Appendix D

Stream Process Groups

Introduction

In the early 1980's a method of inventorying channel types was developed for the Tongass National Forest to identify, classify, and map the distinguishing parts of stream and river (fluvial) systems. This inventory system, which was finalized for the Tongass National Forest in 1992 (Paustian et. al., 1992), allows for the logical categorization of fluvial channels and provides a process for predicting channel response to management- or naturally-caused changes.

The inventory groups channels into nine basic fluvial process groups (Table D-1). These process groups describe streams and rivers with similar physical "processes," that is with similar interrelationships between watershed runoff, landform relief, geology, and glacial or tidal influences on fluvial erosion and deposition.

Each process group includes a number of channel types. Channel types represent a finer delineation than process groups. They more precisely characterize a channel and help predict the probable responses to natural and human influences. Like process groups, channel types are defined by physical attributes, but channel types also incorporate other aspects of channel gradient, channel pattern, stream bank incision and containment, and riparian community composition. A description of each channel type is listed in Table D-2.

Channel types and process groups are used for guiding land management activities and for predicting the effects of those activities along all stream and river systems of the Tongass National Forest. In this Plan, channel types and process groups are central to the direction for Riparian Area management (see the Riparian Forest-wide Standards & Guidelines in Chapter 4). For further information on riparian management considerations for each of the channel types, consult Paustian et. al. (1992).

Process Groups

Beginning on page D-5 is a discussion of each process group, including a listing of the channel types which are incorporated within the process group. A summary of process group characteristics can be found in Table D-3. An illustration of the typical setting of each of the process groups, and their relationship within a watershed, is provided in Figure D-1.

Table D-1
Stream Classification and Stream Length by Process Group

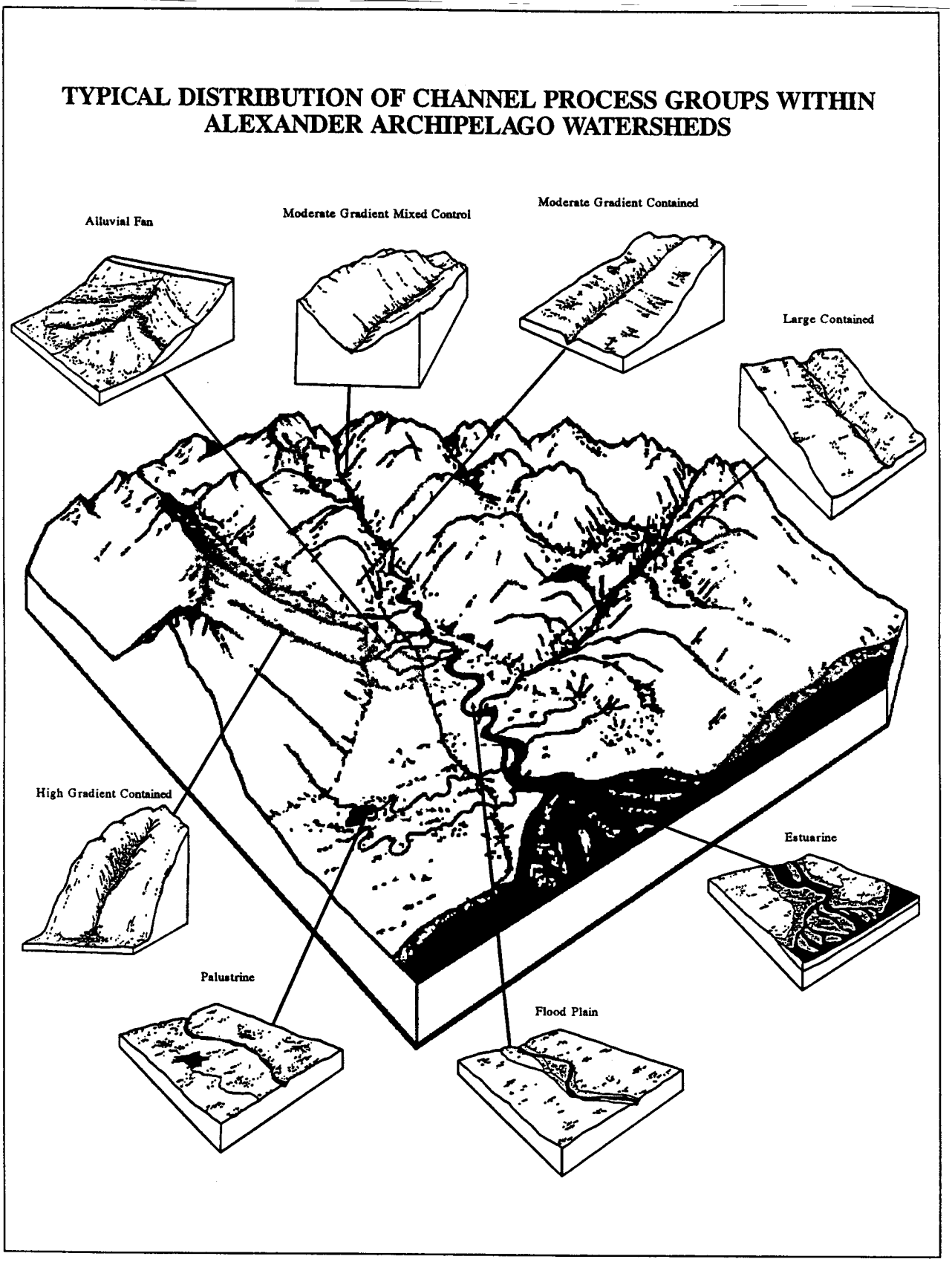
Stream Process Groups	Channel Type Classification	Miles
Flood Plain	FP1, FP2, FP3, FP4, FP5	4,303
Glacial Outwash	GO1, GO2, GO3, GO4, GO5	1,189
Alluvial Fan	AF1, AF2, AF8	1,564
Large Contained	LC1, LC2	695
Moderate Gradient, Mixed Control	MM1, MM2	4,827
Moderate Gradient Contained	MC1, MC2, MC3	3,238
High Gradient Contained	HC1, HC2, HC3, HC4, HC5, HC6, HC8, HC9	35,403
Palustrine	PA1, PA2, PA3, PA4, PA5	1,824
Estuarine	ES1, ES2, ES3, ES4, ES8	646

Source: Paustian et. al. (1992) & Revision GIS Database Query #Q3012E. Miles are adjusted for estimates of channels missed in the inventories.

Table D-2
Channel Type Descriptions

Channel Type	Description
AF1	Moderate Gradient Alluvial Fan Channel
AF2	High Gradient Alluvial Cone Channel
AF8	Glacial Alluvial Cone Channel
ES1	Silt Substrate Estuarine Channel or Slough
ES2	Narrow Small Substrate Estuarine Channel
ES3	Narrow Large Substrate Estuarine Channel
ES4	Large Estuarine Channel
ES8	Braided Glacial Outwash Estuarine Channel
FP1	Uplifted Beach Channel
FP2	Uplifted Estuarine Channel
FP3	Narrow Low Gradient Flood Plain Channel
FP4	Low Gradient Flood Plain Channel
FP5	Wide Low Gradient Flood Plain Channel
GO1	Glacial Outwash Flood Plain Side Channel
GO2	Large Meandering Glacial Outwash Channel
GO3	Large Braided Glacial Outwash Channel
GO4	Moderate Width Glacial Channel
GO5	Cirque Channel
HC1	Shallowly Incised Muskeg Channel
HC2	Shallowly to Moderately Incised Footslope Channel
HC3	Deeply Incised Upper Valley Channel
HC4	Deeply Incised Muskeg Channel
HC5	Shallowly Incised Very High Gradient Channel
HC6	Deeply Incised Mountain Slope Channel
HC8	Moderate/High Gradient Glacial Cascade Channel
HC9	High Gradient Incised Glacial Torrent Channel
LC1	Low Gradient Contained Channel
LC2	Moderate Gradient Contained Channel
MC1	Narrow Shallow Contained Channel
MC2	Moderate Width and Incision Contained Channel
MC3	Deeply Incised Contained Channel
MM1	Narrow Mixed Control Channel
MM2	Moderate Width Mixed Control Channel
PA1	Narrow Placid Flow Channel
PA2	Moderate Width Placid Flow Channel
PA3	Shallow Groundwater Fed Slough
PA4	Flood Plain Backwater Slough
PA5	Beaver Dam/Pond Channel

Figure D-1


TYPICAL DISTRIBUTION OF CHANNEL PROCESS GROUPS WITHIN ALEXANDER ARCHIPELAGO WATERSHEDS
Alluvial Fan
Moderate Gradient Mixed Control
Moderate Gradient Contained
Large Contained
High Gradient Contained
Estuarine
Palustrine
Flood Plain

Flood Plain

Stream channels in this process group include: FP1 (uplifted beach), FP2 (uplifted estuary) foreland channel types, and FP3 - FP5 (narrow to wide) flood plain channel types. Generally lowland and valley bottom streams and rivers, alluvial deposition is prevalent in these low gradient (less than 2 percent gradient) channels. High stream flows often are not contained within channel banks resulting in flood plain development. In larger stream and river systems the riparian area width may extend well beyond 100 feet from the streambanks.

Flood plain streams are relatively efficient at trapping nutrients from riparian forest detritus and inorganic sediment delivered from headwater areas. These streams also buffer against flood disturbances by spreading runoff across densely vegetated flood plains and into numerous side channels and sloughs. Shallow alluvial aquifers associated with these streams store runoff from flood flows and hillslope tributaries and slowly release groundwater to surface channels during periods of low rainfall. The ability of flood plain channels to dampen the effects of runoff extremes and to store nutrients are primary factors contributing to productive aquatic communities found in these streams.

Channel materials are composed of fine sediments, small boulders and cobble which are deposited by the stream. Streambanks consist of unconsolidated materials such as sand, gravel, or organic materials and are often unstable. Channel migration and braiding may occur. Root networks of trees and shrubs have an important role in holding unconsolidated streambanks together. Large woody debris (LWD) also plays a role in controlling streambed and bank stability by regulating the stream's energy dissipation. Pools and cover from LWD provides good fish habitat.

Glacial Outwash

Glacial outwash channel types are alluvial channels with stream gradients usually less than three percent. This process group includes GO1 (glacial side channel), GO2 (large meandering), GO3 (large braided), GO4 (moderate width, and GO5 (cirque channel) glacial outwash channel types. With the exception of high elevation, cirque basin channel types (GO5), there are generally valley or lowland streams. Because mountain glacier meltwater is the source of runoff to these streams, they carry extremely high sediment loads and have very turbid water. Riparian areas are wide and may extend for many hundred feet in large braided river systems.

Glacial outwash channel types share many of the attributes of the flood plain process group. However, glacial streams tend to have larger seasonal variations in stream flow and large sediment loads that result in more dynamic or unstable channels and flood plains. These factors, along with colder water temperatures, tend to limit overall aquatic productivity.

Alluvial Fan

This process group includes AF1 (moderate gradient), AF2 (high gradient), and AF8 (glacial) alluvial fan/cone channel types. These are generally tributary streams that are located on footslope landforms in a transitional area between valley flood plains and steep mountain slopes. They are low to moderate gradient (generally less than 5 percent gradient) stream channels that are strongly influenced by sediment deposition processes. Alluvial fans are formed by the rapid change in sediment transport capacity as the high energy mountain slope stream segments spill onto the valley bottoms. Stream channels change course frequently, resulting in a multi-branch stream network. Sediment deposition tends to create elongated islands of bare cobbles and gravel between these multi-branched channels. Alluvial fan stream channels are often unstable. Streamflow may be intermittent during the summer and winter months due to infiltration of water into coarse gravel substrate. Riparian areas commonly associated with these poorly contained streams are very

narrow at the top of the fans and become wider as the fan spreads out. Due to the complex stream network, riparian areas for alluvial fan channels may be extensive.

Large woody debris can play a major role in trapping sediment on the fan surface and within stream channels. Scour and dam pools formed by LWD can be very important for fish rearing habitat in alluvial fan streams. Gravel aquifers associated with alluvial fan drainages are commonly an important source of groundwater discharge to adjacent valley bottom streams.

Moderate Gradient Mixed Control

This process groups includes MM1 (narrow) and MM2 (moderate width) channel types are a mixture of stream channel containment. These channel types are moderate gradient (2-6 percent) streams where sediment deposition processes are limited. Some segments are constrained by bedrock outcrop or the valley walls, while other areas develop narrow flood plains. Streambanks are dominated by coarse alluvium (boulders, cobbles) or bedrock. These stream segments generally have a balance between sediment transport and deposition. Riparian vegetation is important in regulating stream energy losses through large woody debris input. LWD forms such water energy dissipaters as log step pools and lateral scour pools. LWD can strongly influence channel form, sediment storage and pool and cover habitat in streams with minor bedrock control. Riparian areas seldom extend beyond 100 feet from stream banks.

Large Contained

Stream flow in channels in this process group are well contained by adjacent landforms. Bedrock outcrops that constrain or control channel migration and downcutting are common. This process group includes LC1 (low gradient) and LC2 (low to moderate gradient 1-3 percent) large contained channel types. The riparian influence zone often extends over 100 feet up channel side slopes on these entrenched streams. Channel side slope vegetation plays a major role in controlling the rate of downslope soil movement and large woody debris into stream channels. LWD accumulations also dissipate stream energy (slow its velocity) and store sediment within the stream channel. The larger valley and lowland streams often have narrow alluvial terraces within the river gorge. Riparian areas are discontinuous, and are generally less than 150 feet wide. Streambed and banks are dominantly composed of coarse alluvium (cobble to boulder size) and occasional bedrock outcrops. These streams generally have a balance between sediment transport and deposition. Waterfalls and cascades that form at bedrock knick points can be barriers to upstream anadromous fish migration.

Moderate Gradient Contained

This process group includes MC1 (narrow, shallow incision), MC2 (moderate width and incision), and MC3 (deeply incised) moderate gradient contained channel types. Streamflow in this process group is completely contained by adjacent landforms and channel side slopes. Streambank and streambed erosion are frequently controlled by bedrock outcrops. These channels have balanced or transport oriented sediment regimes. Gravel bars are infrequent channel features (plain bed channels). Large woody debris within the wetted channel provide localized sediment storage sites and habitat diversity. Riparian areas are limited to the bank influence zone and are generally less than 100 feet.

High Gradient Contained

Channels in this process group (HC1, HC2, HC3, HC4, HC5, and HC6 channel types that are shallowly to deeply incised, high gradient (over 6 percent), mountain slope streams. High gradient glacial meltwater streams, HC8 and HC9 channel types, are also included in this process group. These steep, headwater streams are important source areas for runoff, organic and inorganic sediment transported to downstream riparian and fish habitats. Stream channels are well contained within the narrow valley bottoms or ravines. Channel substrate is mostly comprised of large material, either bedrock or well-packed boulders and cobbles. High stream

energy enables these streams to transport large sediment loads during spring and fall flood events. Riparian areas generally extend to the upper stream side slope break. Riparian vegetation consists of narrow strips (often less than 50 feet wide) of alder, salmonberry, devil's club, or currant/shrub communities. Spruce and hemlock forests are also present on ravine side slopes. These channels are predominantly influenced by hillslope erosion processes. Soils in the adjacent upland area are shallow and subject to mass wasting. Although these are dominantly transport or erosive channels, significant amounts or forest litter and sediment can be trapped and stored temporarily behind woody debris jams.

Palustrine

This process group includes PA1 through PA5 palustrine channel types. Streams within this process group are low gradient (less than 1 percent slope) and associated with low relief landforms dominated by wetlands. Water movement and sediment transport rates are low. These channel types typically act as storage areas for fine sediments. Streambanks are composed of dense organic root mats that are resistant to bank erosion. Streambeds consist of fine alluvial gravel and sand, and organics. Flood waters spread out across adjacent wetlands to buffer against downstream flooding. Another important function of these channels is to sustain streamflows during dry periods. Slow flowing palustrine streams can have elevated water temperatures that can be detrimental to some aquatic species during summer months. Riparian areas are usually wider than 100 feet and can be very wide in peatland landscapes.

Estuarine

This process group includes ES1 (silt substrate) ES2 (narrow sand substrate), ES3 (narrow cobble substrate), ES4 (large estuary), and ES8 (glacial outwash) estuarine channel types. These channel types occur at the mouths of watersheds with estuarine landforms (located along inlets and deltas at the head of bays). Water level fluctuations, channel morphology, sediment transport, water chemistry are influenced to some degree by saltwater inundation in these channel types. Riparian areas consist of saltwater marches, meadows, mudflats, and gravel deltas that are depositional environments. Estuarine channels are usually single to multiple thread channels, shallowly entrenched, and poorly constrained. Stream substrate is fine textured alluvium that is easily eroded by currents and wave action. Much of the sediment produced from any given watershed is ultimately deposited in or along the estuarine channel types, consequently, these channels are highly sensitive to upstream disturbances. Sedge and grass communities dominate the riparian vegetation. The amount of stream migration and channel braiding vary, depending on bank and bed materials and upstream erosion and sediment transport regimes. Riparian areas are normally more than 100 feet wide and are often several hundred’s of feet wide on large river deltas.

Table D-3
Stream Process Group Characteristics, Alaska Region. (Paustian and others, 1992)

	Glacial Outwash	Palustrine	Estuarine	Flood Plain and Alluvial Fan	Large Contained	Moderate Gradient Mixed Control	Moderate Gradient Contained	High Gradient Contained
Landform	Glacial River Flood Plain	Lowland/ Wetlands	Estuary/Delta	Flood Plain/ Alluvial Fan-Cone	Canyon or Entrenched in Lowlands	Footslope/ Narrow Valleys	Entrenched in Hills or Lowlands	Mountain Slope
Flood Plain Width	>2 times Channel Width	>2 times Channel Width	>2 times Channel Width	>2 times Channel Width	<1.5 times Channel Width	1 to 2 times Channel Width	<1 times Channel Width	<1 times Channel Width
Stream Gradient	<6%	<1%	0.5% to 1%	0.5% to 2% (fans can be steeper)	1% to 3%	2% to 6%	2 to 6%	>6%
Channel Form	Meandering/ Braided	Meandering (high sinuosity)	Meandering/ Anabranch	Meandering/ Multi-branch	Straight, Single Thread	Straight	Straight, Single Thread	Straight, Single Thread
Water Source	Glacial Meltwater	Peatland Runoff/ Groundwater	Mountain slope source area runoff dominates in these stream segments. Groundwater discharge is also significant in flood plain and alluvial fan segments.					
Sediment Regime	Deposition/ Aggrading	Deposition	Deposition/ Aggrading	Deposition/ Aggrading	Balanced	Balanced	Erosive	Erosive
Stream Class	Class I & Class II	Class I & Class II	Class I	Class I & Class II	Class I & Class II	Class I & Class II	Class I & Class II	Class II, Class III & Class IV