SUSITNA HYDROELECTRIC PROJECT

FEDERAL ENERGY REGULATORY COMMISSION
PROJECT No. 7114

IMPACTS ASSESSMENT DOWNSTREAM VEGETATION

DRAFT REPORT

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SUSITNA JOINT VENTURE

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SUSITNA HYDROELECTRIC PROJECT

DOWNSTREAM VEGETATION IMPACTS ASSESSMENT

Report by

Harza-Ebasco Susitna Joint Venture

Prepared for

Alaska Power Authority

Draft Report
March 1986

NOTICE

ANY QUESTIONS OR COMMENTS CONCERNING
THIS REPORT SHOULD BE DIRECTED TO
THE ALASKA POWER AUTHORITY
SUSITNA PROJECT OFFICE

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1.0 INTRODUCTION

Altered flow, flood, and ice regimes downstream of the proposed Susitna Hydroelectric Project will affect the floodplain vegetation between Devil Canyon and the mouth of the river. These effects will likely be marked between Devil Canyon and Talkeetna (the middle Susitna River; see Figure 1), and much less downstream of Talkeetna (lower Susitna River) since flows and floods in the Lower River will be largely controlled by the Chulitna and Talkeetna rivers.

The purposes of this report are to: 1) quantify to the extent possible changes in the lower limits of both early and mature vegetation communities along the lower and middle Susitna River, 2) estimate the amount of floodplain which will experience such changes, and 3) estimate the changes in acres of various riparian vegetation communities with-project.

2.0 CONCEPTUAL MODEL

The conceptual model used in the analysis of downstream vegetation impacts is presented in Figure 2. Helm et al. (1985) developed the typical succession series for the Susitna River: silt to herbaceous to willow to alder to immature balsam poplar to mature balsam poplar to mature white spruce and birch. Herbaceous and willow vegetation communities were classified as early successional, while alder and immature balsam poplar were classified as intermediate successional. We defined the "active zone" to be that vegetated portion of the floodplain which elevationally and areally corresponds to these early and intermediate successional vegetation communities (Figure 2A). This zone is where vegetation is regularly affected by river flows and flood events. Both the location and width of the active zone will change after operation of the Susitna Hydroelectric Project is begun. We conceptually anticipated that the active zone would narrow somewhat and occur at lower elevations as the project progressed (Figure 2B).

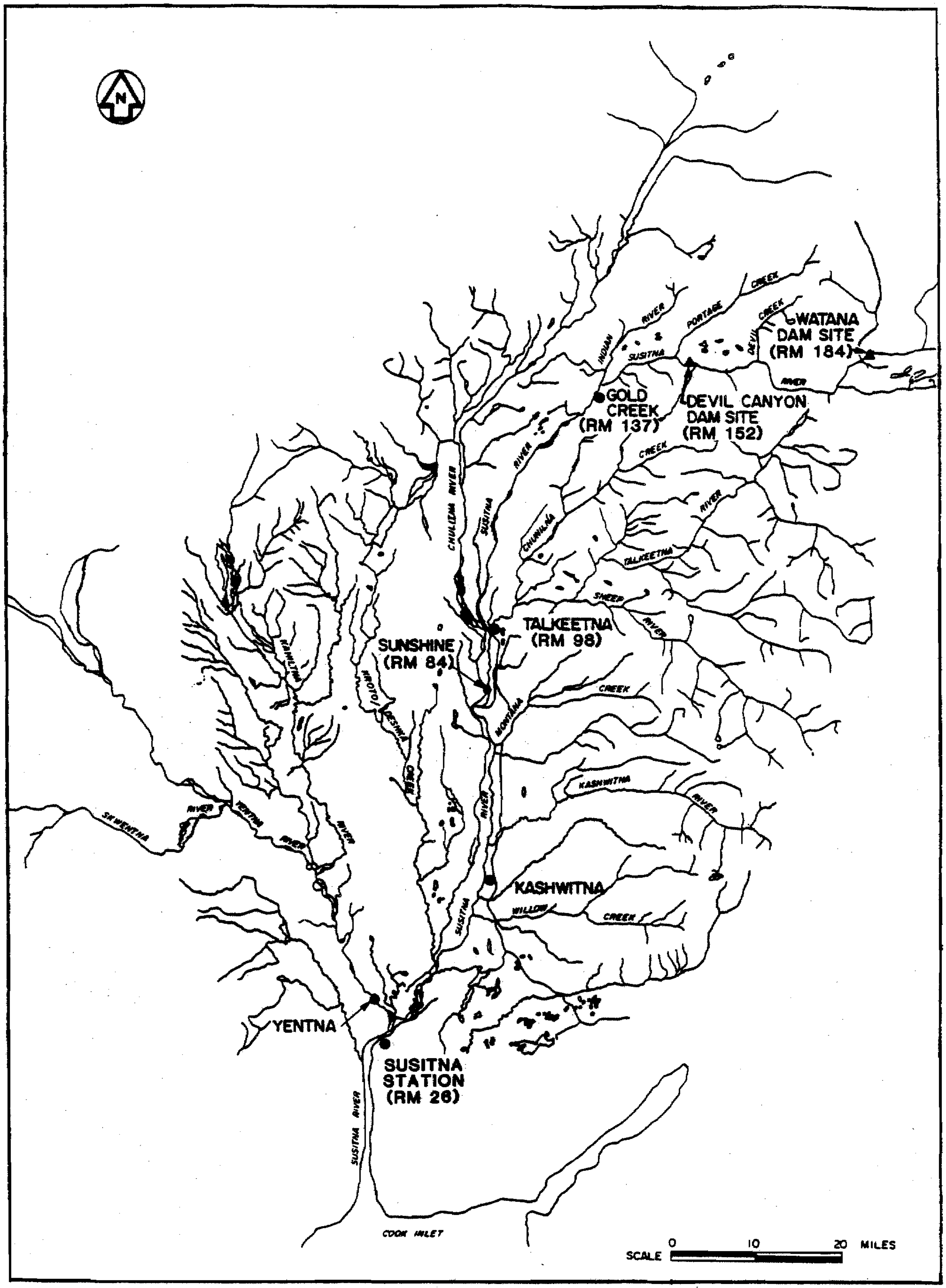

FIGURE 1. Area map of middle (Talkeetna to Devil Canyon) and lower (Talkeetna to Susitna River mouth) Susitna River reaches, including locations of U.S.G.S. gaging stations (Gold Creek, Sunshine, and Susitna Station).

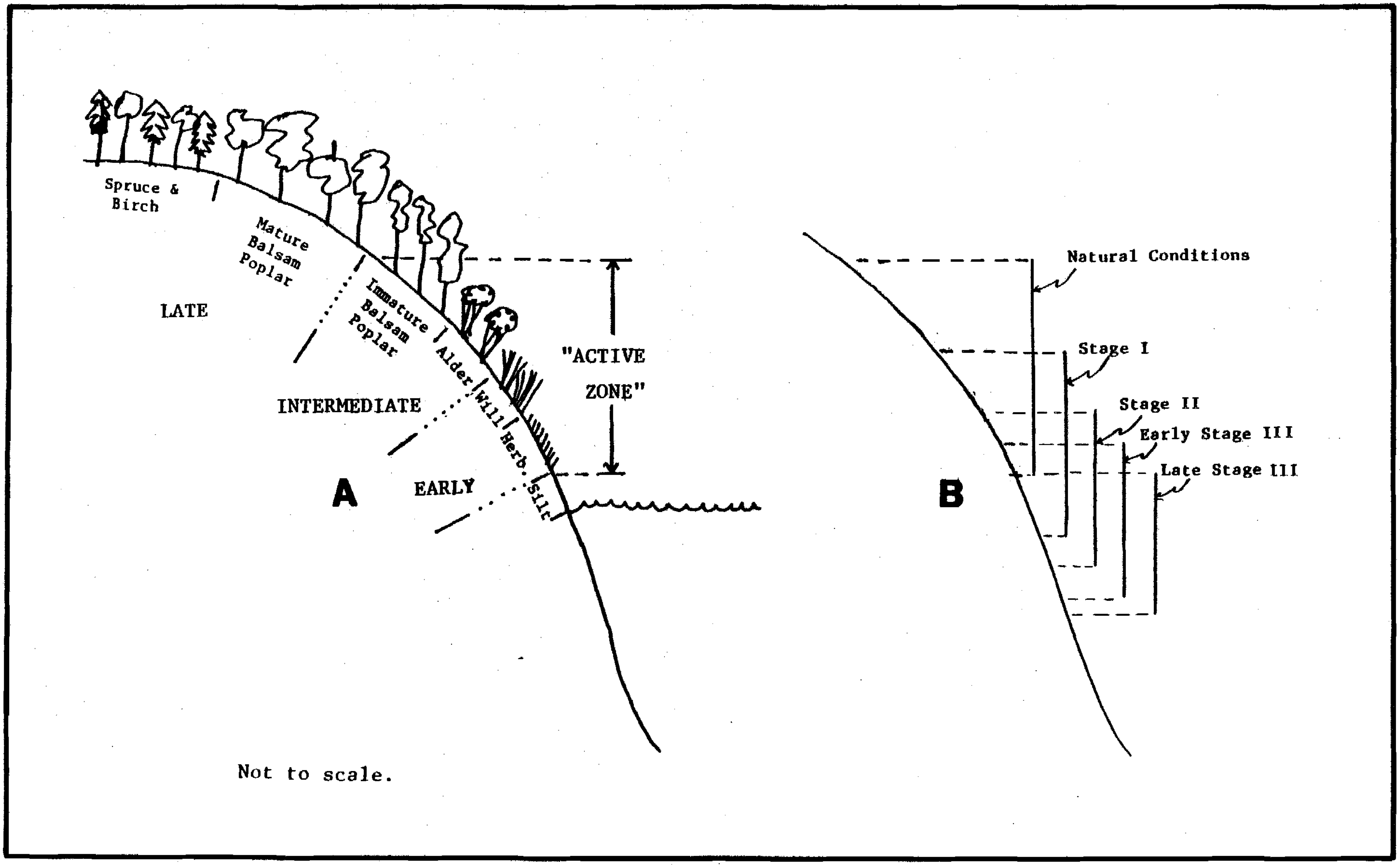

FIGURE 2. Conceptual model of downstream vegetation impacts. A - Successional progression based on Helm et al. (1985). B - Changes in active zone with-project. Note that the active zone narrows as well as lowers in elevation with-project.

3.0 METHODS

Vegetation notations along hydrographic cross-sectional surveys of the middle Susitna River (LRX-3 to LRX-68, RM 98.5 to RM 150; R&M Consultants, Inc. 1981) were examined. Elevations were noted at each cross section where the presence of various vegetation species was noted as well as at transitions between vegetation types. In our analysis of the river cross section data, we attempted to determine the minimum elevations noted for the following categories: all species; immature woody species, mature balsam poplar, and mature spruce and birch.

Elevations were next related to discharges at each location. This was done for flows less than 52,000 cubic feet per second (cfs) graphically for surveyed river cross sections having stage-discharge curves (Harza-Ebasco 1984a) and by linear interpolation for other surveyed river cross sections (Draft License Amendment Table E.2.2.24; Harza-Ebasco 1985a). Water surface elevations for discharges above 52,000 cfs were approximated using linear regressions of the 34,500 and 52,000 cfs points from Table E.2.2.24, and the 90,000 and 118,000 cfs data from a February 18, 1983 run of the U.S. Army Corps of Engineers Hydraulic Engineering Center program for determining water surface profiles (HEC-2) (R&M Consultants, Inc. 1983). All discharges were in terms of flows at Gold Creek.

In the middle Susitna River, mainstem discharges were related to acres of wetted surface area. The difference in wetted surface area between a high and a low discharge corresponds to the area of additional substrate exposed if the river's discharge dropped from the high to low discharge. Wetted surface areas were calculated from areas associated with discharges of 5,100 to 23,000 cfs at Gold Creek determined by Klinger-Kingsley et al. (1985), and values associated with discharges of 90,000 and 118,000 cfs calculated from a HEC-2 run (R&M Consultants, Inc. 1983). Lower Susitna River area-discharge data were not available at the discharges needed for this report.

Since stage-discharge and area-discharge curves are only relatable to flows along the main channel, and the HEC-2 model used to compute water surface elevations for given discharges does not recognize side channel and slough water surface levels different from those of the main channel, only those values along the main channel or large volume side channels were used. Even though elevations in side channels and sloughs cannot be easily related to main channel discharges, aerial mapping and wetted surface area data are available which relate the areas in side channels and sloughs to main channel discharge.

The following assumptions were used in analyses of the cross-sectional data:

(1) Lower vegetation limits are determined by a complex of factors which ultimately can be defined in terms of water surface elevation.

(2) Water surface elevations can be correlated with predictable main channel flows and flood events.

(3) Impacts due to the project may be inferred by examining project effects upon flows and flood events.

(4) No significant channel degradation or aggradation will occur during the license period.

(5) To become established and mature, vegetation must be above water for at least half the growing season (June through August).

(6) Higher elevation vegetation limits at some cross sections are due to substrate characteristics, including steep cutbanks and other forms of natural variability, and to error during surveying and/or data recording.

(7) Lower elevation vegetation limits at some cross sections are due to natural variability and to error during surveying and/or data recording.

(8) Although the active zone is defined in terms of discharge events, ice effects are also contained within this zone.

Middle River cross sections which crossed islands were examined using stereoscopic aerial photos (1 inch = 1,000 feet; photos taken September 6, 1983; Doc. No. 1445) for information on distribution of mature balsam poplar communities. Since the slope of most island shores is low, artifacts due to cutbanks are relatively rare. At least one, and usually both, sides of the islands are in contact with main channel flows or large side channel flows which probably have similar water level characteristics to those predicted by the HEC-2 model for the main channel.

Cross sections in the reach between Talkeetna and Sunshine (LRX-84.6 to LRX-2.3, RM 84.6 to RM 98.42) had no vegetation notations made while surveys were taken (R&M Consultants, Inc. 1985a). These cross sections were compared to 1 inch = 2,000 feet black and white aerial photos (photos taken September 6, 1983; Doc. No. 1446) viewed under a steroscope, and notations were made of presence and absence of types of woody vegetation. Rating curves were available up to 100,000 cfs for some cross sections, while Table E.2.2.24 of the Draft License Application Amendment (Harza-Ebasco 1985a) was used for elevations at other flows and cross sections. Insufficient cross section data were available downstream of Sunshine to enable analyses of this nature.

To estimate how areas within and beyond the active zones will be vegetated over time if the project is built, analyses were conducted using the following assumptions:

(1) The natural active zone (Bands 1 and 2: see page 8 for explanation of bands) is in a dynamic equilibrium of one-third

early successional communities and two-thirds intermediate communities (derived from Helm et al. 1985).

(2) The successional species and time schedule presented in Helm et al. (1985) for riparian communities are accurate.

(3) Stationary coverage of plants by ice is not a major cause of seedling and sapling mortality.

(4) All natural early successional stands begin the analysis (1999) at the midpoint of their lifetime, i.e. 12 years since colonization.

(5) All intermediate succession stands begin the analysis as one-third alder at 35 years since colonization and two-thirds immature balsam poplar at 70 years since colonization (based on Helm et al. 1985).

(6) All barren exposed areas in active zone Bands 3 and 4 are colonized in a logarithmic fashion, requiring five years after exposure for complete colonization of Band 3, and 10 years for complete colonization in Band 4.

4.0 RESULTS

The pattern of change in the active zones with-project is similar in the Middle and Lower River. A fairly large change occurs when Watana Stage I begins operation. The active zone remains essentially unchanged from Stage I through early Stage III operation. Another major change occurs between early and late Stage III operation.

4.1 Middle River

The lower limit of vegetation ("greenline", "vegetation clip line") on the middle Susitna River under natural conditions is estimated to occur at a level which corresponds to a 36,000 cfs discharge at Gold Creek. The actual lower limit corresponds to a range of flows throughout this reach, fluctuating between the mean summer (June through August) flow (25,000 cfs; Harza-Ebasco 1985a) and the mean annual flood (48,000 cfs; Harza-Ebasco 1985c).

Recorded variations within this range are the results of differences in substrate, ice effects, other natural variability, and experimental error. Since a specific value rather than a range is necessary for impact assessment, it was deemed reasonable to use the mean of these two flows.

The upper limit of early and intermediate successional communities (corresponding to the lower limit of late successional communities) lies between the 5- and 10-year floods. This corresponds to flows of between 63,000 and 74,000 cfs at Gold Creek under natural conditions (Harza-Ebasco 1985c). Since this range of flow is considerably narrower than that of flows determining the lower limit of vegetation along the river, and corresponds to water surface elevation differences of less than one foot, it was decided to use the conservative value of the 10-year flood for impact assessment purposes.

The active zone in the middle Susitna River therefore can be approximately described as that bank area between the water surface elevations of the 10-year flood and the mean of the mean summer flow and the mean annual flood. The discharges associated with the natural and with-project active zones are shown graphically in Figure 3. The area of the active zone in the middle Susitna River is about 2,050 acres under natural conditions, 1,000 acres with Stages I, II, and early Stage III, and 1,300 acres with late Stage III operation.

With Watana Stage I operation, the area exposed between about 74,000 and 44,000 cfs (Band 1; 1,650 acres) begins to mature since it is no longer in the active zone (Figure 4). The area between about 44,000 and 35,000 cfs (Band 2; 400 acres) remains part of the active zone, while the area between about 35,000 and 25,000 cfs (Band 3; 600 acres) is exposed as barren substrate, and is colonized by early successional plant species over a period of 5 years.

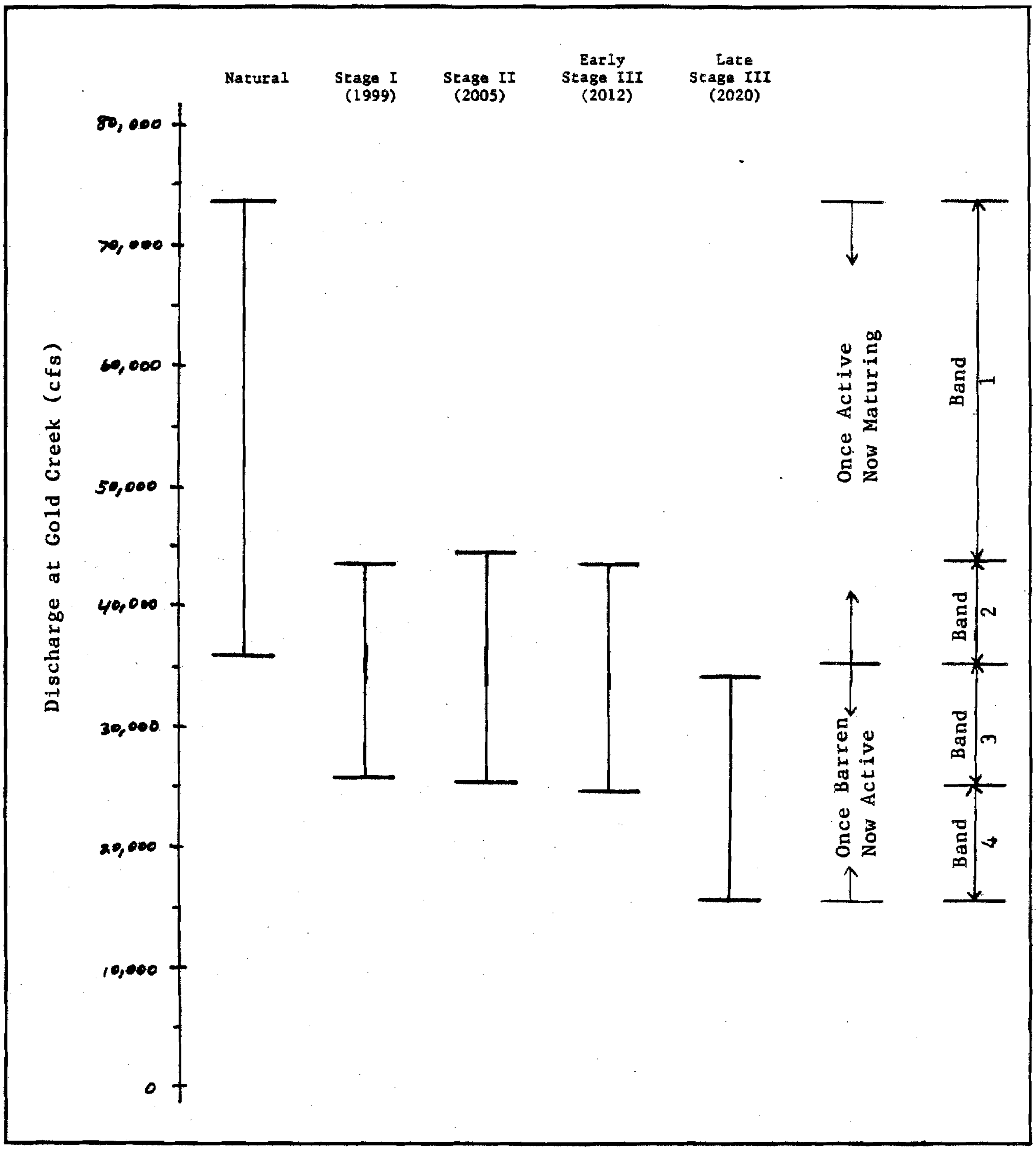

FIGURE 3. Discharges associated with active zones along the middle Susitna River, Alaska, from Devil Canyon to Talkeetna.

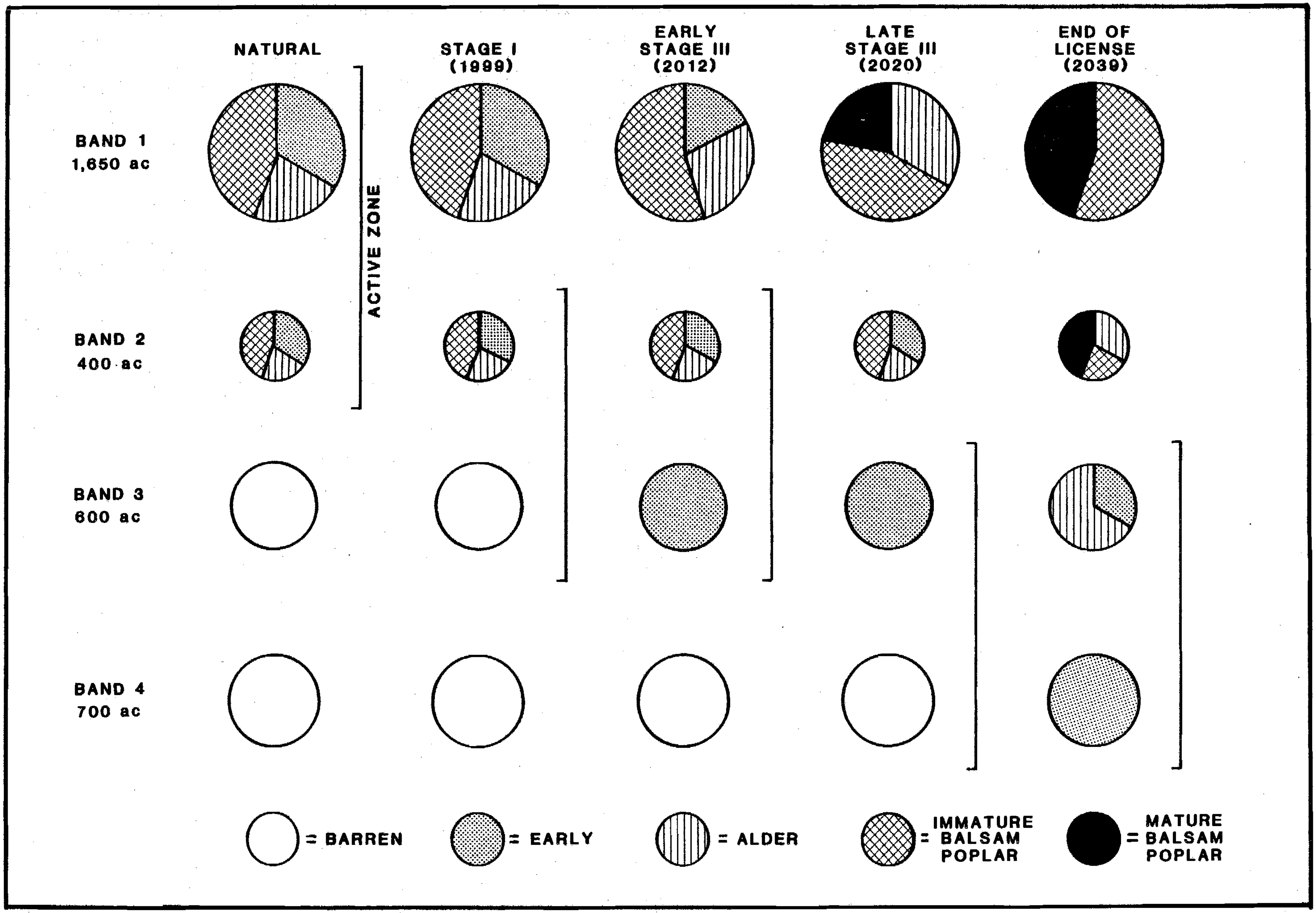

FIGURE 4. SUCCESSION OF VEGETATION IN BANDS OF THE ACTIVE ZONE ALONG THE MIDDLE SUSITNA RIVER, ALASKA, WITH THE SUSITNA HYDROELECTRIC PROJECT. SEE TEXT (p.8) FOR EXPLANATION OF BANDS, AND TABLE 1 FOR ASSOCIATED ACREAGES.

During the period from Watana Stage I operation through early Watana Stage III operation (a period of about 15 years) the active zone consists of Bands 2 and 3. As the load demand increases late Stage III operations take place, further stabilizing flows and reducing flood flows. Due to these reduced flows, Band 2 is no longer in the active zone and begins to mature. Band 3 continues to succeed to typical active zone vegetation, and the area between about 25,000 and 16,000 cfs (Band 4; 700 acres) is exposed and, over a period of 10 years, is colonized by early successional plant species. All four bands succeed to later successional communities for the rest of the license period, but Bands 3 and 4 remain as the active zone.

Results of the vegetation succession analyses for the middle Susitna River are shown in Figures 5 and 6 and Table 1. Figure 5 shows the area of early and intermediate succession vegetation communities, Figure 6 the area of late successional communities, and Table 1 the acreages associated with these figures. Early and intermediate vegetation community acreage will oscillate during and after the license period. Early and alder communities will show roughly 30 and 55 percent increases , respectively, at the end of the license period compared to natural conditions, while immature balsam poplar communities will decrease about five percent in area during the same period. The total area of early and intermediate communities will be about 20 percent greater at the end of the license period. One hundred years with-project, changes in early and intermediate communities will essentially be over, and there will be about a 35 percent total loss of areas of these communities.

Band 1 is the largest of the four, and will mature to later successional plant communities as soon as Stage I is placed in operation (Figure 4). This will tend to decrease the amount of early and intermediate successional communities along the middle Susitna River. Such a decrease will be offset during the license period by the early and intermediate plant communities forming when Bands 3 and 4 are exposed and colonized.

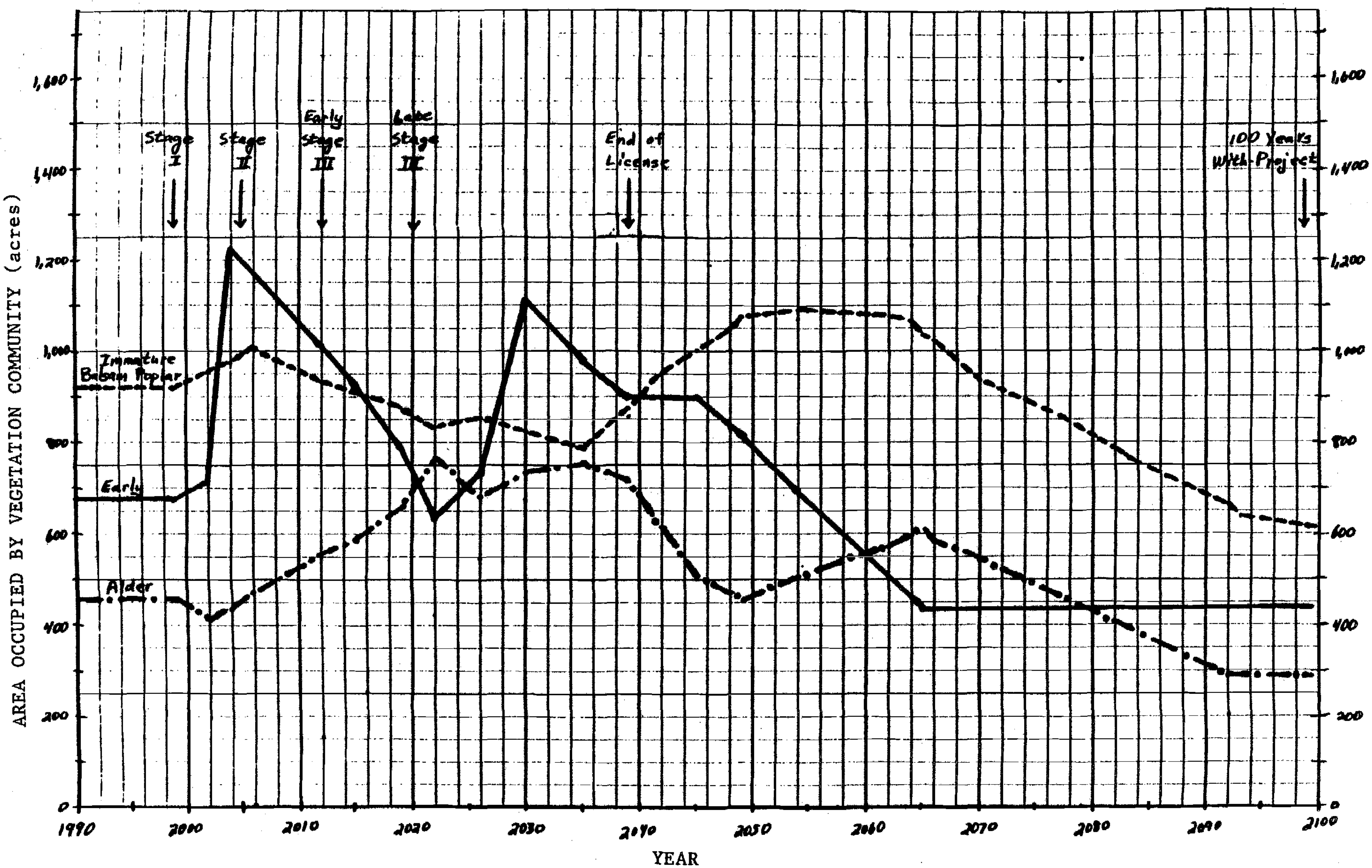

FIGURE 5. Acreages of early and intermediate (alder and balsam poplar) successional communities in the riparian zone of the middle Susitna River, Alaska, with the Susitna Hydroelectric Project. Community descriptions follow Helm et al. (1985).

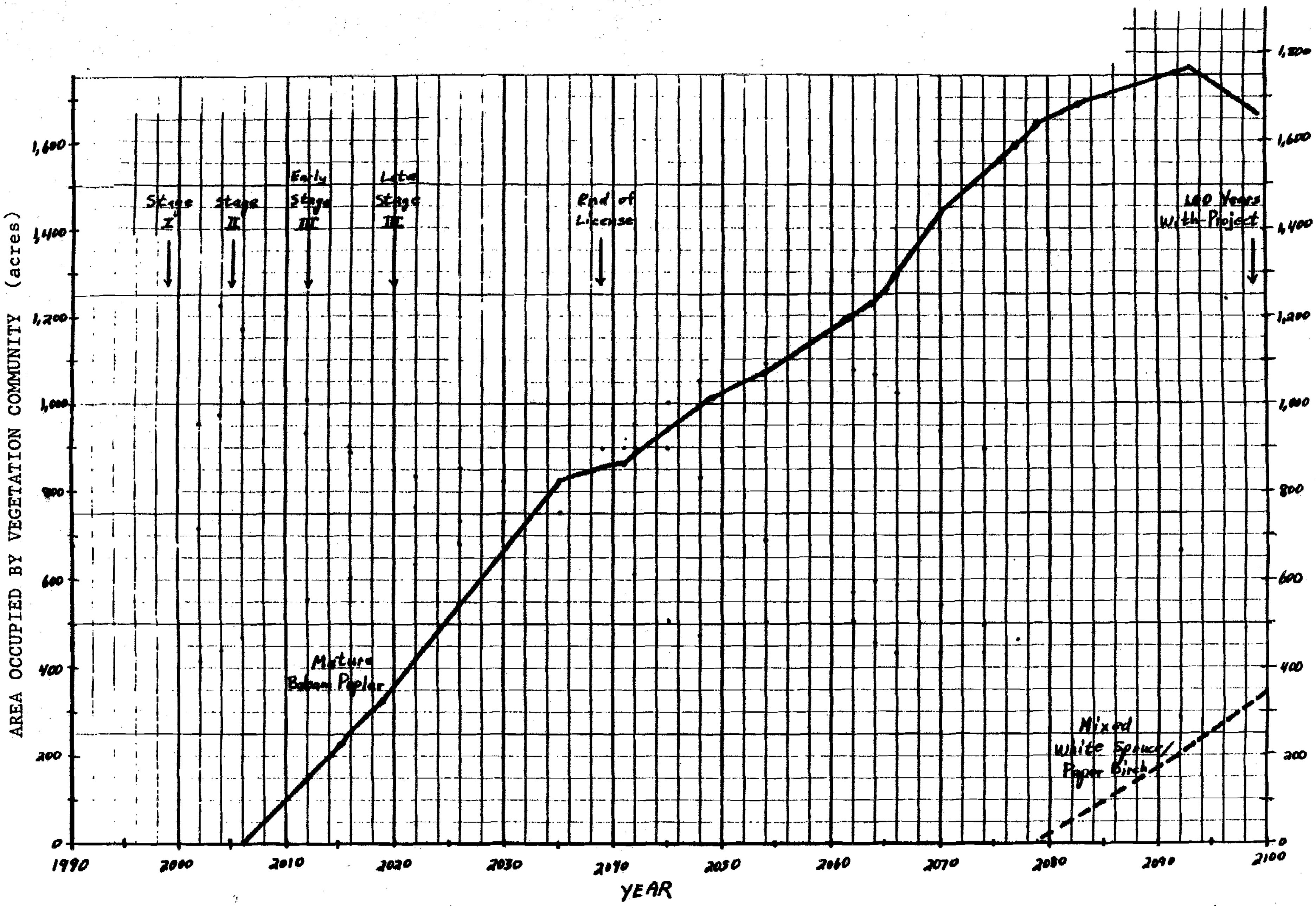

FIGURE 6. Acreages of late successional communities in the riparian zone of the middle Susitna River, Alaska, with the Susitna Hydroelectric Project. Community descriptions follow Helm et al. (1985).

Table 1

AREAS OF MIDDLE SUSITNA RIVER RIPARIAN COMMUNITIES
UNDER NATURAL CONDITIONS AND WITH THE SUSITNA HYDROELECTRIC PROJECT

Community	Area (acres)						
	Natural	Stage I (1999)	Stage II (2005)	Early Stage III (2012)	Late Stage III (2020)	End of License (2039)	100-Year With-Project (2099)
Time Interval (yrs.)			6	7	8	19	60
Barren	0	600	0	0	700	0	0
Early	683	683	1,200	1,008	736	900	433
Alder	456	456	457	554	693	717	289
Immature Balsam Poplar	911	911	993	936	863	877	619
Mature Balsam Poplar	0	0	0	152	360	856	1,670
White Spruce/ Paper Birch	0	0	0	0	0	0	339
TOTAL IMMATURE	2,050	2,050	2,650	2,650	2,292	2,494	1,341

The process of Bands 3 and 4 becoming riparian communities in approximately the proportions presently found in the Middle River riparian areas will not be complete until about the year 2100. At that time, there will be about 35 percent less total area of both early and intermediate communities than under natural conditions along the Middle River.

It is important to note that there will be an overall increase in the total vegetated terrestrial habitat as the active zone changes with-project. In the middle Susitna River, this will be those areas identified as Bands 3 and 4, a total of about 1,300 acres (Figure 7).

4.2 - LOWER RIVER

Lower River cross sections are available from Talkeetna to Susitna Station (RM 98.5 to RM 26.0), but these cross sections have no vegetation data and rating curves at low flows only. Cross sections examined in conjunction with aerial photographs indicated that the same discharge events used in modeling the Middle River vegetation changes can be used to model the lower limit of the active zone in the Talkeetna to Susitna Station reach. Therefore, we believe that the processes responsible for active zone limits are the same throughout the Susitna River, and can be extrapolated from Middle River to Lower River active zones downstream to the river's mouth. Figures 8 and 9 depict the discharges associated with the lower Susitna River active zones.
Acreages of these lower river active zones cannot be calculated because there are no area-discharge curves for the lower river that exceed discharges of 80,000 cfs.

Using stage-discharge curves for the Sunshine and Susitna Station U.S.G.S. gaging stations, maximum elevation changes in the Lower River active zones can be estimated. In the reach near Sunshine, the upper limit of the active zone will drop something less than 3.5 vertical feet between natural and late Stage III conditions. The lower limit will drop less than two feet in elevation during the same period. This is at least 20 percent less change

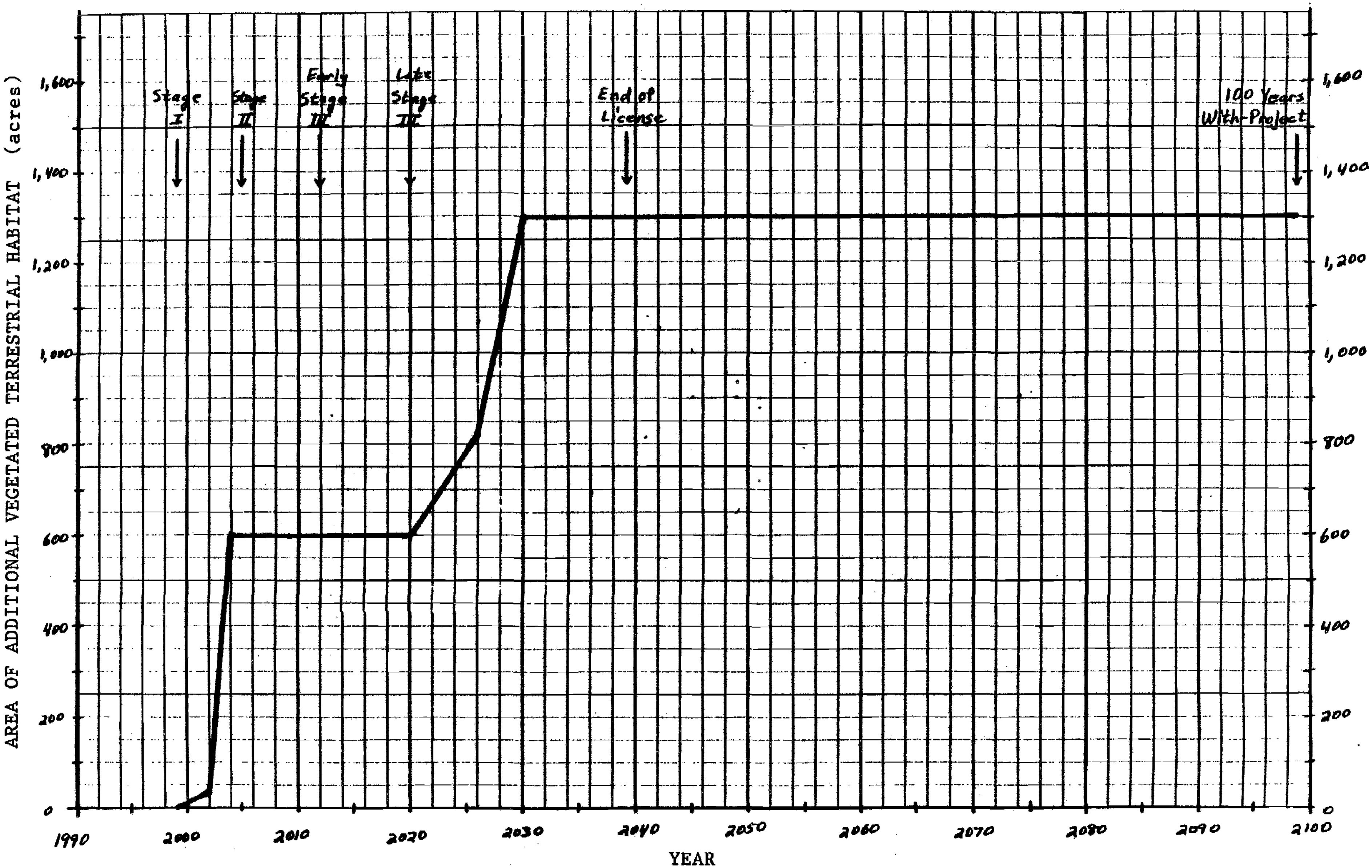

FIGURE 7. Acreages of additional terrestrial habitat in the riparian zone of the middle Susitna River, Alaska, with the Susitna Hydroelectric Project, as a result of project effects upon river flow regime.

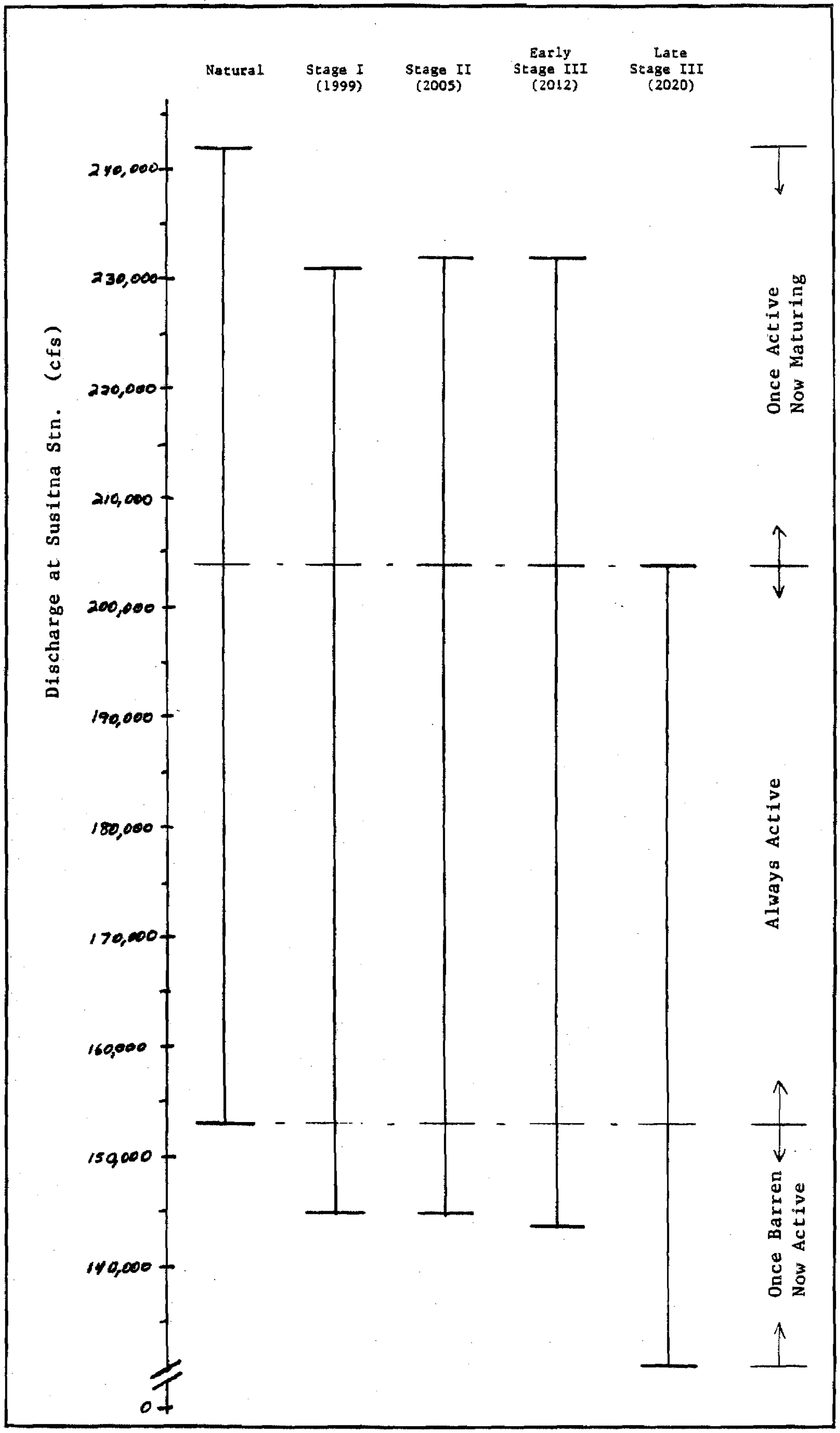

FIGURE 8. Discharges associated with active zones along the lower Susitna River, Alaska, from the Yentna River to the mouth of the Susitna River.

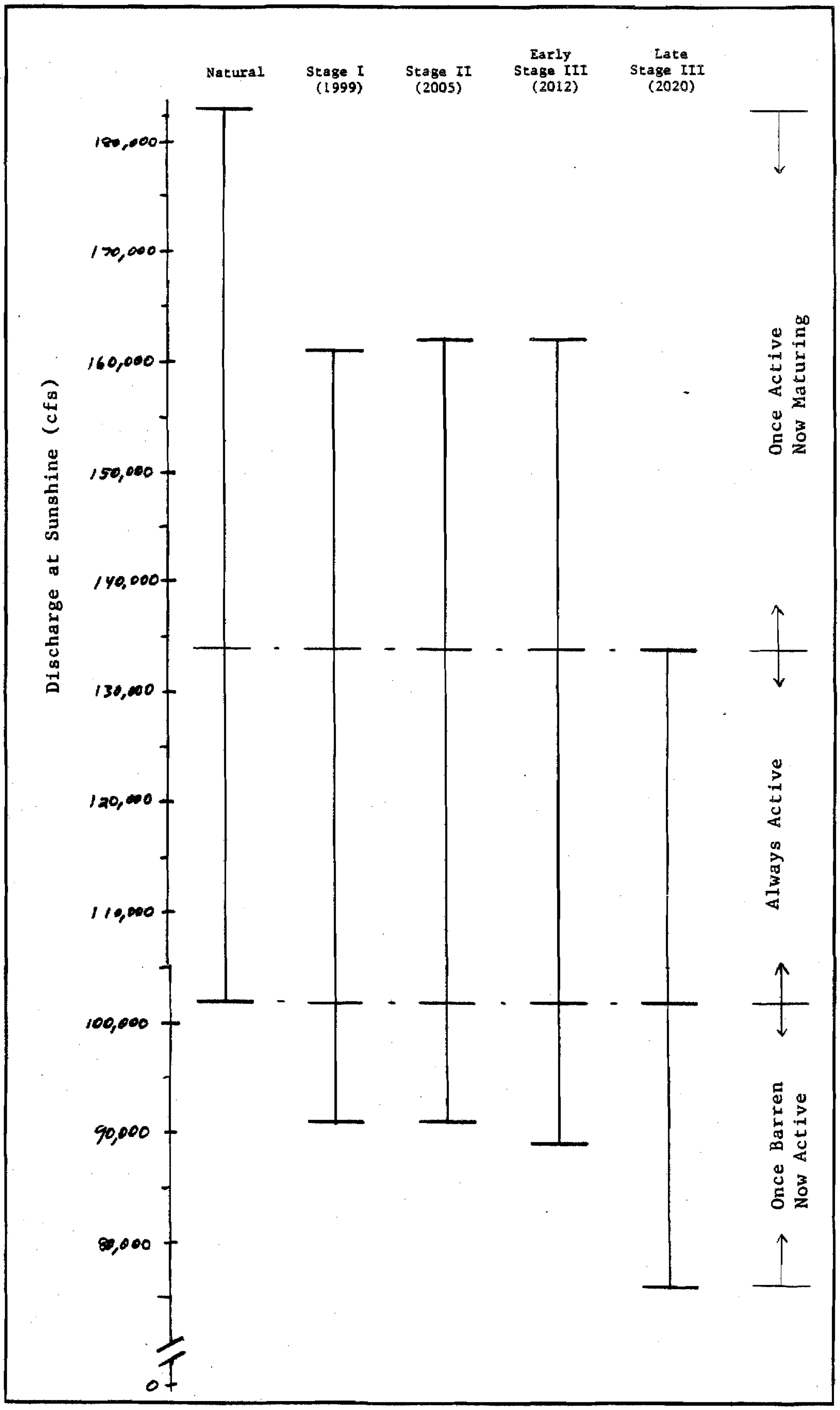

FIGURE 9. Discharges associated with active zones along the lower Susitna River, Alaska, from Talkeetna to the Yentna River.

than that seen in the Middle River. In the reach near Susitna Station, the expected upper limit change in elevation is less than two feet, while that for the lower limit is less than 1.5 feet.

We anticipate that the early and intermediate successional plant communities in the Lower River will increase in total area during the license period in much the same manner as the increases predicted for those communities in the Middle River. In fact, there will likely be a large net increase in these communities during and well after the license period. This will be due to the large surface area of gravel bars which are currently just below the lower limit of the active zone. These areas will become part of the active zone with-project, and develop into productive riparian communities. Since these communities will remain within the active zone, they will be comprised of early and intermediate successional species.

5.0 DISCUSSION

In general, the results of this study agree with our conceptual model (compare Figure 2 with Figures 3, 8, and 9). The major difference is that the model anticipated an incremental change in active zone with each project stage, while the results indicate that only two significant changes in plant communities occur: 1) between natural and Watana Stage I, and 2) between early and late Watana Stage III operations.

Both the absolute and relative magnitude of changes in the active zones under with-project conditions decrease downstream. This is largely due to the diluting effects of the Talkeetna, Chulitna, and Yentna River tributaries.

As shown in Figures 3, 8, and 9, there are three distinct areas of floodplain associated with changes in the active zone: areas active under natural conditions that mature with-project, areas active both with and without the project, and areas under water or barren under natural conditions which become active with-project. In the middle river, there is no area which is always active because the lower limit of the natural active zone is essentially the same as the upper limit of the late Stage III active zone.

The empirically derived upper and lower limits for the active zone make sense in a deductive manner. It seems reasonable that establishing vegetation must be entirely above water at least half of the growing season, and that colonization should therefore be able to proceed to some point below the mean annual flood. Information pertaining to short-term inundation survival is reviewed in Lee et al. (1982). The lower limit is also supported by the concept of the "dominant discharge", defined as the discharge which, if allowed to flow constantly, would have the same overall channel shaping effect as natural fluctuating discharges would (U.S.D.I. Bureau of Reclamation 1977). Under natural conditions in most rivers, the dominant discharge is equivalent to the 2-year flood. From Stage I operation through early Stage III, the middle Susitna River dominant discharge has been calculated as between 24,000 and 28,000 cfs. During late Stage III, it drops to 16,000 cfs (Harza-Ebasco 1985a). At the upper limit, flows greater than the 10-year flood generally do not substantially raise the water surface elevation for a fairly wide range of flood flows. Vegetation above this elevation is rarely subjected to disturbances and therefore matures. Mature trees are large enough to resist displacement due to flood flows, and therefore tend to fix the upper limit of the active zone.

A major assumption of the active zone vegetation analysis was that all underwater and barren areas exposed as the active zone moves down the bank are colonizable, and that vegetation invades these areas in five or ten years after exposure. These rates are based on substrate characteristics. Van Cleve and Viereck (1981) documented establishment of early successional communities along the Tanana River two to five years after exposure of bare surfaces. Helm et al. (1985) found a wide variety of times-to-colonization, but noted that early communities were generally in place five years after island stabilization. It is believed that the channel substrate between Devil Canyon and Talkeetna will slowly be scoured of its finer soil components, leaving mostly pebbles and cobbles on channel banks after some time (Harza-Ebasco 1985b). This loss of soil will occur as a result of high water events transporting smaller soil particles from the channel to locations downstream. At the same time, the Watana reservoir will capture essentially all incoming settleable soil particles. This process is common to downstream sections of rivers with reservoirs (Simons 1979, Williams and Wolman 1984). As presently understood, portions of the river channel wettable at dominant discharges or less will begin to be scoured of fine materials when Stage I is built. Scouring will begin at the dam and progress downstream, perhaps requiring 5 to 10 years to affect the Gold Creek area. In the Middle River, Bands 1 and 2 will not be affected by the scouring since they are vegetated at present. Band 3 will be affected to a slight or moderate degree, while Band 4 may be mostly large gravels and cobbles when exposed. The effect of this removal of soil material upon plant colonization rates is not quantifiable at present, but we felt that doubling the period for complete colonization of Band 4 compared to Band 3 (from five to 10 years) was a conservative estimate.

Ice processes are not expected to have any significant effects upon the vegetation scenarios presented in this report. In the Middle River, ice staging will expose establishing vegetation to stationary ice cover in portions of the with-project active zones. Although the vertical portion of active zone covered by ice will increase from Stage I through late Stage III, the number of miles of ice-covered middle Susitna River will decrease from about 45 to 15 miles during the same period. This ice cover may slow colonization of some sites and may reduce the annual growth of some species, but it is not expected to eliminate colonization or annual growth. Many creeks and rivers throughout Alaska have substantial amounts of riparian vegetation covered by ice when aufeis is formed. Middle River ice cover will vary from year to year, with many areas not affected by ice staging during dry years. These respites from ice effects should provide ample opportunity for colonization and establishment of plants on exposed substrates. In the lower Susitna River, the water level due to ice staging with-project will be at or a little above the mean summer flow level. Since this is below the lower limit of the active zone, ice will have little or no effect on vegetation in the Lower River active zones.

Some channel degradation is expected to occur in the Middle River, and there is a possibility of aggradation at the confluence of the Susitna River with the Chulitna and Talkeetna Rivers (Harza-Ebasco 1984b, 1985b; R&M Consultants, Inc. 1985b). By the time Stage III comes on line, there will likely be about one foot of degradation of the main channel in the Middle River, with eventual channel equilibrium being reached after 0.8 to 1.3 ft of degradation. This will not markedly effect the analysis in this report, and should actually increase acres of main channel bank available for colonization while decreasing the disturbance rate of colonizing slough and side channel banks. The acreage figures given in Table 1, therefore, can be considered as conservative estimates. Although some aggradation is expected near the Talkeetna confluence, the extent and ramifications of such an aggradation are presently unknown but expected to be of small magnitude (Harza-Ebasco 1984b).

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