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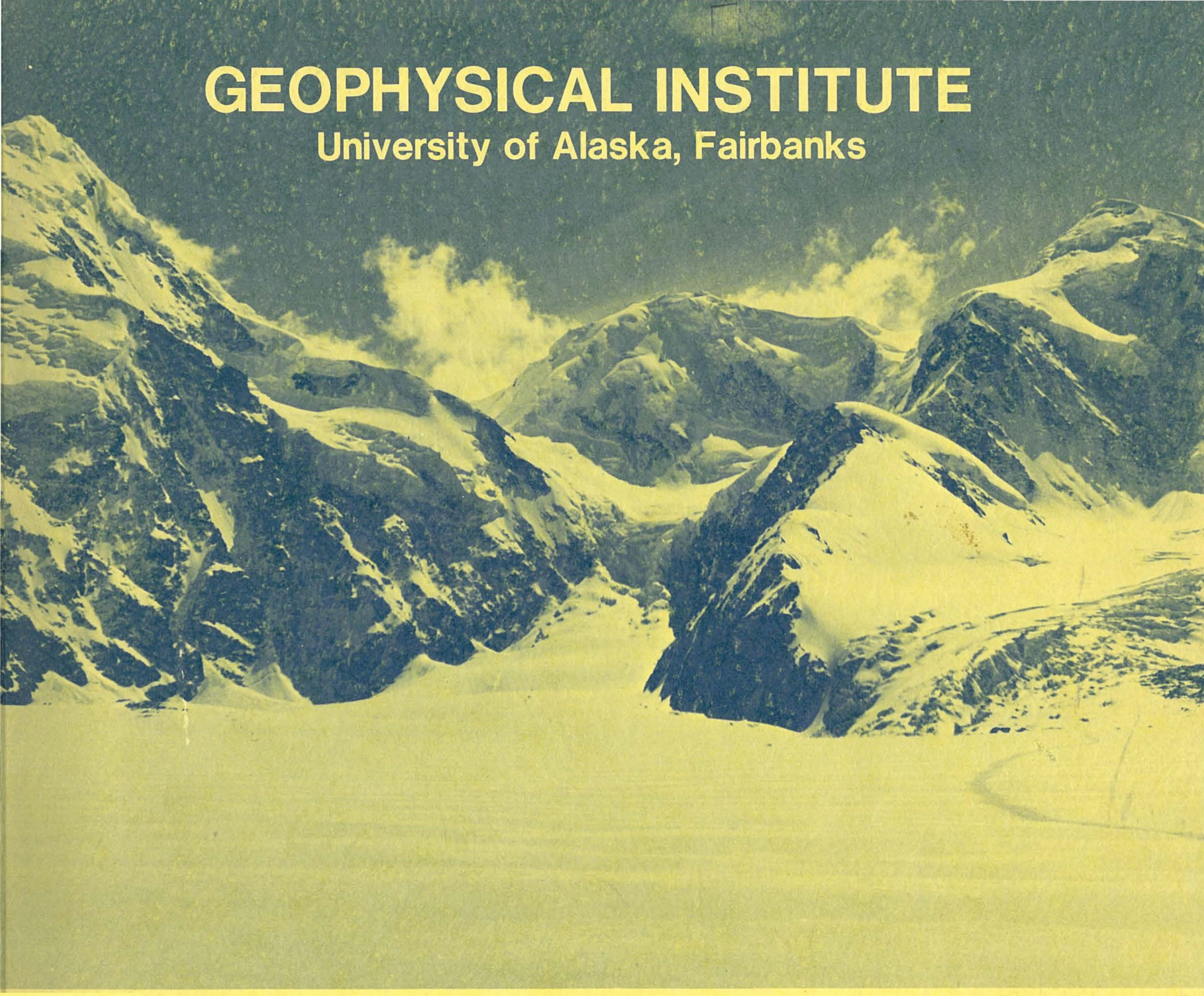

STREAM CORRIDOR PHYSIOGRAPHY OF THE
SUSITNA RIVER VALLEY, ALASKA

Final Report

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ABSTRACT

Floodplains in the vicinity of a stream form a corridor which is a primary habitat zone. Knowledge of surficial geology along this corridor will provide a data base to aid land-management decisions.

Generally, streams in the Susitna River Valley are incised into glacial deposits and are braided and sediment ladened. Floodplains and terraces develop as the streams migrate, downcut and deposit alluvium. The floodplains are divided into four categories based on surface morphology including presence of channels or sloughs, density and type of forest cover, and proximity to height above stream channel(s). These divisions include active, partly active, infrequently active and abandoned floodplain surfaces.

A traverse from the existing stream channel to the limit of the floodplain demonstrates a slight increase in elevation, increase in the density of the forest canopy, a decrease in number of sloughs and abandoned channels, and a gradation from deciduous to coniferous forests. This trend parallels a decrease in flood susceptibility away from the stream.

INTRODUCTION

The land surface in the vicinity of a stream is a primary habitat zone because of its proximity to water, shallow water table, and gently, sloping terrain. The purpose of this project is to study and map the landforms within a corridor along select streams in the Susitna River Valley. The results will provide land managers with an initial data base to establish riparian management zones or buffer zones to protect fish and wildlife and their habitats from disturbance or damage.

A secondary purpose is to compare the minimum size of floodplains and number of floodplain categories derived from aerial photography to that derived from Landsat imagery (see Appendix A).

Landforms are studied and mapped along the Yenta, Susitna, Skwentna, Kahiltna Rivers and Lake Creek in the Susitna River Valley. The results of the project are displayed on 17 USGS topographic quadrangles (scale 1:63,360), including Tyonek B-2, C-1&2, D-1 thru D-6 and Talkeetna A-1 thru A-4 and B-1 thru B-3.

PHYSICAL SETTING

The Susitna River Valley is located in southcentral Alaska northwest of Anchorage (Fig. 1). The valley grades southward to sea level at Cook Inlet and is bounded by the Talkeetna Mountains on the east and the Alaska Range on the north and west. These mountains hinder the northward migration of storms from the north Pacific Ocean, producing 74 cm (29 inches)* of precipitation annually (Rieger, 1979), the largest amount of precipitation in the state excluding areas immediately adjacent to the coast.

Major streams within the study area include the Susitna, Yentna, Kahiltna, Chulitna, Tokositna, and Talkeetna Rivers. The Susitna River, which is the largest in the area, drains southward into Cook Inlet. Glaciers including the Dall, Yentna, Kahiltna, Lacuna, Tokositna, Ruth and Eldridge are located in the nearby Alaska Range at the headwaters of rivers and several subordinate tributaries.

Numerous south trending lakes, wetlands and forested ridges of low relief are typical on the valley floor. Most of the present topography has resulted from glacial, glaciofluvial and fluvial processes (Dean, 1980).

Transportation corridors include the Parks Highway and the Alaska Railroad along the eastern margin of the study area. A secondary road to Petersville and surrounding mines traverses the central portion of the area. Some agricultural, timber harvesting, and mining enterprises are located near Talkeetna. Lode and placer mining operations are active in the hills and mountains surrounding the valley. The minerals or

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*Measurements from the U.S. Weather Service station in Talkeetna, Alaska.

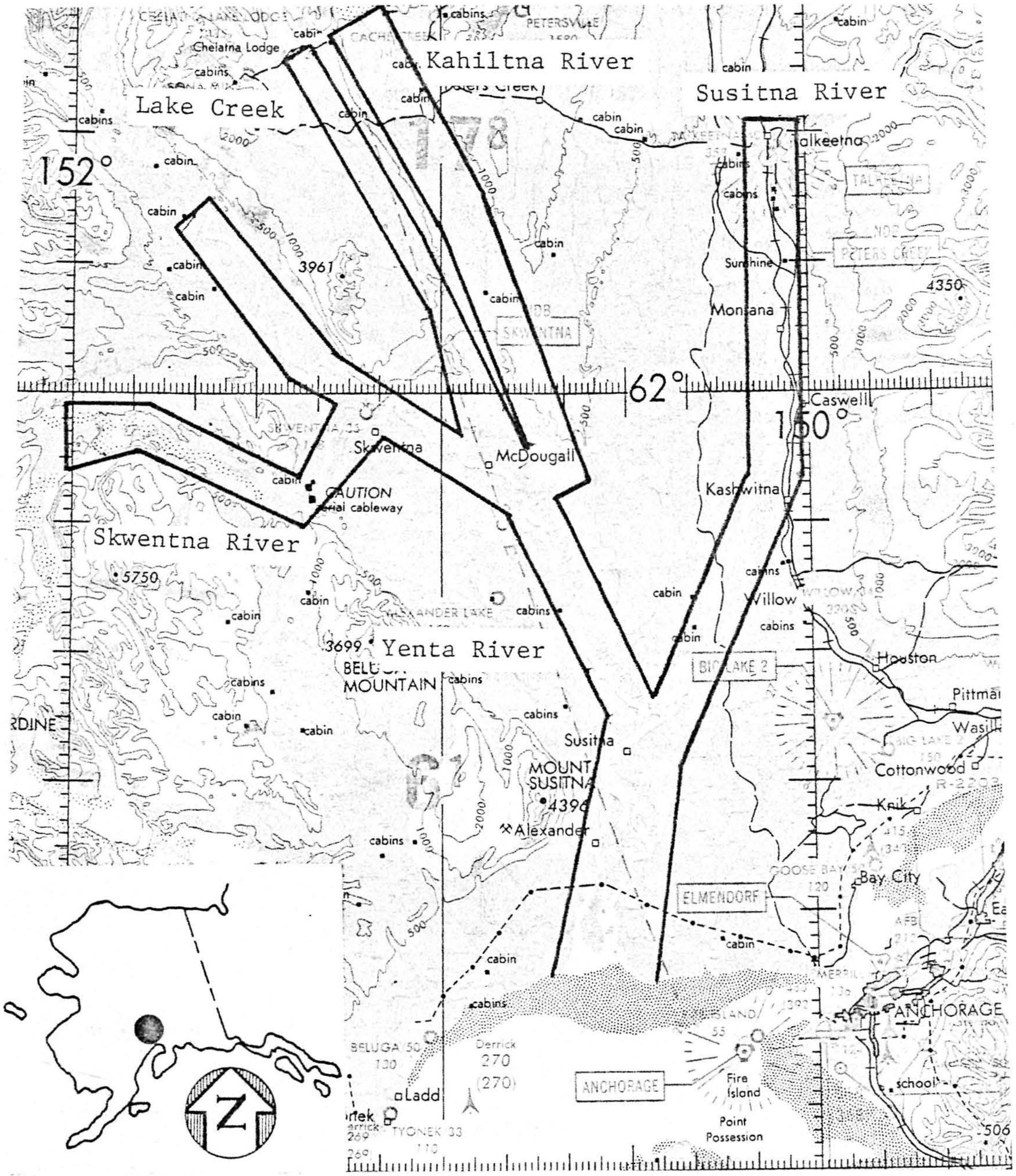

Figure 1. Location of stream corridors in the Susitna River Valley.

elements being mined include molybdenum, copper, chromium, gold, uranium, platinum, tin coal and thorium (Reed and others, 1978).

The region is generally sparsely populated. Clusters of small settlements occur along the Parks Highway especially in the vicinity of Willow and to the south where newly developed subdivisions are prevalent. These subdivisions reflect the pressure for land development along the Parks Highway.

REGIONAL SURFICIAL GEOLOGY

The surficial geology of the Susitna River Valley is dominated by glaciation (Caulter, and others, 1965, Reger, 1976). This area is a trough into which mountain glaciers and drainages from the surrounding Alaska Range and Talkeetna Mountains are funneled.

At least five glacial advances (Nelson and Reed, 1978) have altered the landscape in the Susitna River Valley (Table 1).

Table 1. Glacial advances in the Cook Inlet Basin.

Glaciation	Age	Sources
Alaskan	200-4800 yrs. ago[1]	(Nelson & Reed 1978)
Naptowne	6,000-30,000 yrs ago[1]	(Péwé, 1975)
Knik	38,000-65,000 yrs ago[2]	(Karlstrom, 1964)
Eklutna	25,000[1]-110,000[2] yrs. ago	(Karlstrom, 1964)
Mt. Susitna	Pre-Illonian	(Karlstrom, 1964)

The Mt. Susitna glaciation is the oldest and most extensive glacial advance documented in the Susitna River Valley by Nelson and Reed (1978) and in the Cook Inlet basin by Karlstrom (1964). Each successive glaciation was less extensive. The Mt. Susitna and Eklutna Glaciations completely filled the Susitna Valley and Cook Inlet basin, but during the

[1]Carbon-14 date
[2]Boulder count date (estimated)

Knik and Naptowne Glaciations coalescing glacial lobes in valleys did not completely fill the basin (Nelson and Reed, 1978). The Alaskan Glaciation was generally confined to narrow mountain valleys where end moraines were commonly deposited at the confluence with broader valleys.

The Susitna River Valley contains landforms that resulted from glacial, fluvial, lacustrine, periglacial and paludal processes. During Pleistocene glacial advances bedrock was scoured and debris was transported and deposited by the glaciers and streams. Most of the present topography on the valley floors resulted from the southward advance of the Naptowne glaciation (Nelson and Reed, 1978) which terminated between McDougall and Talkeetna (Karlstrom 1964).

After retreat of the Naptowne glaciers, streams in the Susitna River Valley incised the glacial drift, attempting to re-establish a lower gradient stream profile by transporting eroded material downstream and redepositing it below the terminus of the Naptowne advance. Erosional and depositional processes have resulted in incised stream channels in the northern Susitna Valley and the aggradation of alluvium in the valley south of the limit of the Naptowne Glacial advance.

MATERIALS AND METHOD OF INVESTIGATION

The investigation utilized color-infrared aerial photography, Landsat imagery, USGS topographic maps and aerial and ground verification procedures. NASA aerial photography acquired in 1974, 1976 and 1977 at the scale of 1:120,000 was the primary data source for interpreting and mapping landforms. Landsat images were used to obtain an understanding of regional relationships of landforms.

Landform interpretations were performed through a mirror stereoscope with a X3 magnification lens and the results were mapped on an overlay. The overlay was displayed and enlarged through a vertical projector onto the mylar topographic maps so that the map units could be transferred to the map base. Mylar copies of USGS quadrangles at the scale of 1:63,360 were used as a final map base.

DESCRIPTION OF MAP UNITS

Glacial Landforms

Deposits in the Susitna River Valley are composed of unconsolidated glacial drift. Drift is composed of unsorted silt, sand, gravel, cobbles and boulders (till) and is intermixed with stratified silt, sand and gravel of fluvioglacial origin.

The resulting landforms include undifferentiated hummocky terrain (d), fluted till ridges (r), zones of standing water ($\underline{\psi}$), eskers (e) and outwash fans (ow). All of these map units are located on the Susitna Valley floor beyond the floodplains (Table 1).

The undifferentiated hummocky terrain (d) is composed of glacial drift which protrudes above the surrounding terrain. Depressions or kettles are typical on the surface and trap surface water. Segmented, abandoned drainage-channels traverse the drift sheet. These drainage channels are remnant of previous drainges and often contain standing water. Vegetative growth on the drift consists mostly of deciduous and coniferous forests. In some localities in the vicinity of Talkeetna, eolian sand blankets the drift deposits.

Fluted till ridges (r) parallel the direction of glacial movement. Ridges have low relief and are better drained than the lower surrounding landscape as indicated by deciduous tree growth.

Extensive areas of standing water ($\underline{\psi}$) lie between fluted till ridges and drift deposits. The terrain is low and flat with small undifferentiated deposits of drift scattered throughout. Poor drainage is a result of a low gradient and the impermeable till. Discontinuous permafrost is suspected in swampy areas.

Table 1. Landform map explanation.

fa	- active floodplain
f_1	- party active floodplain
f_2	- infrequently active floodplain
f_3	- abandoned floodplain
fd	- undifferentiated floodplain
tr	- terrace(s)
	- standing water
ox	- oxbow
d	- undifferentiated, hummocky terrain composed of till and fluvioglacial deposits
r	- fluted till ridge
ow	- glacial outwash fan
e	- esker
	- prominant scarp
bs	- scoured bedrock
ac	- alluvial cone
af	- alluvial fan
al	- undifferentiated landscape composed alluvium and colluvium
cl	- coastal lowland
be	- beach ridge(s)
s	- sand or silt dune
sd	- sparse undifferentiated dunes
	- incised stream
	- subordinate drainage channels with standing water
?	- map unit needs further field verification

Eskers (e) and remnant outwash (ow) fans occur in some areas. They consist of fluvioglacial deposits which are exellent sand and gravel sources and are well drained. Deciduous forests typically grow on these surfaces.

Along the margins of the valley the surrounding mountains have been scoured by glacial advances. Ice-scoured bedrock (bs) is often blanketed by a thin layer of till. At lower elevations alluvial cones (ac) and fans (af) extend onto the valley floor.

Fluvial Landforms

Streams in the Susitna Valley are typically incised into the landscape reworking the glacial drift and depositing stratified silt, sand and gravel as point bars, islands, overbank deposits or channel fill forming floodplains in the vicinity of the streams.

The floodplains are divided into six categories: active (fa), partly active (f_1), infrequently active (f_2), abandoned (f_3), terraces (tr), and undifferentiated (fd).

Active floodplains (fa) include the existing stream channel(s), prominent sloughs, recently abandoned stream channels, sand and gravel bars, vegetated and unvegetated islands. Adjacent shore areas include exposed silt, sand and gravel deposits or are with standing water. Vegetation includes uncrowded deciduous forests, typically cottonwood, with a broken canopy and willows. Understory is sparse in some areas.

Partly active floodplains (f_1) are intricately laced with subordinate sloughs and drainage channels usually connected to the dominant stream. These channels contain flowing or standing water, or swamp deposits. The floodplain surface is vegetated by mature mixed deciduous forests which generally are uncrowded and have broken canopies. The floodplain surface may extend several feet above the normal stream stage.

Infrequently active floodplains (f_2) are dissected by abandoned channels and sloughs, which often are not connected to the parent stream. A few oxbows (ox) are also present. The floodplain surface is vegetated by mature deciduous and mixed forests and is slightly elevated. These forests in contrast to forests on more active floodplains, are generally denser and the canopy is only occasionally broken.

Abandoned floodplains (f_3) have few readily apparent channels, oxbows or sloughs. Coniferous forests tend to prevail and the forest canopy is dense and not usually broken. Areas of standing water are minimal or absent.

Terraces (tr) are remnant floodplains at higher elevations than other floodplain categories and indicate a former floodplain level. They are separated from present floodplains by steeply sloping scarps and are predominantly vegetated by coniferous and mixed coniferous and deciduous forests with a dense, unbroken canopy. Standing water is minimal to non-existent. Often several levels of terraces are included within one map unit.

The undifferentiated floodplain (fd) classification is used along subordinate streams and is generally less than 300m (1000 ft.) wide. Stream flow is often restricted between steep banks. Previously described floodplain divisions are included within this unit and are distinguishable on the photography but too small to be delineated.

Delta-Plain Landforms

In the southern portion of the study area where the Susitna River empties into Cook Inlet aggradation rather than downcutting is dominant. This results in the deposition of large quantities of alluvium and hence more expansive floodplains than to the north. Landforms include coastal lowlands (cl), beach ridges (be) and dunes (s & sd).

Generally, the surface is mapped as coastal lowlands (cl). The area is low, near sea level, and very gently sloping. Standing water is prevalent in many areas and mudflats are extensive during low-tides.

Coastal lowlands and the floodplains bear beach ridges (be) along the coast and eolian dunes (s & sd) further inland. Typically, beach ridges are defined as subparallel ridges of sand, shell or pebble generally varying in amplitude from a few inches to many feet (Davies, 1968) and mark former shorelines. In the study area these ridges support deciduous vegetation which contrasts with the surrounding vegetation on the coastal lowlands.

The eolian dunes are wind deposited ridges composed of vegetated sand and silt and encroach upon areas of standing water. The (s) designation refers to individual dunes and the (sd) designation refers to dune complexes which are typically separated by areas of standing water.

DESCRIPTION OF STREAMS

Susitna River: The Susitna River extends from Susitna and West Fork Glaciers in the Alaska Range to Cook Inlet and most streams in the Susitna Valley drain into this river. That portion of the river in the vicinity of Talkeetna and south to Cook Inlet is included in the study area.

The associated floodplain of the Susitna River is broad and the stream is extensively braided. Islands composed of exposed silt, sand, and gravel are numerous but often temporary while vegetated islands are more stable. The floodplain is divided into five categories: active, partly active, infrequently active, abandoned and terraces. Scarps often border the floodplain north of Willow but from there south the floodplains become very broad with standing water and grade into coastal lowlands (Krebs, and others, 1978 and 1978b). Windblown silt and sand is typical on the coastal lowlands, and dunes in the area are vegetated which indicates some degree of stability. The Susitna River is susceptible to glacial outburst floods north of the Parks Highway crossing (Post and Mayo, 1971).

Yenta River: The Yenta River extends from the Yenta, Lacuna and Dall Glaciers to the Susitna River and is moderately braided with braiding decreasing downstream. Floodplain categories predominantly include: active, party active and infrequently active. The floodplains are broadest near the headwaters and narrow downstream and include many vegetated islands. Areas with standing water are numerous and most extensive in the upper reaches. The Yentna River is susceptible to the effects of glacial outburst floods upstream from the confluence with the Skwentna River (Post and Mayo, 1971).

Kahiltna River: The Kahiltna River is a braided stream which extends from the Kahiltna Glacier to the Yentna River. Near the headwaters, the floodplain is broad with extensive areas of standing water and is divided into active and partly active categories. Downstream, the floodplain is divided into active, partly active and infrequently active categories with many terraces along the margins. The active floodplain becomes very narrow such that in some areas only the stream channel is present. The Kahiltna River is susceptible to the effects of outburst floods near Kahiltna Glacier (Post and Mayo, 1971).

Skwentna River: The headwaters of the Skwentna River are located in the Alaska Range where glaciers contribute water to many subordinate tributaries. The portion of the stream east of Porcupine Butte to the confluence with the Yentna River is included in the study. The floodplain divisions include active, partly active, infrequently active and abandoned, with few terraces evident. Generally, the floodplain is wide but constrained between glacial-scoured, mountain slopes in its western portions but to the east the floodplain is very broad at its confluence with the Yentna River. Extensive areas of standing water are present east of the Old Skwentna Road House. The stream is susceptible to glacial outburst floods upstream from the Old Skwentna Road House (Post and Mayo, 1971).

Lake Creek: Lake Creek drains Chelatna Lake into the Yentna River and is not glacial fed. The associated floodplain is narrow and incised into the glacial landscape especially along a portion centrally located between its headwaters and confluence with the Yentna River. Most of the floodplain is classified as undifferentiated with many terraces along the margins. The meandering stream becomes braided near its confluence with the Yentna River and is the only stream in the study which is clear of suspended sediment.

DISCUSSION

The floodplain classification is based on landform and vegetation including the existence of stream channels and their relationship to the parent stream, proximity to height above the dominant stream channel, density of vegetative canopy, and type of vegetation. Ideally, floodplain categories geographically progress from active in the immediate vicinity of the existing stream to party active, infrequently active, abandoned and terraces at the farthest extent (Figure 2).

Susceptibility of floodplain surfaces to flood events, decreases away from the active floodplains, as indicated by the landforms and variations in vegetation. In the vicinity of the stream surfaces have numerous active and abandoned stream channels which are typically connected with existing stream channels. The presence of these channels gradually decrease on floodplain surfaces away from the stream until they are non-existent. Those abandoned channels furthest from the stream often have no obvious relationship to existing stream channels. These channels indicate former positions of the active floodplain in the recent past. Height of floodplain surfaces slightly increase away from the stream channel as expected.

The active floodplain is sensitive to migrations of stream channels and fluctuation in stream discharge. Abandoned channels on this surface become active during increase discharge phases, likely annually and land surfaces are often flooded.

The partly active floodplain has numerous abandoned channels which also become active during flood events, but not necessarily annually. The land surface is subject to flooding during flood stages greater than annual high water.

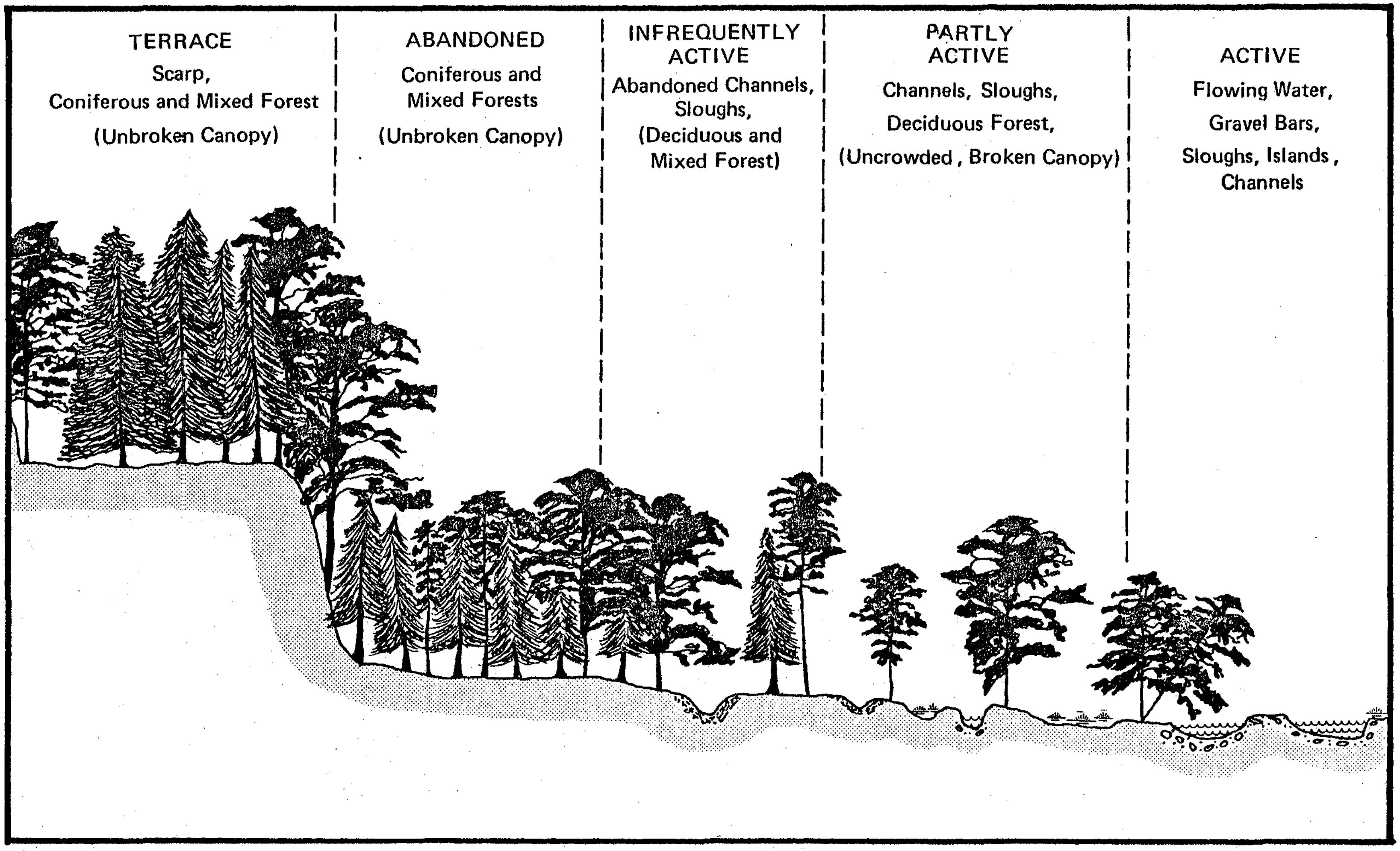

FIGURE 2: Typical transition from an active floodplain to a terrace. Dominant characteristics of each are listed.

On the active and partly active floodplains, cottonwood forests are typical, often with relatively sparse understory consisting of willows, especially along the Susitna River. These forests tend to prevent erosion of fine grained materials by dissipating the higher velocity of floodwater and thus inhibit the transport of coarse material. Studies of the Missouri River (Schmudde, 1963) also indicate that scouring of channels or beaches decrease on cleared floodplains beyond a fringe of trees along the stream.

The infrequently active floodplain is the final floodplain surface to have abandoned channels. Unlike channels on previous surfaces, these are often separated from the active floodplain. Annual flooding events may affect existing channels and sloughs but not the floodplain surface which is affected by periodic flooding of larger than normal water discharges.

Abandoned floodplains and terraces have few if any abandoned channels oxbows or sloughs. These surfaces are least susceptible to flood events. Most terraces are not likely to be flooded because of their height above other floodplain surfaces.

Floodplains with numerous active and abandoned channels are close to the existing stream, only slightly elevated above the existing streams and hence, most susceptible to flooding. The trend of decreasing channels away from the stream parallels not only flood susceptibility but also a change in the type and character of vegetation. Generally, forests are deciduous with broken canopies on younger floodplain surfaces near the stream and coniferous on floodplain surfaces furthest from the stream. Studies by Viereck (1970) in interior Alaska have found a similar trend with respect to coniferous vegetation on older floodplain surfaces. Density of the forest canopy also increases away from the stream.

CONCLUSIONS

Floodplains interpreted on aerial photography were divided into five categories. Typically, the following divisions would be encountered from the existing stream channel and proceeding across the floodplain: active, partly active, infrequently active, abandoned and terraces (Fig. 2). Each floodplain category is distinguished by specific surficial conditions, including flowing and standing water, subordinate channels or sloughs (active and abandoned), vegetation type, density of the forest canopy and height above existing stream surfaces. Generally, flowing and standing water and subordinate channels and sloughs are typical in the vicinity of streams and vegetative landcover consists of deciduous forests with open canopies. Away from the primary stream-channel the number of subordinate channels and sloughs decrease, coniferous trees appear, the mixed forest develops a more closed canopy, the elevation of the floodplain surface increases and standing water is less prevalent.

The decrease of stream channels and appearance of coniferous vegetation away from the stream parallels the decrease in flood susceptibility of floodplain surfaces.

RECOMMENDATION

One purpose of this study is to describe stream corridor physiography to aid decisions relating to floodplain management. This report provides geogrpahically mapped data concerning relative flood susceptibility, geographic relationships of floodplains, surface morphology and generalized vegetative cover. Further studies which could provide additional complementary data are:

(1) Detailed analysis of vegetation including type and density of forests and understory prepared from CIR aerial photography with field verification.

(2) Tree ring analysis for dating flood frequency and the age of the floodplain.

(3) Correlate transverse ground profiles of floodplains at stream gage locations for further correlations of surface morphology with the areal extent of major historic floods.

(4) Map soils and soil moisture on floodplain surfaces.

(5) Record depth to water table where information is available.

Recommendation #1 is a routine remote sensing investigation procedure. Recommendation #2 thru #5 are detailed analysis techniques which if applied to a specific accessible study area (such as the Susitna River) would further describe the physical conditions of each floodplain surface. These physical conditions could be used to model each type of floodplain and then be extrapolated to other floodplain surfaces mapped from aerial photography.

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APPENDIX A

Comparison

Landsat Imagery vs. Aerial Photography

COMPARISON

Landsat Imagery vs. Aerial Photography

Floodplain map units in this study were compared to those mapped from 1:125,000 scale Landsat imagery on a previous study (Dean, 1980). Although the objective of the previous study involved regional surficial geology, the comparison is informative.

Floodplains interpreted on Landsat imagery are divided into three categories; fa-active, f_1-partly or infrequently active, and f_2-abandoned. Criteria used to distinguish these categories are: contrast with surrounding cover types, geometric patterns, geographic position and shadows caused by scarps.

Floodplains mapped on the aerial photography are divided into five categories; fa-active, f_1-partly active, f_2-infrequently active, f_3-abandoned and tr-terraces. Criteria used to distinguish these categories are the same as those based on Landsat interpretations plus vertical relief from the stereo coverage and density of forest canopy.

Comparing the floodplain maps indicate that there is close agreement between the boundaries of the active floodplains and the boundaries defining the extent of floodplains. The intervening floodplain surfaces between these two extremes are also similar in that those interpreted from Landsat imagery are divided into two categories, and those interpreted from the aerial photography are divided into four categories. Generally, partly active and infrequently active photographic categories are equivalent to the partly or infrequently active Landsat category of floodplains, and abandoned and terrace photographic categories are equivalent to abandoned Landsat category of floodplains (Table 2).

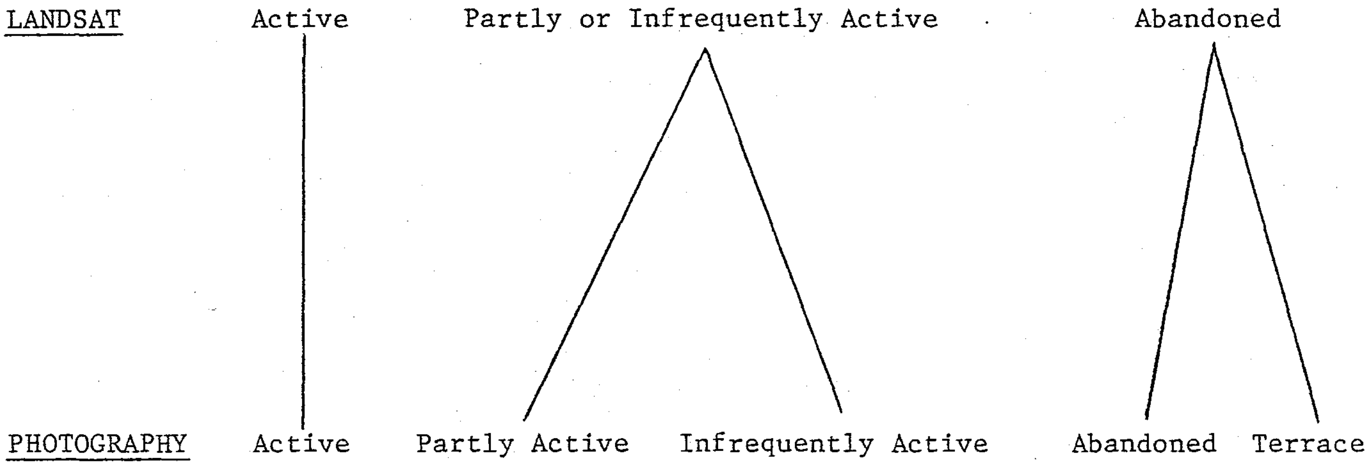

Table 2. A comparison of floodplain categories interpreted from Landsat imagery and high-altitude aerial photography.

Generally, on Landsat imagery (1:250,000 scale), a mappable floodplain is greater than 1km wide but on 1:125,000 scale imagery (the largest visually interpretable scale which can be efficiently utilized) floodplains as small as ½ km wide are mappable.* Interpretable floodplains mapped from 1:120,000 scale aerial photography are greater than 100m wide.*

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*These estimates are based upon floodplain measurements along the Susitna and Kahiltna Rivers.