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GEOMORPHIC CHANGE IN THE DEVIL CANYON TO TALKEETNA REACH OF THE SUSITNA RIVER SINCE 1949

PRELIMINARY REPORT

ARCTIC ENVIRONMENTAL INFORMATION AND DATA CENTER

DRAFT
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INTRODUCTION

Analysis was undertaken of aerial photography of the Devil Canyon to Talkeetna reach, herein called the middle reach, of the Susitna River, taken from 1949-51 and from 1977-80. The purpose of the study was to determine geomorphic change in that reach of the river over the more than 30 years that have elapsed since the earlier photography. It was hoped that any noted change in the river might be related to natural fish habitat transformation over time, at least during the past 30 years. This would give an index of habitat stability in the natural system, and might give clues as to the effects of the Susitna River Hydroelectric Project on future habitat stability or change. Accordingly, the entire middle reach of the river was studied and mapped to show generalized geomorphic changes that have occurred, and the individual sloughs that have been identified by the Alaska Department of Fish and Game (Friese, 1975) were analyzed more closely in order to discern possible changes in slough type, which is an important clue to habitat characteristics. Three additional sloughs, here designated "X, Y, and Z," were also included. These are shown in Klinger and Trihey (1984) between sloughs 8B and 8A (Figure 1). It should be noted that only relatively large morphologic changes in river and slough characteristics were discernable at the scale of the photography used; detailed changes such as water depth, riffle activity, beaver damming, etc., could not be distinguished, nor could any direct indications be discerned as to the suitability of the habitats for fish. This document reports preliminary results showing the general direction of geomorphic changes of the river reach and its sloughs. The final report will document results of ongoing studies to resolve implication to fish habitat.

METHODS

For comparison purposes, photographic sets of the middle reach of the Susitna River were gathered for the extreme ends of the time period in question. In each case it was necessary to use photography from more than one year in order to cover the entire middle reach, since no one flight included the whole reach. For the early part of the period, photography from 1949 to 1951, taken for the U.S. Geological Survey (USGS), was utilized. For the late part of the period, photography from 1977 to 1980, taken for the Bureau of Land Management (BLM), was used. Daily discharges from USGS records for each photo set are shown in Figure 2.

Since all photography was not taken at the same scale, manual alternation in scale was done in order to bring all mapping to approximately the same scale of 1:60,000. This was done using a Lucy-graf, an opaque projector with reducing and enlarging capabilities. Due to imprecision in the Lucy-graf, slight shifts may be noticed between corresponding parts of the river in the map set (Figure 1). These have no serious effect in the portrayal of geomorphic change.

Comparisons of all identified side and upland sloughs for the two time periods were accomplished using the same sets of photography, but also the photomap sets of sloughs, depicted at various discharges, included in the report by Klinger and Trihey (1984).

RESULTS

Generalized changes in river morphology over the approximately 35 years since the original photography are shown in the accompanying map set

(Figure 1). During that period, a number of old, vegetated islands have disappeared; numerous new gravel bars have appeared and there is now a much larger total number of gravel bars; many, old, barren gravel bars have now become further developed and vegetated, and are now stabilized islands or terraces; and there appear to be many new gravel beaches on the upstream and downstream ends of old islands.

More detailed changes in the sloughs, including changes in slough types, are indicated in Figure 2. It can be seen that some sloughs have come into existence since 1949-51, some have changed character and/or type significantly, and others have not yet changed enough to be noticeable at this scale. Notably, many sloughs have evolved from side channels to side sloughs or from side sloughs to upland sloughs. In some few cases, the evolution has progressed all the way from a side slough to an upland slough. Specifically, seven sloughs changed from side channels to side sloughs (8, "Z", 13, 16, 21, 21A, 22); two sloughs changed from side sloughs to upland slough ("Y", 19); and two changed from side channels all the way to upland sloughs (12, 15). One slough (8C) did not exist in 1949 and is now a side slough behind a newly deposited gravel bar. Of the sloughs studied, only Slough 11, which was observed to be altered by ice jam flooding and erosion processes in 1976, evolved in the opposite direction, from an upland slough to a side slough.

CONCLUSIONS AND DISCUSSION

With the exception of Slough 11, which was changed by ice processes, all sloughs that have changed type have evolved to a perched condition; that is, they are now higher in elevation relative to the water surface at a given

discharge. The perching of the sloughs is apparently due to general river degradation over the 35-year period. As the river has slowly eroded its bed, water surface at any discharge has become lower in elevation relative to the surrounding topography. It is interesting to note, however, that no sloughs have changed type below Lane Creek, while 13 of the 24 studied sloughs above Lane Creek have evolved to a new type. Of the sloughs that have not evolved to another type, some degree of perching is indicated at most of them by an increased extent of vegetation on their enclosing gravel bars or islands.

The evolution of many old, barren gravel bars to vegetated, and often forested, islands and terraces is another indication of long-term river degradation. These islands and terraces are no longer flooded during even high normal summer stages, allowing a permanent vegetation cover to establish itself. This indicates that these islands and terraces are now also perched.

A great number of new, barren gravel bars have appeared in the river. Some of these, such as the gravel bar enclosing Slough 8C, did not exist at all in 1949 and have formed as a result of deposition or emergence. Some other sloughs, which have evolved from side channels to side sloughs, did so not only because of perching but also because of deposition and further growth of the enclosing gravel bars.

Emergence of gravel bars to an exposed condition could be a result of the above-noted long-term river degradation. As the water level recedes to a lower elevation, preexisting gravel bars emerge above the water surface. However, there appears to be a much greater number of exposed gravel bars in the middle reach of the Susitna River now than there was in 1949-51 and many old bars are now much larger in size. If long-term river degradation were the only explanation, one might expect the general number of barren gravel bars to remain relatively constant as new bars emerged and old, exposed bars

became perched and vegetated. The great increase in the number and sizes of barren gravel bars seems to hint at aggradation in the river.

It is speculated that there may have been a short-term period of river aggradation superimposed upon the long-term process of river degradation during the last 35 years. Studies are now in progress to determine the timing and rate of changes that led to the appearance of the gravel bars. Photography at intervals throughout the 35-year period is being analyzed to try to determine the process that initiated the aggradation phase. The results of these studies and discussion of the implications of geomorphic change on fish habitats will appear in the final report of this study.

REFERENCES

Friese, Nancy V., 1975. Preauthorization assessment of anadromous fish populations of the upper Susitna River watershed in the vicinity of the proposed Devil Canyon Hydroelectric Project. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage, AK. 108 pp.

Klinger, Sharon, and Woody Trihey, 1984. Draft report, May. Response of aquatic habitat surface areas to mainstem discharge in the Talkeetna to Devil Canyon reach of the Susitna River, Alaska. Report prepared by E. Woody Trihey and Associates for the Harza-Ebasco Susitna Joint Venture. 11 pages plus appendices.

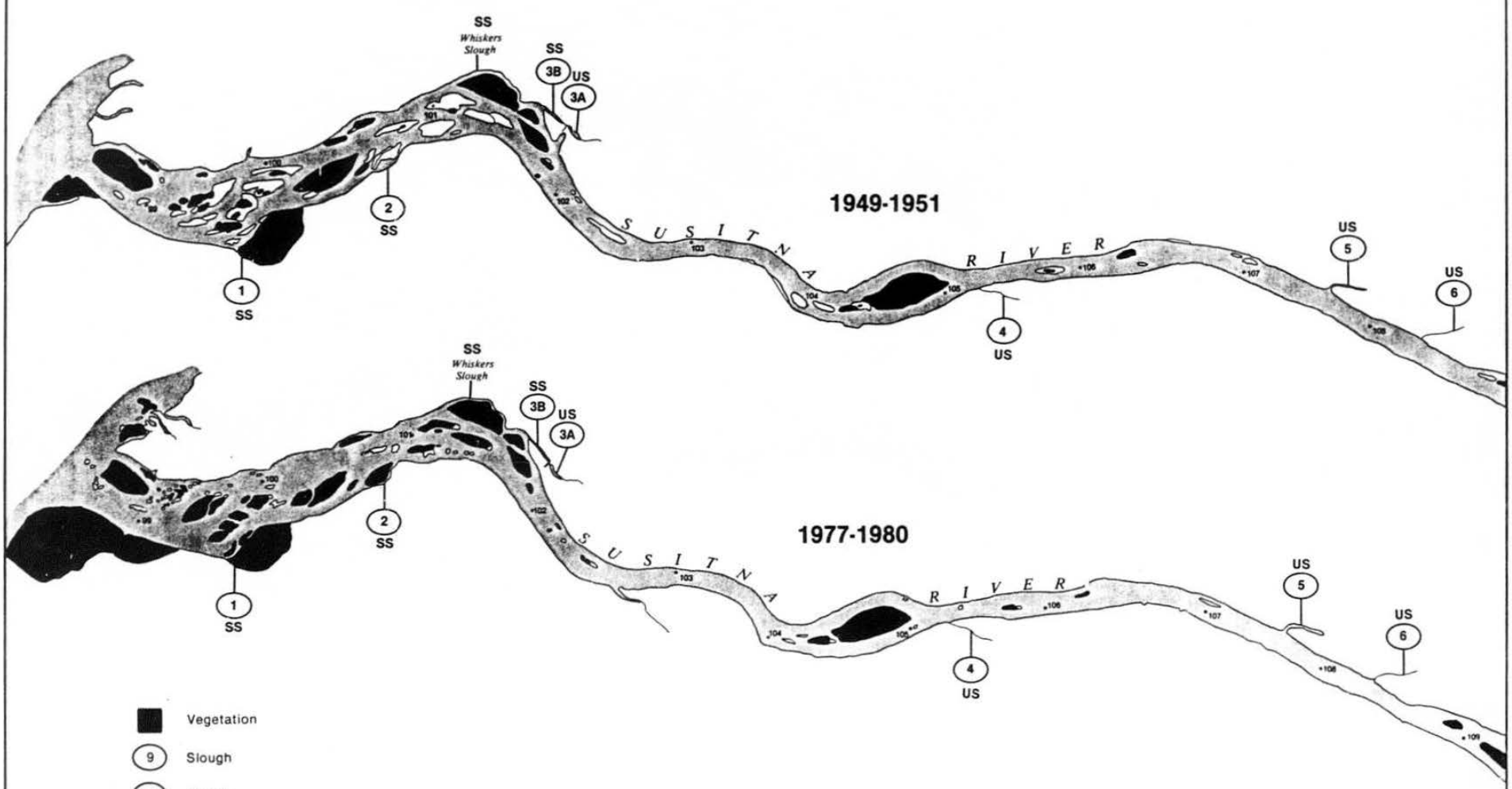


Figure 1

COMPARATIVE GEOMORPHOLOGY

1949-51 to 1977-80
Middle Susitna River
River Mile 98-109

Approximate Scale 1:60,000
1 Inch = .9 Miles

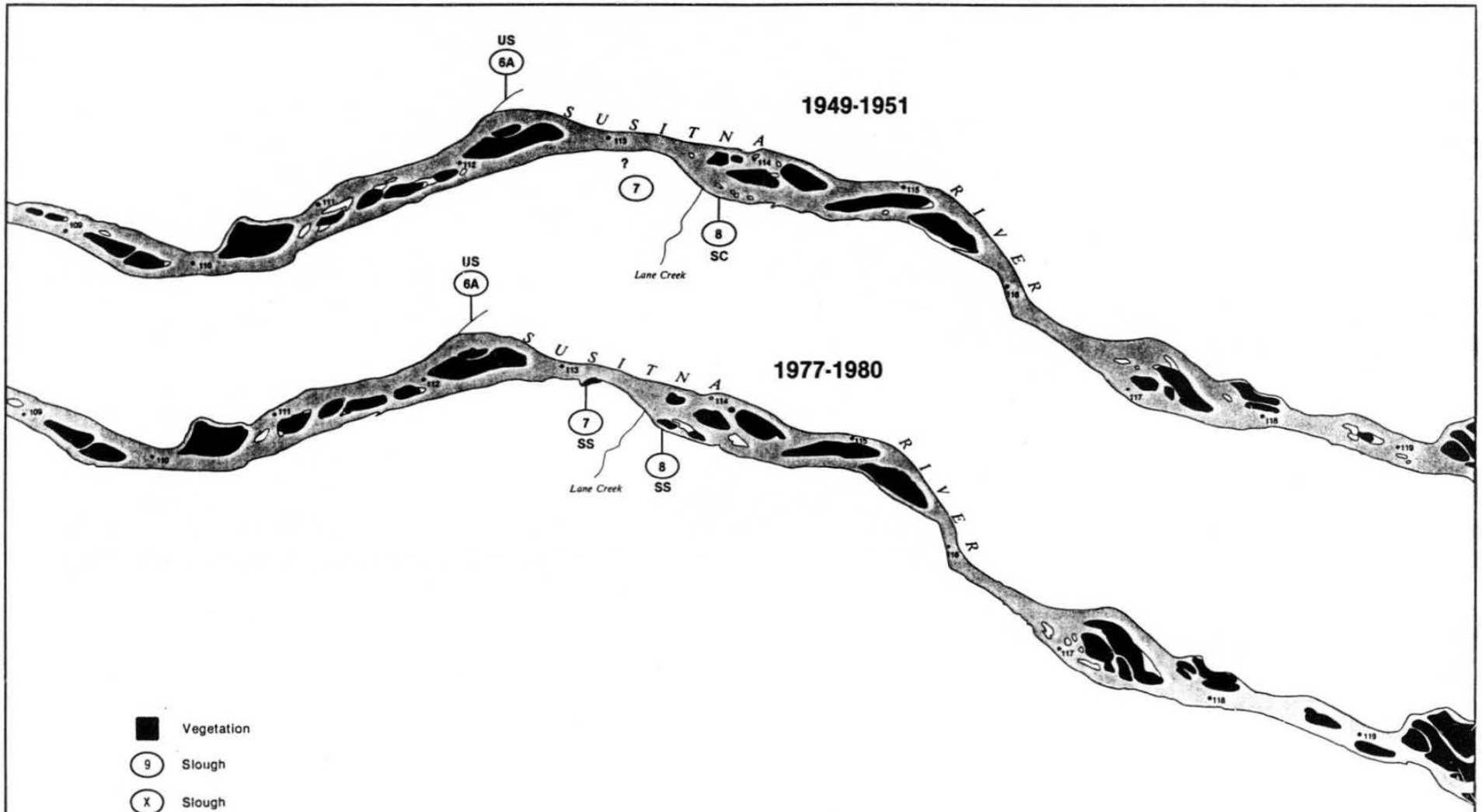


Figure 1

COMPARATIVE GEOMORPHOLOGY

1949-51 to 1977-80
Middle Susitna River
River Mile 109-119

Approximate Scale 1:60,000
1 Inch = .9 Miles

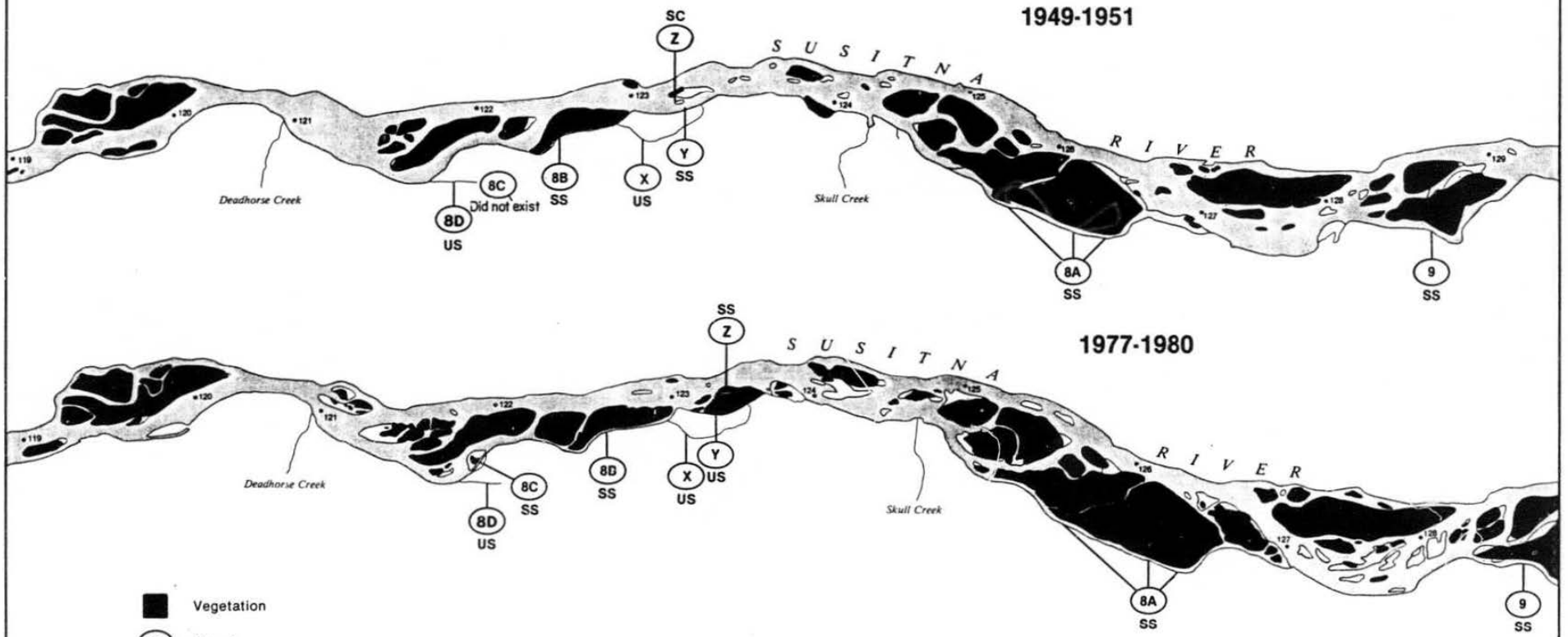


Figure 1

COMPARATIVE GEOMORPHOLOGY

1949-51 to 1977-80
Middle Susitna River
River Mile 119-128

Approximate Scale 1:60,000
1 Inch = .9 Miles

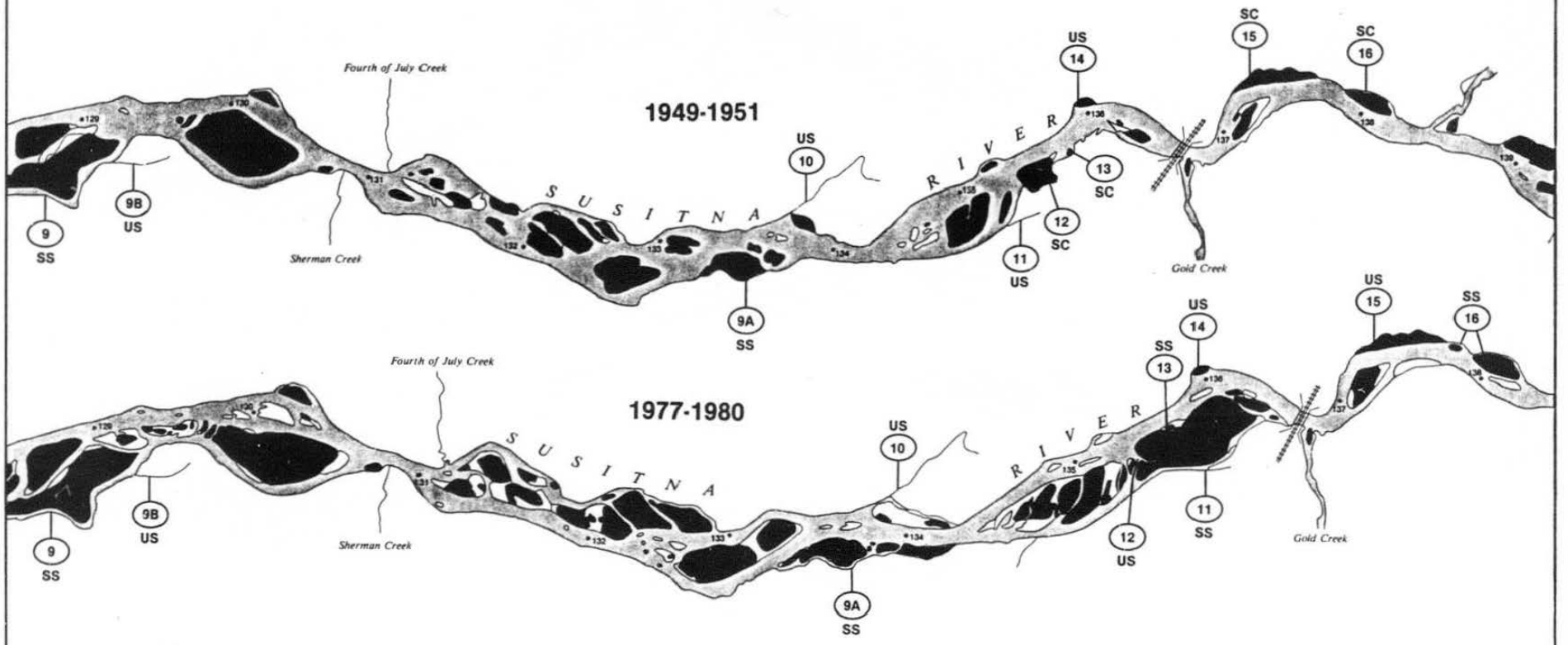


Figure 1

COMPARATIVE GEOMORPHOLOGY

1949-51 to 1977-80
Middle Susitna River
River Mile 128-138

Approximate Scale 1:60,000
1 Inch = .9 Miles

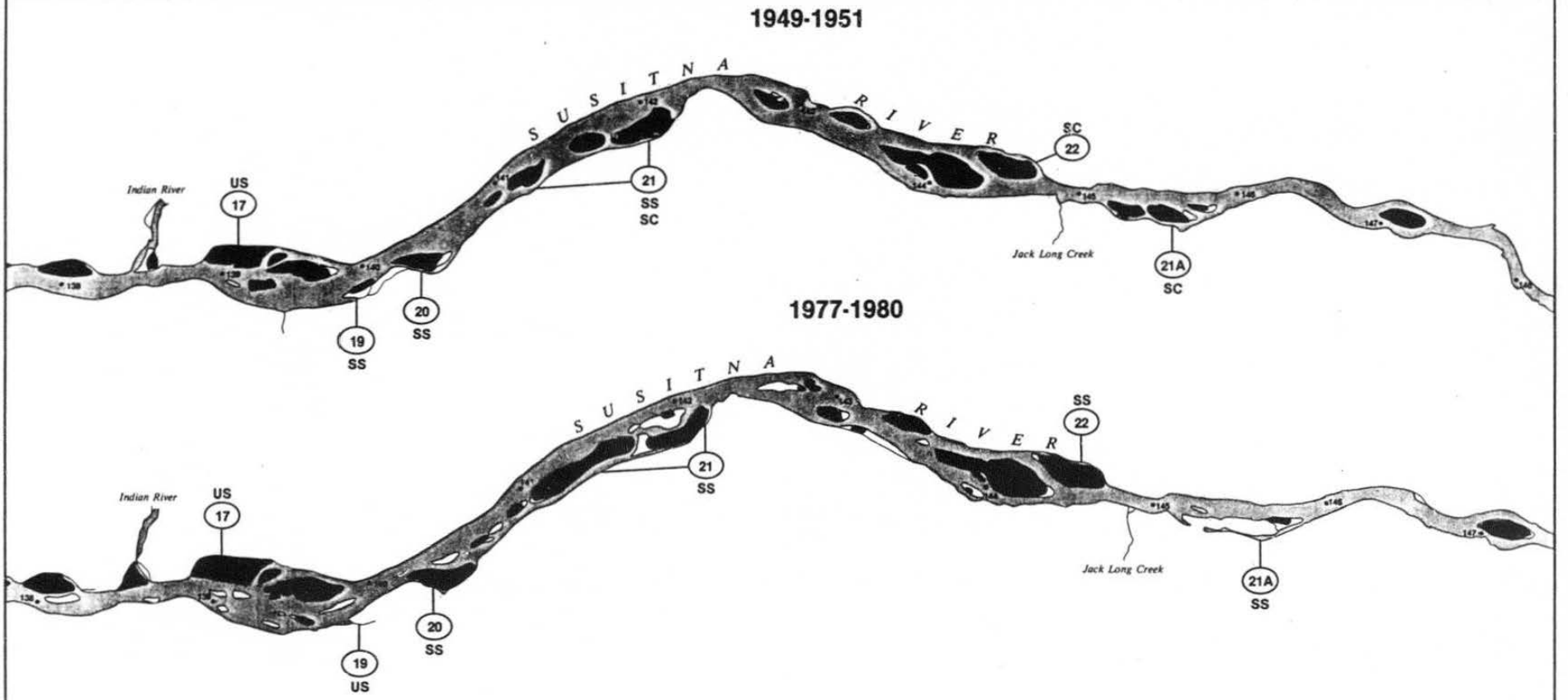
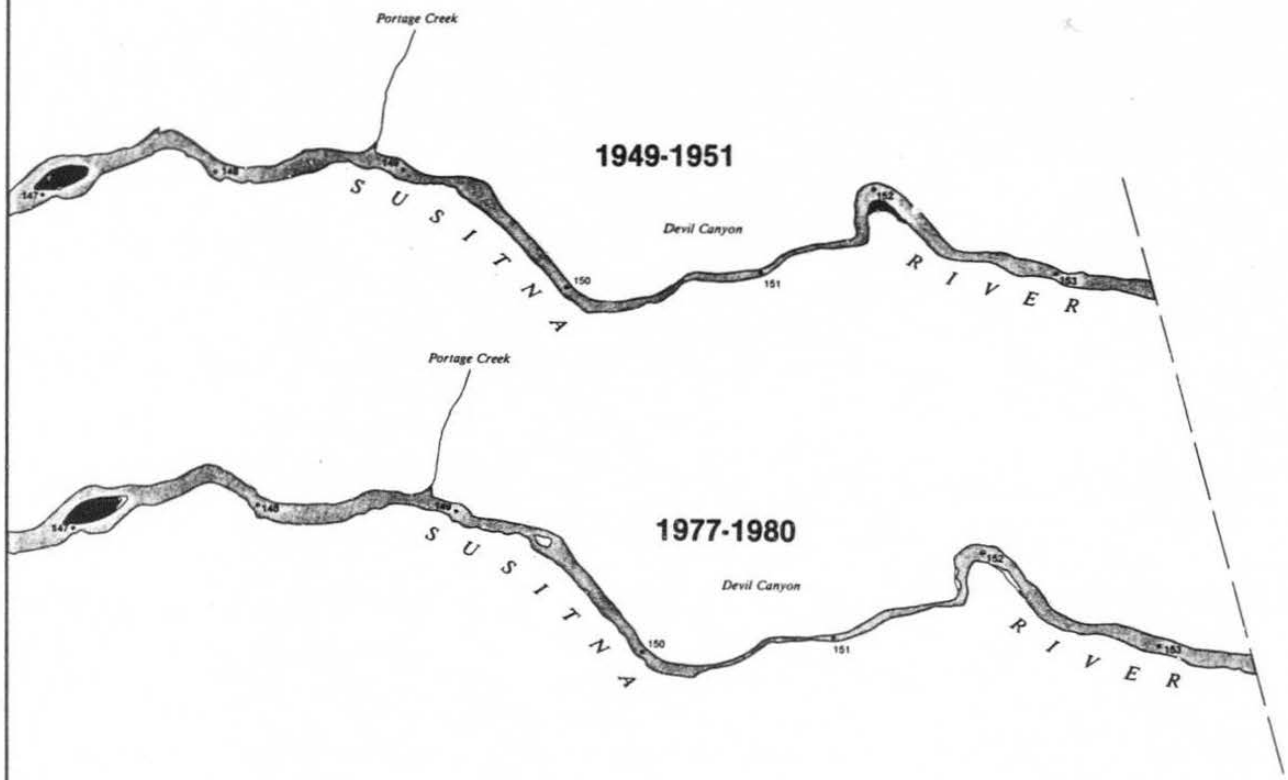


Figure 1

COMPARATIVE GEOMORPHOLOGY

1949-51 to 1977-80
Middle Susitna River
River Mile 138-147

Approximate Scale 1:60,000
1 Inch = .9 Miles



Vegetation

9 Slough

X Slough

SC Side Channel

SS Side Slough

US Upland Slough

148 River Mile

Figure 1

COMPARATIVE GEOMORPHOLOGY

1949-51 to 1977-80
Middle Susitna River
River Mile 147-153

Approximate Scale 1:60,000
1 Inch = .9 Miles

Figure 2. Slough Change, Middle Susitna River, Since 1949

Slough	TYPE 1949-51	TYPE 1984*	Comparative Photography	Slough Changes Noted
1	SS	SS	7/3/51 6/19/77	No apparent changes in slough, but bar at slough mouth has become vegetated.
2	SS	SS	7/3/51 6/19/77	No apparent changes in slough, but more vegetation has developed on outer part of enclosing gravel bar.
Whiskers	SS	SS	7/3/51 6/19/77	No apparent changes.
3A	US	US	7/3/51 6/19/77	No apparent changes.
3B	SS	SS	7/3/51 6/19/77	No apparent changes.
4	US	US	7/3/51 6/19/77	No apparent changes.
5	US	US	7/3/51 6/19/77	No apparent changes.
6	US	US	7/3/51 6/19/77	No apparent changes.
6A	US	US	7/3/51 6/19/77	No apparent changes.
7	-	SS	8/14/49 6/19/77	Slough not discernable on photos.
8	SC	SS	8/14/49 6/19/77 8/1/80	In 1949 the enclosing gravel bars were much smaller, lower, mostly awash, and completely unvegetated. The "slough" was a side channel. In 1977-80 the bars are larger, higher, and better defined, with much vegetation from grasses up to high brush and small trees.

Figure 2. (continued)

Slough	TYPE 1949-51	TYPE 1984*	Comparative Photography	Slough Changes Noted
8D	US	US	8/14/49 8/1/80	No apparent changes.
8C	Did not exist	SS	8/14/49 8/1/80	In 1949 there was no enclosing gravel bar and the slough did not exist. In 1980 the enclosing gravel bar is small and lightly vegetated in its center, up to small brush.
8B	SS	SS	8/14/49 8/1/80	No apparent changes.
Unnamed X	US	US	8/14/49 8/1/80	No apparent changes.
Unnamed Y	SS	US	8/14/49 8/1/80	Enclosing gravel island did not exist in 1949; only small, partly emergent, unvegetated bars existed. In 1980 the enclosing gravel island is larger, high, and completely vegetated up through strands of trees.
Unnamed Z	SC	SS	8/14/49 8/1/80	In 1949 existed as sides channel behind heavily forested island. In 1980 slough exists in lower part of channel only, with berm in upper part. Shoreward of slough, bars that were bare and awash in 1949 are now higher and fully vegetated.
8A	SS	SS	8/14/49 8/11/80	No apparent changes.
9	SS	SS	8/10/49 8/11/80	No apparent changes in slough, but bars on west end of enclosing island have become vegetated.
9B	US	US	8/10/49 8/11/80	No apparent changes.

Figure 2. (continued)

Slough	TYPE 1949-51	TYPE 1984*	Comparative Photography	Slough Changes Noted
9A	SS	SS	8/14/49 8/11/80	No apparent changes in slough, but channel appears wider now and the morphology of the enclosing island has slightly changed.
10	US	US	8/14/49 8/11/80	No apparent changes.
11	US	SS	8/14/49 8/11/80	In 1949 existed only as a short upland slough at edge of terrace. In 1976, a breakup ice jam occurred that flooded the terrace and eroded the present slough, cutting off the terrace to an island.
12	SC	US	8/14/49 8/11/80	In 1949 entire channel was flooded and appeared as a side channel. In 1980 only the lower part of the channel is normally wetted, as an upland slough.
13	SC	SS	8/14/49 8/11/80	In 1949 enclosing gravel bar was less developed and mostly awash; slough appears as side channel. In 1980 the enclosing gravel bar is better developed and higher, enclosing a side slough.
14	US	US	8/14/49 8/11/80	No apparent changes.
15	SC	US	8/10/49 8/11/80	In 1949 channel was completely flooded and appeared as side channel. In 1980 only the lower part of the channel is normally wetted, as an upland slough.

Figure 2. (continued)

Slough	TYPE 1949-51	TYPE 1984*	Comparative Photography	Slough Changes Noted
16	SC	SS	8/10/49 8/11/80	In 1949, enclosing gravel bar was less developed, mostly awash; slough appeared as side channel. In 1980, the enclosing gravel bar is better developed and higher, enclosing a side slough.
17	US	US	8/10/49 8/11/80	No apparent changes.
18	(Not identifiable)			
19	SS	US	8/10/49 8/11/80	In 1949, slough occupied channel behind gravel bar that is partly awash. In 1980, slough is lower part of channel behind vegetated bar.
20	SS	SS	8/10/49 8/11/80	In 1949 slough was behind partially vegetated island. In 1980, island is heavily forested.
21	SC & SS	SS	8/10/49 8/11/80	In 1949, channel below first enclosing island was open (no gravel berm), making entire lower section of slough a side channel. In 1980, a high gravel bar has formed in the channel, making a high berm and causing the lower section of slough to be a side slough. Behind the upper island, the channel is a side slough in both years.

Figure 2. (continued)

Slough	TYPE 1949-51	TYPE 1984*	Comparative Photography	Slough Changes Noted
21A	SC	SS	8/10/49 8/11/80	In 1949 channel was totally flooded and appeared as a side channel. In 1980 enclosing island appears better developed and higher and slough is side slough.
22	SC	SS	8/10/49 8/11/80	In 1949 channel was totally flooded and appeared as a side channel. In 1980 enclosing island appears higher and slough is a side slough.

Definitions (Klinger and Trihey, 1984)

SC - Side Channel. These contain turbid, glacial waters, the same as found in the mainstem. These channels convey less than ten percent of the total flow.

SS - Side Slough. These contain clear water. Local surface runoff and upwelling are the primary water sources that supply clear water to the side sloughs. Side sloughs have non-vegetated upper thalwegs that are overtopped during periods of moderate to high mainstem discharge. Once overtopped, side sloughs are considered side channels.

US - Upland Slough. These contain clear water and depend upon upwelling and/or local runoff as their clear water sources. Upland sloughs possess vegetated upper thalwegs that are seldom overtopped by mainstem discharge.

* 1984 Type classification from Klinger and Trihey, 1984.

PHOTOGRAPHY	DISCHARGE (cfs)
August 10, 1949	29,900
August 14, 1949	28,600
July 3, 1951	18,200
June 19, 1977	41,000
August 1, 1980	31,100
August 11, 1980	22,600