve fish habitat condition and hydrologic connectivity, and have a high probability to be effective once implemented. Maintenance problems, fish passage problems, and lack of information about road conditions have all been documented for the roads recommended to be closed.

Road condition survey data indicate there are 28 red pipes in the Kadake Creek watershed, with structures still in place on many NFS roads closed by vegetation. Six temporary roads slated for decommissioning were visited in 2007 to document current condition and verify decommissioning needs as part of the North Kuiu WRP. Initial assessment focused on non-system roads identified as having structures in place and identified in the Kuiu Island Road Analysis (2001c) and Draft Petersburg Ranger District ATM (2005b) for decommissioning. While no roads met these criteria in the Kadake Creek watershed, they did occur in Saginaw, Security, Rowan, and Dean Creek watersheds. Surveys indicated three roads visited in Kadake needed tank traps at MP 0+00 for proper closure, but no further work was required on the remainder. Only a small portion of the roads proposed for closure were visited (Table 4). All road sites are entered into the Tongass Watershed Improvement Tracking (WIT) database for road decommissioning proposal development. Temporary and NFS roads that were not visited during field efforts in 2003-2004 and 2007 will be prioritized for field assessment according to objectives outlined in the Draft 2005 Petersburg Ranger District Access Travel Management (ATM) plan.

Table 4. Proposed road closures in Kadake Creek Watershed.

Route #	Miles	Notes
Temporary	1.6	spur roads on 3 separate NFS roads
'46030'	2.6	constructed for timber sale
'46031'	0.7	constructed for timber sale
'46091'	1.6	1.1 miles rebuilt for timber sale, 14 culverts
'46152'	2.0	0 culverts
'46154'	0.5	0 culverts
'46355'	1.6	41 culverts
'6419'	0.4	0 culverts
'6420'	1.2	39 culverts
'6421'	0.4	0 culverts
'6426'	2.7	29 culverts, 1 log bridge
'6429'	1.7	26 culverts
'6435'	1.4	11 culverts (2 red), 2 log bridges
Grand Total	18.4	160 culverts (2 red), 3 log bridges

Previous Enhancement Activities

Hillslope enhancement activities have primarily been restricted to pre-commercial thinning treatments and general road maintenance (Table 5). Previous thinning treatments

have focused on reducing conifer density, alder density, or overall tree spacing to improve conifer growth and understory condition, but have not incorporated other ecosystem components such as wildlife, soil and stream chemistry, or leaf litter.

Table 5. Known upland enhancement activities in the Kadake Creek watershed.

Resource	Activity	Acres Treated	Year Implemented
Silviculture	Pre-commercial thinning	125	1985
Silviculture	Pre-commercial thinning	58	1989
Botany	APC non-structural improvements with grasses and forbs.	1	1990
Transportation	Replace 46500 with shorter spur road, replace road 46354 with 46360, and convert road 6466 from specified to temporary road	0	1991
Transportation	Blowdown salvage - 200 feet of temporary road approved to harvest blowdown	22	1991
Transportation	APC blowdown salvage	6	1992
Transportation	Road maintenance blowdown salvage - Identify and remove logs that could threaten road safety for travelers throughout island	Ongoing	1993
Silviculture	Pre-commercial thinning & pruning	40	1997
Silviculture	Commercially thin acreage to increase tree growth, subsequently increasing timber value, and to maintain understory vegetation for wildlife needs	78	1998
Silviculture	Thinning of 23 overstocked second growth stands on Kuiu and Kupreanof to promote growth of largest best formed trees within.	62	2001
Silviculture	Pre-commercial thinning	897	2005
Silviculture	Pre-commercial thinning	211	2005
Silviculture	Pre-commercial thinning	963	2005
Transportation	Routine reconditioning and brushing of roads 6420, 6428, 6437	Ongoing	2006

Floodplain Conditions

Streams

Floodplain conditions in the Kadake Creek watershed reflect a combination of many soil types in the watershed, but primarily the very deep, well drained Kwatahein silt loam soils occurring on steep upland slopes and contributing to the well-developed floodplains throughout the watershed, and the Kushneahin-Maybeso complex occurring on slopes from 3 to 35 percent. This is also a very deep soil type, but is very poorly drained with an organic layer overlaying glacial till and colluvium, and is generally comprised of

muskegs and "scrub" timber stands containing several conifer species (USDA Forest Service, 1989). There are 46.2 miles of floodplain (FP), alluvial fan (AF), and moderate gradient mixed-control (MM) channels in the watershed (Table 6).

Table 6. Kadake Creek Watershed stream channel process groups.

Channel Type	Length (miles)	Percent of Total
AF	1.3	1
ES	0.0	0
FP	15.0	9
HC	96.8	57
L	0.8	0
LC	3.9	2
MC	3.4	2
MM	29.9	18
PA	18.7	11
Total	169.8	100

Tier II surveys were conducted in summer 2007 on eight Class I and Class II stream sites in FP and MM channels. Survey locations targeted sites of known disturbance such as riparian harvest, landslides, and higher road densities (Figure 9). Results will be summarized and compared with Tongass NF standards in FY 2008.

Kadake Tier 2 Site Map

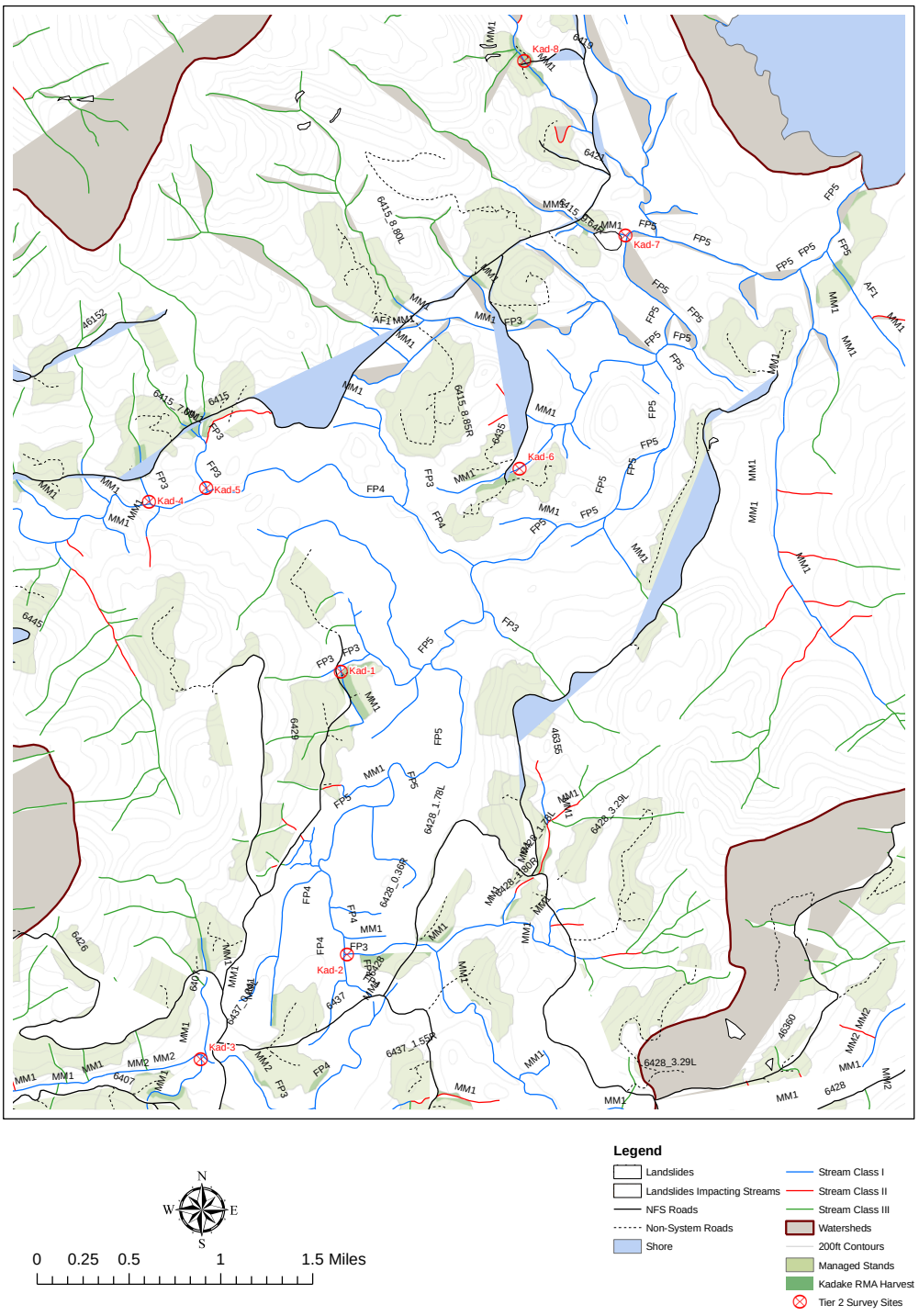

Figure 9. 2007 Tier II stream survey locations in Kadake watershed.

In 2004, stream channel characteristics were measured in a 4 mile long reach of FP5 stream in the mainstem of Kadake Creek. The reach reflected poor condition for the number of pools; excellent condition for the percentage of channel area in pools; and between fair and good condition for wood loading and width-to-depth ratio (Table 7). The poor rating for number of pools, and excellent rating for percent of channel area in pools indicates that there are few pools, but that they are larger than average for a stream of this size. Both wood loading and width-to-depth ratio are average. The available stream channel condition data represent a snapshot in time, and it cannot be determined whether the low number of pools represents a decrease in pools over time, or simply natural variability in stream channel conditions.

Table 7: Stream channel condition: Mainstem Kadake Creek

Channel characteristic	Value	Percentile ranking	Condition
Number of pools / kilometer	11	Less than 25th	Poor
% channel area in pools	69	Greater than 75th	Excellent
Pieces of wood per 1000 m^2	5	= 50^{th} percentile	Fair / good
Width-to-depth ratio	45	= 50^{th} percentile	Fair / good

Riparian Harvest

The degree to which logging in riparian areas may have altered watershed processes in the Kadake Creek watershed is not known. Approximately 160 acres of timber was harvested in RMAs over a 12-year period, with the exception of riparian harvest near the mouth of Kadake Creek in 1915. Overall, riparian harvest has occurred in an area equal to 0.5% of the watershed. Most RMA harvest occurred in FP and MM stream channel types in low-gradient valley bottoms with easily accessible, productive timber stands (Figure 10). While smaller in scale than other North Kuiu watersheds, the riparian harvest in the Kadake Creek watershed may have altered wood loading in streams, wood recruitment, stream shading, and wildlife habitat quality, and effected stream channel morphology, fish habitat quality, stream temperature, and summer low flows. In 2007, Tier II stream surveys were conducted on 8 stream sites targeting areas of riparian harvest and other disturbance including landslides and high road densities. The data will be summarized in FY2008, but initial assessments indicated some of the sites had already been thinned as part of a pre-commercial thinning project conducted in 2001, including the riparian zones. None of the sites currently need riparian thinning treatments, but approximately 80 additional acres of previous RMA harvest need to be reviewed for

potential thinning opportunities.

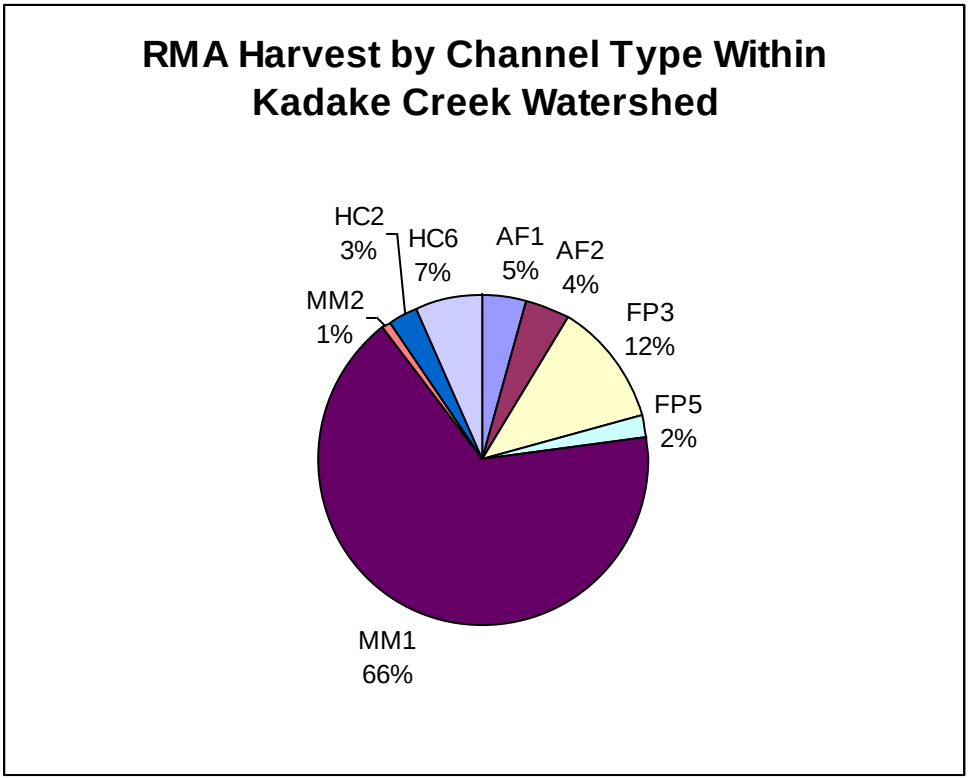

Figure 10. Timber harvested in the RMA by channel type in Kadake Creek Watershed.

Roads

There are 47.2 miles of National Forest System (NFS) roads and 33.0 miles of temporary roads in the Kadake Creek watershed. Most of the NFS roads, including 6415, 6407, and 6420 are located primarily on the toe slopes, and run roughly parallel to the West and South Forks of Kadake Creek (Figure 8). Portions of roads 6415 and 6416 are located within the floodplain of West Fork Kadake Creek; portions of roads 6407, 6420, 6437 are located within the floodplain of South Fork Kadake Creek. Most of the temporary roads gain elevation to access timber on the hillslopes, but portions occur within the floodplain of both forks. Approximately 12 percent of timber harvested in this watershed was accessed between 1975 and 1987, and some of these roads have had little vehicle traffic since then. The last timber entry in this watershed was 2000, and generally, maintenance needs are increasing as the road system and drainage structures age.

Previous Enhancement Activities

Known riparian area enhancement activities occurring in the Kadake watershed are summarized in Table 8. The acreages presented were generated from GIS and may vary slightly from on-the-ground acres. There are sparse details concerning some of the projects. LWD stream placements continue to be encountered in the field while conducting Tier II or fisheries surveys, and site locations and general conditions are

documented when encountered. The potential exists for monitoring previous LWD placements and riparian thinning treatments in this watershed (see monitoring section).

Table 8. Known riparian / watershed enhancement activities in Kadake Creek watershed.

Resource	Activity	Description	Year implemented
Transportation / Engineering	Instream Large Wood Placements	3 LWD placements found in FP3 channels near Rd. 6415_7.1, likely placed as part of road / culvert work	est. 1988-1992
Transportation / Engineering	Instream Large Wood Placements	LWD placements found in MM1 channel near Rd. 6415_10.0, likely placed as part of road / culvert work	est. 1988-1992
Transportation / Engineering	Instream Large Wood Placements	5 LWD placements found in MM1 channel near jxn of Rd. 6407 and 6437, likely placed as part of road / culvert work	est. 1988-1992
Watershed	Kadake Tributary Channel Restoration	Channel restoration via placement of 7 rock & log weirs in constructed channel	2005

Restoration Opportunities

Timber harvest and road building were the dominant forces of change in the Kadake Creek watershed from 1975 to 2000. The restoration strategy for this watershed addresses change caused by timber harvest and road building, and focuses on restoring watershed processes in harvested riparian areas and along roads with maintenance problems. Projects developed in response to these needs will include instream placements of large wood for fisheries habitat improvement, decommissioning all former temporary roads that have not been decommissioned, and close NFS roads identified in the 2005 Draft PRD ATM (Table 9). Future assessments will expand stream channel surveys and identify all roads currently in "closed" status used by wheeled traffic.

Implementing restoration recommendations and objectives will improve watershed function and health in the following ways:

- Enhancing 0.6 miles of stream habitat along harvested RMAs on three FP3 channels through the addition of LWD to the stream channel to benefit fish habitat.
- Restoring natural floodplain function by storing 0.5 miles of 46154 encroaching on the West Fork Kadake Creek floodplain.
- Restoring natural floodplain function by closing 1.6 miles of 46355; 0.3 miles of 6420; and 2.7 miles of 6426 with portions encroaching on the South Fork Kadake Creek floodplain.
- Restoring natural floodplain function by closing 0.4 miles of 6419; 0.4 miles of 6421; and 1.4 miles of 6435 with portions encroaching on the floodplain north of the junction of the West and South Forks.

- Enhancing 15.3 miles of Class I and 1.1 miles of Class II fish habitat by removing up to 252 culverts (11 red) and 3 log stringer bridges and closing 15.9 miles of NFS roads.
- Reducing sediment input and risk of mass wasting, and restoring natural surface and groundwater drainage pathways by decommissioning 1.6 miles of temporary roads in the upper Kadake Creek watershed.
- Improving access and slowing / stabilizing stream bank erosion by replacing Kadake Bay cabin and outhouse to meet accessibility guidelines and relocating structures away from currently eroding bank.
- Reducing sediment input and improving natural drainage in MM1 tributary and FP5 mainstem floodplain through Kadake Creek access trail enhancement.
- Monitoring instream restoration and landslide stabilization projects, and updating the Kadake WRP with results and photo points.
- Prioritizing approximately 80 additional acres of previously harvested riparian areas to determine potential riparian treatment opportunities.
- Expanding inventories of stream channel condition on streams where initial inventories identified deficiencies compared to Tongass Fish Habitat Objectives, including randomly selected reference reaches for comparison with Tier II stream data obtained in summer 2007.
- Expanding inventories of temporary and NFS roads for input into the Tongass WIT database and subsequent project proposal development.
- Expanding invasive weed surveys on approximately 30 miles of mainline road in Kadake Creek and other North Kuiu watersheds.

Table 9. Kadake Creek Watershed restoration opportunities highest priority list.

Project Name	Sub-Basin	Landscape Position	Project Type	Watershed Processes	Relative Priority	Length (miles)	Acres	Admin / NEPA	Survey Design	Implementation	Total
Tributary LWD Enhancements & Placements	W & S Fork	Low - Riparian	Stream Enhancement	Hydro / Instream	Medium	1.0		$ 2,000	$ 5,250	$ 35,000	$ 42,250
Kadake Creek Access Trail Enhancement	North Fork	Low - Riparian	Access improvement	Riparian	Low	0.5		$ 5,000	$ 3,000	$ 40,000	$ 48,000
Kadake Bay Cabin replacement & relocation	Kadake Bay	Low - Riparian	Recreational cabin relocation	Hydro / Riparian	Medium		1	$ -	$ -	$ -	$ -
46030 Hydrologic Connectivity Restoration	W Fork	Headwaters	Road Storage	Hydro	Low	2.6		$ -	$ -	$ -	$ -
46031 Hydrologic Connectivity Restoration	W Fork	Mid-slope	Road Storage	Hydro	Low	0.7		$ -	$ -	$ -	$ -
46091 Hydrologic Connectivity Restoration	W Fork	Mid-slope	Road Storage	Hydro	Medium	1.6		$ -	$ -	$ -	$ -
46152 Hydrologic Connectivity Restoration	W Fork	Mid-slope	Road Storage	Hydro	Medium	2.0		$ -	$ -	$ -	$ -
46154 Hydrologic Connectivity Restoration	W Fork	Low / Mid	Road Storage	Hydro	Medium	0.5		$ -	$ -	$ -	$ -
46355 Hydrologic Connectivity Restoration	S Fork	Low / Mid	Road Storage	Hydro	High	1.6		$ -	$ -	$ -	$ -
6419 Hydrologic Connectivity Restoration	North Fork	Low - Slope	Road Storage	Hydro	Medium	0.4		$ -	$ -	$ -	$ -
6420 Hydrologic Connectivity Restoration	S Fork	Low - Slope - Riparian	Road Storage	Hydro	High	0.3		$ -	$ -	$ -	$ -
6421 Hydrologic Connectivity Restoration	North Fork	Low - Slope - Riparian	Road Storage	Hydro	Medium	0.4		$ -	$ -	$ -	$ -
6426 Hydrologic Connectivity Restoration	S Fork	Low / Mid	Road Storage	Hydro	High	2.7		$ -	$ -	$ -	$ -
6429 Hydrologic Connectivity Restoration	S Fork	Mid-slope	Road Storage	Hydro	Medium	1.7		$ -	$ -	$ -	$ -
6435 Hydrologic Connectivity Restoration	Kadake Bay	Low - Riparian	Road Storage	Hydro	High	1.4		$ -	$ -	$ -	$ -
Temporary Road Decommissioning	W & S Fork	Upper - Slope	Road Decommission	Hydro	Medium	1.6		$ -	$ -	$ -	$ -
Invasive Weed Road Surveys	All	All	Road / Invasives	Terrestrial	Medium	30.0		$ -	$ -	$ 5,000	$ 5,000
Riparian 2nd Growth Treatment Inventory	All	Low - Riparian	2nd Growth Inventory	Hydro / Instream	High		80	$ -	$ -	$ 5,000	$ 5,000
Tier II Stream Channel Inventories	All	Low - Riparian	Instream habitat surveys	Hydro / Instream	High	~10.0		$ -	$ -	$ 10,100	$ 10,100
NFS & Temp Road Inventory for Decom/Closure	All	All	Road closure inventories	Hydro / Instream	High	~32.0		$ -	$ -	$ 13,700	$ 13,700
											$ 124,050

Project Descriptions

Temporary Spur and NFS Road Closure Inventory

This project proposes a multi-year systematic approach to acquire data for entry into the Tongass WIT database. The primary objective of additional data collection is the eventual decommissioning or storage of temporary and NFS roads. Methods will include removing drainage structures, adding water bars as needed to improve drainage, and blocking the entrance to the roads to eliminate unmanaged use. Road condition and Tongass WIT surveys in 2007 indicated three temporary roads needed tank traps at MP 0+00 for proper closure, but no further work was required on the remainder. Only a small portion of the roads proposed for closure were visited (Table 4). Temporary and NFS roads that were not visited during field efforts in 2003-2004 and 2007 will be prioritized for field assessment according to Petersburg Ranger District management objectives. Closing system roads is consistent with current Petersburg Ranger District management objectives and could require removing up to 252 culverts (11 red) and 3 log stringer bridges (Table 4). Approximately 1.6 miles of temporary would be closed, primarily in the mid and upper portions of the watershed. Project proposals will be developed through the Tongass WIT database and will be submitted for NFVW and CIP funding. Completion of these closures will reduce the risk of road failures at stream crossings, culvert plugging, stream blocking, and stream diversion, and will re-establish more natural drainage patterns.

Tier II Stream Channel Condition Assessments

The Kadake Creek watershed has approximately 15.0 miles of Class I stream, and 29.9 miles of Class II stream. Only a very small portion of these streams have been inventoried for the purpose of comparing channel characteristics to the Tongass Fish Habitat Objectives. This project proposes a multi-year systematic approach for acquiring Tier II stream data on high priority and reference stream reaches. The primary goal is to expand inventories of stream channel condition on streams where initial inventories identified deficiencies compared to Tongass Fish Habitat Objectives, and inventory randomly selected reference reaches for comparison with Tier II stream data obtained in summer 2007. Information gathered will aid project planning for future riparian 2nd growth thinning treatments and instream LWD enhancement projects, as well as provide additional data on the long-term effects of riparian disturbance on downstream habitat and channel conditions.

Project Monitoring and Evaluation

Comprehensive monitoring plans will be developed prior to implementation of specific restoration / enhancement projects. General objectives and foreseeable monitoring needs include the following:

- Collect routine implementation and effectiveness monitoring information on LWD placement site locations as projects are completed using channel cross sections, longitudinal profile, and photo points. Track changes through site monitoring module in Tongass WIT database. Continue monitoring sites as necessary to determine effectiveness.
- Locate and survey past LWD placement sites implemented beginning 1989 to determine effectiveness of a variety of techniques (cabling, keying into bank, placement location, etc.)
- Collect routine implementation and effectiveness monitoring information to riparian thinning treatments as projects are implemented using photo points, measures of canopy cover/shading, and Tier II stream surveys. Evaluate effectiveness of project and changes in channel morphology and fish habitat condition through time. Continue monitoring on multi-year rotation.
- Implement OHV education, enforcement, and monitoring programs in conjunction with district ATM direction following proposed road closures.

Kadake Tributary Channel Restoration Monitoring

A road-related stream restoration project was implemented in 2006 in order to restore surface water flow connectivity through a 500-foot-long stretch of Class I stream that runs dry during low flows, stranding juvenile coho salmon. The project design included criteria for a specific channel geometry and longitudinal profile, and criteria for reestablishing vegetation. The site was visited 9/12/07 to monitor the effectiveness and current condition of seven weir structures as well as changes in channel geometry and bedload size distribution. The primary objective of continued monitoring is to track changes in channel geometry, bed composition, and the relative success / failure of the weir structures. This will allow early detection of problems concerning aggradation or degradation, provide useful information for refining design techniques, and allow for region-wide information sharing. Survey and photo point results from the 2007 site visit will be summarized and changes in channel geometry and relative condition of the weir structures quantified. Monitoring should be continued on a semi-annual basis or as conditions dictate, with an estimated cost of $6,800 beginning in FY 2009. Products of this effort include a report and updated poster for potential presentation at professional meetings.

Kadake Creek Steelhead Redd Counts

We will continue to conduct annual redd counts on Kadake Creek for use as an indication of spawning activity, with data summarized and updated as it is collected. Peak run timing on Kadake Creek is currently unknown, but is thought to occur in mid-May, similar to steelhead runs on Petersburg Creek. Following consultation with forest fish biologist Dick Aho and ADFG sport fishing biologist Dough Fleming we suggest expanding the study to include either an aerial (helicopter) count component or a multiple count design. This would allow us to determine peak run timing, quantify the error structure associated with our methods and subsequent abundance index, and compare foot

and flight techniques for efficiency. This possibility will be investigated and if viable, proposed in the FY 2009 budget cycle. A flight profile for the proposed helicopter work has already been completed.

Future Needs / Information Gaps

- Summarize stream data collected in summer 2007 and compare with Tongass Fish Habitat Objectives.
- Summarize road survey data gathered in summer 2007 into Tongass WIT database for CIP and NFVW proposals.
- Expand inventories of stream channel condition on streams where initial inventories identified deficiencies compared to Tongass Fish Habitat Objectives, and inventory randomly selected reference reaches for comparison with Tier II stream data obtained in summer 2007.
- Expand inventories of temporary and NFS roads for input into the Tongass WIT database, particularly the 12.6 miles of NFS roads and their associated spurs proposed for closure. Data will be used for project proposal development.
- Update the PRD landslide inventory in North Kuiu watersheds; update GIS layer.
- Update and complete the barrier inventory for known data gaps in the Kadake watershed; update GIS layer.
- Summarize monitoring data from the Kadake Creek tributary restoration site. Update the Kadake WRP with results and photo points.

References

Alaska Department of Fish and Game, Sport Fish Division. 2007. Southeast Alaska Recreational Cabin Survey. http://www.sf.adfg.state.ak.us/region1/trout/cabin.cfm. Accessed: 11/09/07.

Alaska Department of Environmental Conservation. 2006. Waters Quality Standards for Designated Uses. http://www.dec.state.ak.us/water/wqsar/wqs/pdfs/18%20AAC_70%20_Amended_December_28_2006.pdf. Accessed: 10/31/07.

Beschta, R.L., R.E. Bilby, G.W. Brown, L.B. Holtby and T.D. Hofstra. 1987. Stream Temperature and Aquatic Habitat: Fisheries and Forestry Applications. Pages 191-232 in E.O. Salo and T.W. Cundy, editors. Streamside Management: Forestry and Fishery Interactions. University of Washington, Seattle, Washington, U.S.A.

Pentec Environmental, Inc. 1991. Factors Affecting Pink Salmon Pre-spawning Mortality in Southeast Alaska. Technical Report 91-01. Report prepared for the Alaska Working Group and Cooperative Forestry / Fisheries Research. Juneau AK: USDA Forest Service, Wildlife and Fisheries (November). 81pp.

Reeves, G.H., F.H. Everest, T.E. Nichelson. 1989. Identification of Physical Habitats Limiting the Production of Coho Salmon in Western Oregon and Washington. General Technical Report PNW-GTR-245. Portland, OR. USDA Forest Service. 19pp.

USDA Forest Service, 2007. Kuiu Island Timber Sale Final Environmental Impact Statement. Tongass National Forest. Alaska Region R10-MB-604.

USDA Forest Service. 2005. Kuiu Island Landscape Assessment. Tongass National Forest, Alaska Region, R10-MB-545.

USDA Forest Service, 2005b. Draft Petersburg Ranger District Access Travel Management Plan. Tongass National Forest. 19pp.

USDA Forest Service. 2001. Ecological Subsections of Southeast Alaska and Neighboring Areas of Canada. Nowacki, G., Krosse, P., Fisher, G., Brew, D., Brock, T., Shephard, M., Pawuk, W., Baichtal, J., Kissinger, E. US Forest Service, Alaska Region: R10-TP-75.

USDA Forest Service. 2001b. Aquatic Habitat Management Handbook. U.S. Forest Service. Alaska Region: FSH 2090.21.

USDA Forest Service. 2001c. Kuiu Island Road Analysis. Petersburg Ranger District, Tongass National Forest. October.

USDA Forest Service. 1997. Tongass Land and Resource Management Plan. U.S. Forest Service. Alaska Region R10-MB-338dd, Juneau, Alaska.

USDA Forest Service, 1994. Pilot Watershed Analysis Report, Kadake Watershed Stikine Area, Tongass National Forest.

USDA Forest Service, 1992. Classification and Correlation of the Soils of the Stikine Area, Alaska. SSSA-645. February.

USDA Forest Service, 1989. Preliminary Forest Plant Associations of the Stikine Area, Tongass National Forest. Alaska Region, R10-TP-72

USDA Forest Service. 1979. Water Resources Atlas. Alaska Region. Juneau, Alaska.