Bear River/Bear Lake - Hydrologically, Where Would They Be Without Being Connected?

by

Norman E. Stauffer Jr., Ph.D., P.E., and Craig W. Miller, P.E.

Bear River/Bear Lake Model

A simplified model of the Bear River and Bear Lake was created to show the effects of not connecting the Bear River with Bear Lake. A map of the Bear River Basin showing the Bear River and Bear Lake is shown on Figure 1. A schematic of the simulation model is shown on Figure 2. The model operates on a monthly time step for the 70 year, 1923-1992 period. Reach gains were determined from historical flow data, at Alexander, Oneida, and Cutler Dam. The Flows at Cutler Dam were obtained by adding the Bear River Canal Company East and West Side canals to the Bear River at Collinston immediately below the dam. Monthly precipitation and evaporation estimates were made for Bear Lake. The model was then operated assuming that water from the Bear River would not be diverted into Bear Lake.

If Bear River flows were not stored in Bear Lake, historical irrigation diversions and return flows would have been affected from Bear Lake to the Great Salt Lake. The detail required to model this in depth is beyond the scope of this study. An approximation was used to back out the historical Bear Lake storage releases for irrigation. This was accomplished by distributing in percentages the flow changes from historical values during the irrigation season to the simulated land areas shown on Figure 2. These percentages are shown in Table 1. The return flows from the flow changes, positive and negative, were returned to the river with a 50 percent assumed depletion. Return flows to the river were lagged, 50 percent in the month of diversion, 30 percent one month later and 20 percent two months later.

Table 1. Assumed Distribution of Flow Differences from Bear Lake during the Irrigation Season to the Simulated Land Areas.

Land Area	Percent of Flow Difference From Bear Lake Diverted to Land Areas
Bear River at Alexander to Oneida.	10 %
Bear River at Oneida to Collinston	25 %
Bear River at Cutler Dam	65 %

Bear Lake Without Bear River

The model simulated the historical hydrograph of Bear Lake and an estimated hydrograph without diversions from the Bear River for the 70 year period. These hydrographs are shown on Figure 3. Since natural flow into the lake is nearly equal to lake evaporation, the model predicts Bear Lake would spill about three out of every nine water years. Nevertheless, most years the lake would approach spilling. During the dry period of the 1930s, the model predicts lake levels would only have dropped about six feet instead of 21 feet, approximately 30 percent of the historical fluctuation. Because Bear Lake stages would remain higher without Bear River storage and diversions, about 4,000 additional acre-feet of water would have been evaporated annually from Bear Lake. Table 2 summarizes some of the model simulation results for Bear Lake Elevations.

Table 2. Simulated Model Results for Bear Lake Elevations.

	Bear Lake Stage	
	With Bear Lake Irrigation Storage	Without Bear Lake Irrigation Storage
Average	5915.65	5922.00
Maximum	5923.65	5923.65
Minimum	5902.02	5917.44
Standard Deviation	4.62	1.58
Average Annual Fluctuation	3.33	1.02

Records of Bear Lake stage before it was used for a storage reservoir were made at Fish Haven by the U.S. Geological Survey. The record starts in October 1903 and goes to June 1906. There was no record for the spring and summer of 1904. The data is shown on Figure 4. It is not possible to tell from the 1903-1906 record what the absolute lake stage may have been since the record only shows changes relative to a datum of unknown elevation. The U.S. Geological Survey reported an observer, who had lived at the lake 33 years, said that 20 or 30 years earlier the surface of the lake had been about 3.5 feet higher. A definite high-water mark confirmed this report. This would make an observed fluctuation of about five feet on Bear Lake prior to construction of the inlet and outlet canals. This is consistent with the results of the simulation model.

Research related to U.S. Geological Survey Quadrangle Sheets surveyed in 1909 and 1910 show the high water level at that time to be near the present day high lake level of 5923.65 Utah Power and Light Datum. This is documented in a paper entitled "Bear Lake History and Operation" by Wallace N. Jibson, July 5, 1971.

Since evaporation from the lake surface nearly equals the natural flow into the lake, dissolved minerals from the natural inflow would be concentrated by about seven times before being discharged to the Bear River. Electrical conductivities of the Bear River were slightly lower, about 650 umho/cm or 420 mg/l total dissolved solids (TDS), than mid-Bear Lake values, about 700 umho/cm or 460 mg/l TDS in 1984. The natural inflow had roughly half the electrical conductivity of the Bear River inflow to the lake; 350 umho/cm or 220 mg/l TDS from Big Creek and 320 umho/cm or 210 mg/l TDS from Swan Creek. Assuming that these are typical values, if the connection between Bear Lake and the Bear River were eliminated, Bear Lake salinity could be expected to at least triple. Despite an expected rise in salinity, since total phosphorus levels in the Bear River are about seven times higher than the tributary inflow to Bear Lake, the aesthetic qualities of the lake might remain about the same if Bear River irrigation water were no longer stored in Bear Lake.

Bear River Without Bear Lake

The model simulated the historical monthly flows of the Bear River at Alexander, Oneida, and Cutler Dam for the 70 year period. The model was used to estimate the flows at these three points assuming no diversions to Bear Lake and only natural spills from Bear Lake. These hydrographs are shown on Figures 5 through 7. Without Bear Lake storage and diversions, peak average monthly flood flows would have been approximately 67 percent higher at Alexander, 65 percent higher at Oneida, and 25 percent higher at Cutler Dam. Flows in the summer and fall would have been significantly lower, unable to meet irrigation requirements. A summary of the model results for Bear River flows at Alexander, Oneida, and Cutler Dam are shown in Table 3.

Table 3. Simulated Model Results for Bear River Flows at Alexander, Oneida, and Cutler Dam including the East and West Side Canals.

Average Monthly Flows by River Station	With Bear Lake Irrigation Storage		Without Bear Lake Irrigation Storage	
	Peak Flow (cfs)	Minimum Flow (cfs)	Peak Flow (cfs)	Minimum Flow (cfs)
Bear River at Alexander	3724	62	5155	~0
Bear River at Oneida	4069	57	6255	~0
Bear River at Cutler Dam	7998	352	9915	~0

Conclusions

Make your own!

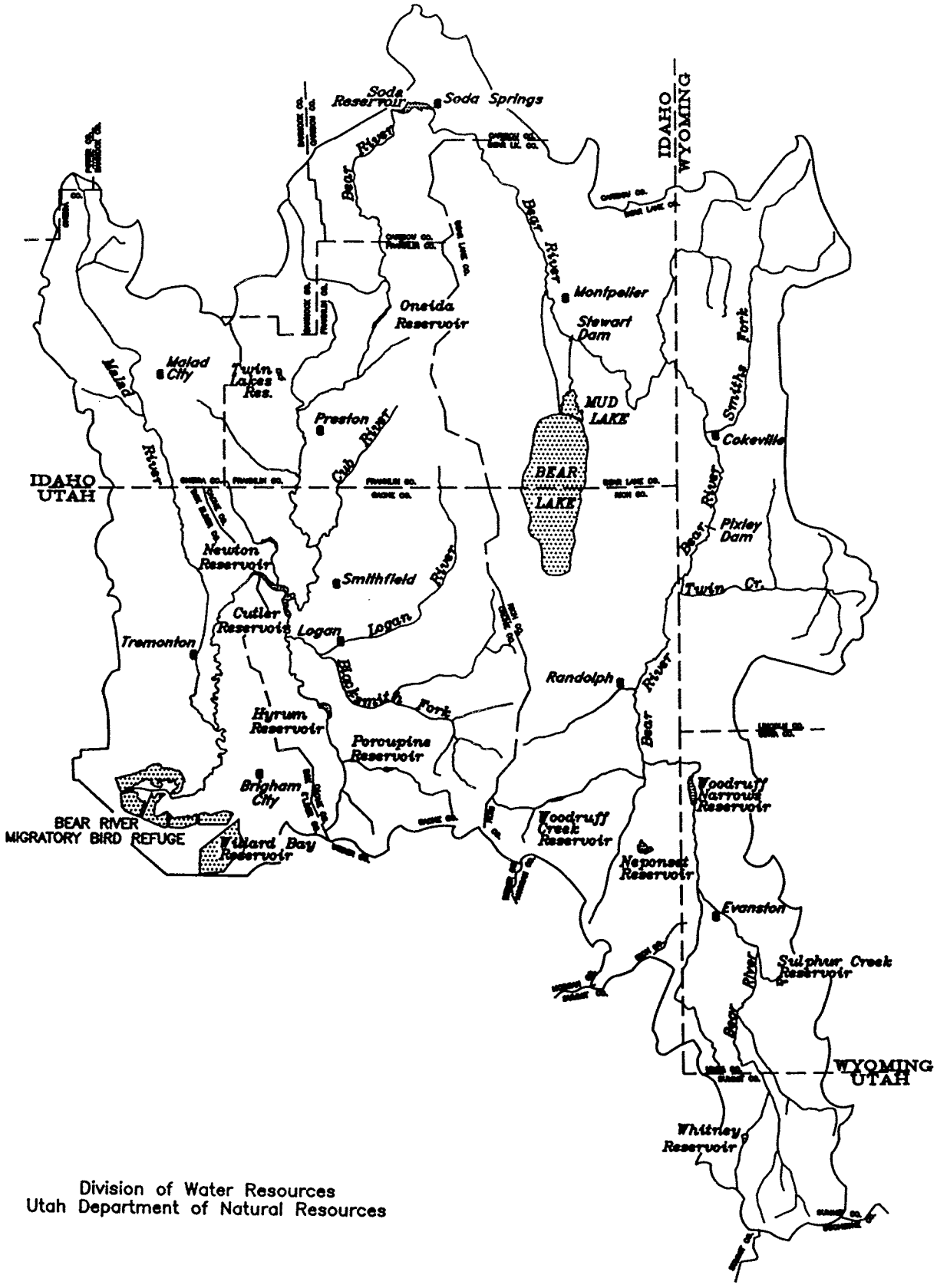
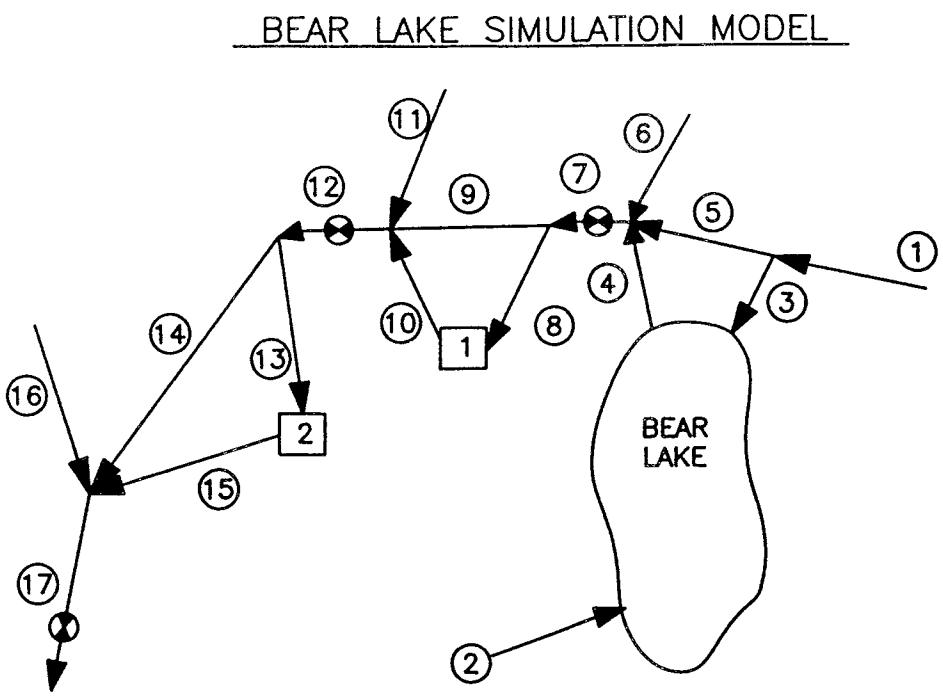


Figure 1. Bear River Basin Map.



MODEL FLOW LOGIC	
QX	DESCRIPTION
1	Bear River Above Bear Lake
2	Ungaged Bear Lake Inflow
3	Rainbow Inlet Canal Near Dingle, Idaho
4	Bear Lake Outlet Canal Near Paris, Idaho
5	Bear Lake Bypass
6	Alexander Reach Gain
7	Bear River at Alexander, Idaho
8	Bear Lake FLow Difference to Land Area 2
9	Bear River Between Alexander and Oneida
10	Land Area 1 Return Flow
11	Oneida Reach Gain
12	Bear River at Oneida, idaho
13	Bear Lake Flow Difference to Lane Area 2
14	Bear River Below Oneida
15	Land Area 2, Return Flow
16	Collinston Reach Gain
17	Bear River at Collinston, Utah East and West Side Canals.

Legend
(1) – Flow Number 1 (QX 1)
[1] – Irrigated Land Area Number 1
⊗ – USGS Gaging Station

Figure 2. Model Schematic.

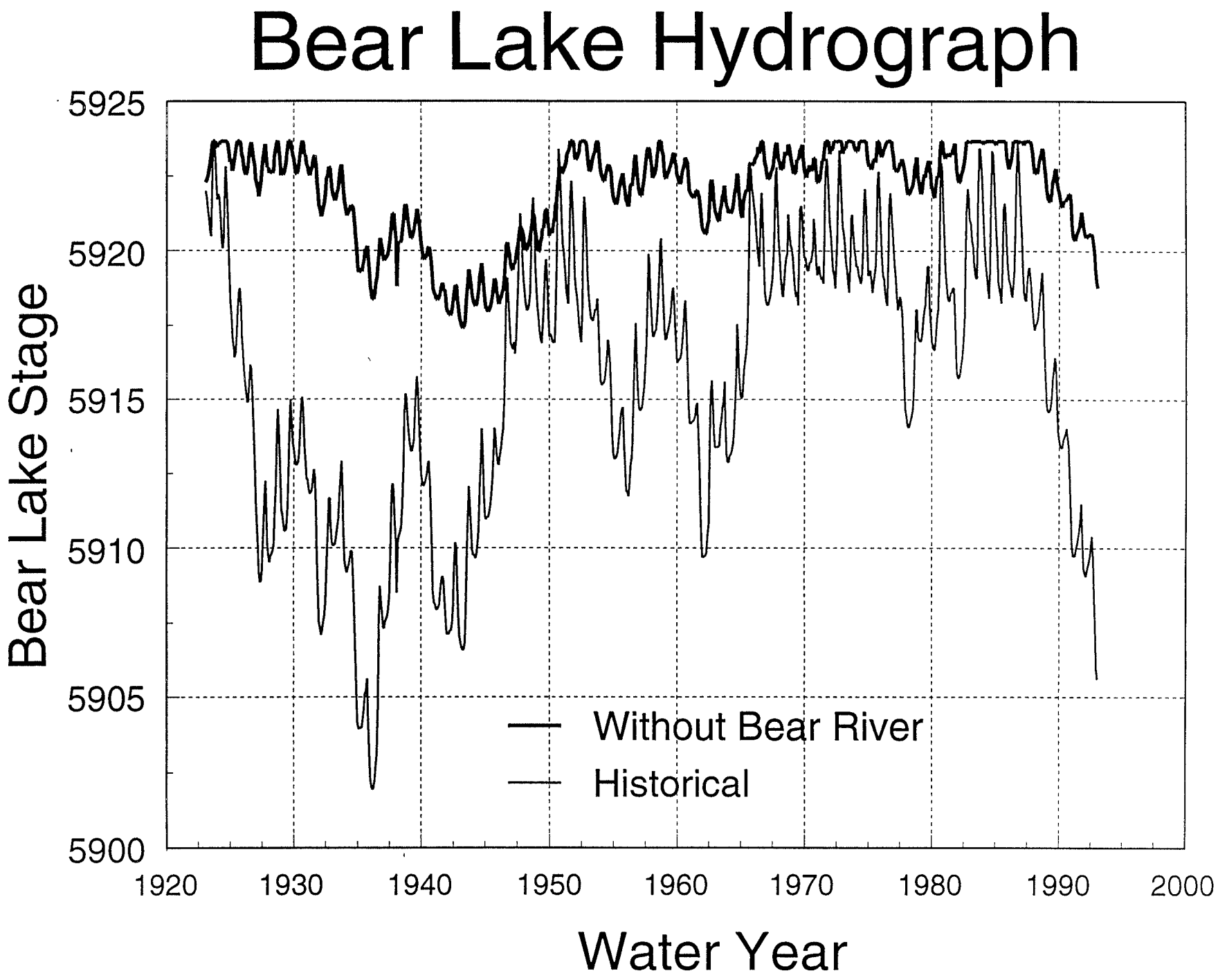


Figure 3. Bear Lake Hydrographs With and Without Bear Lake Irrigation Storage.

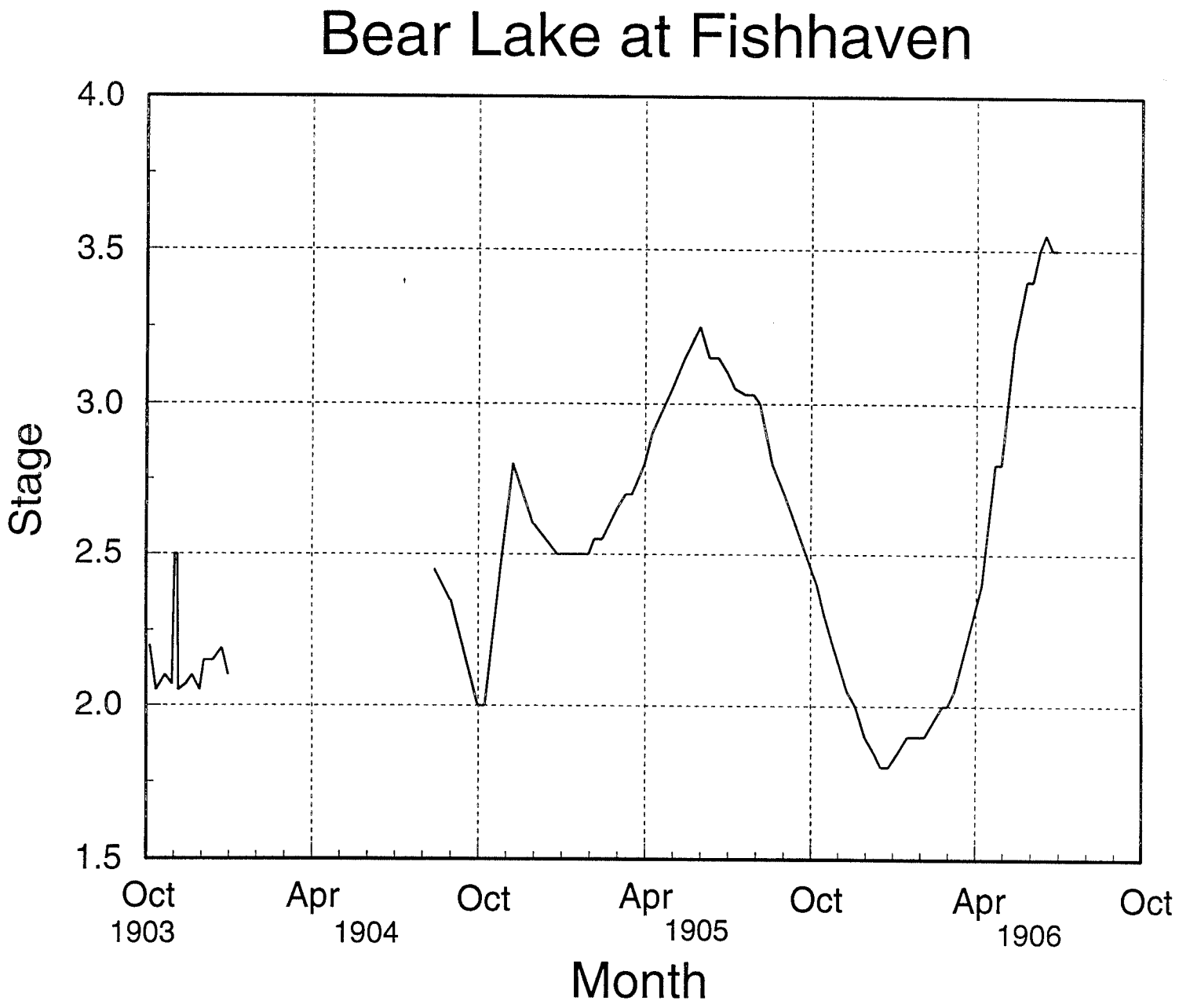


Figure 4. Bear Lake at Fishhaven.

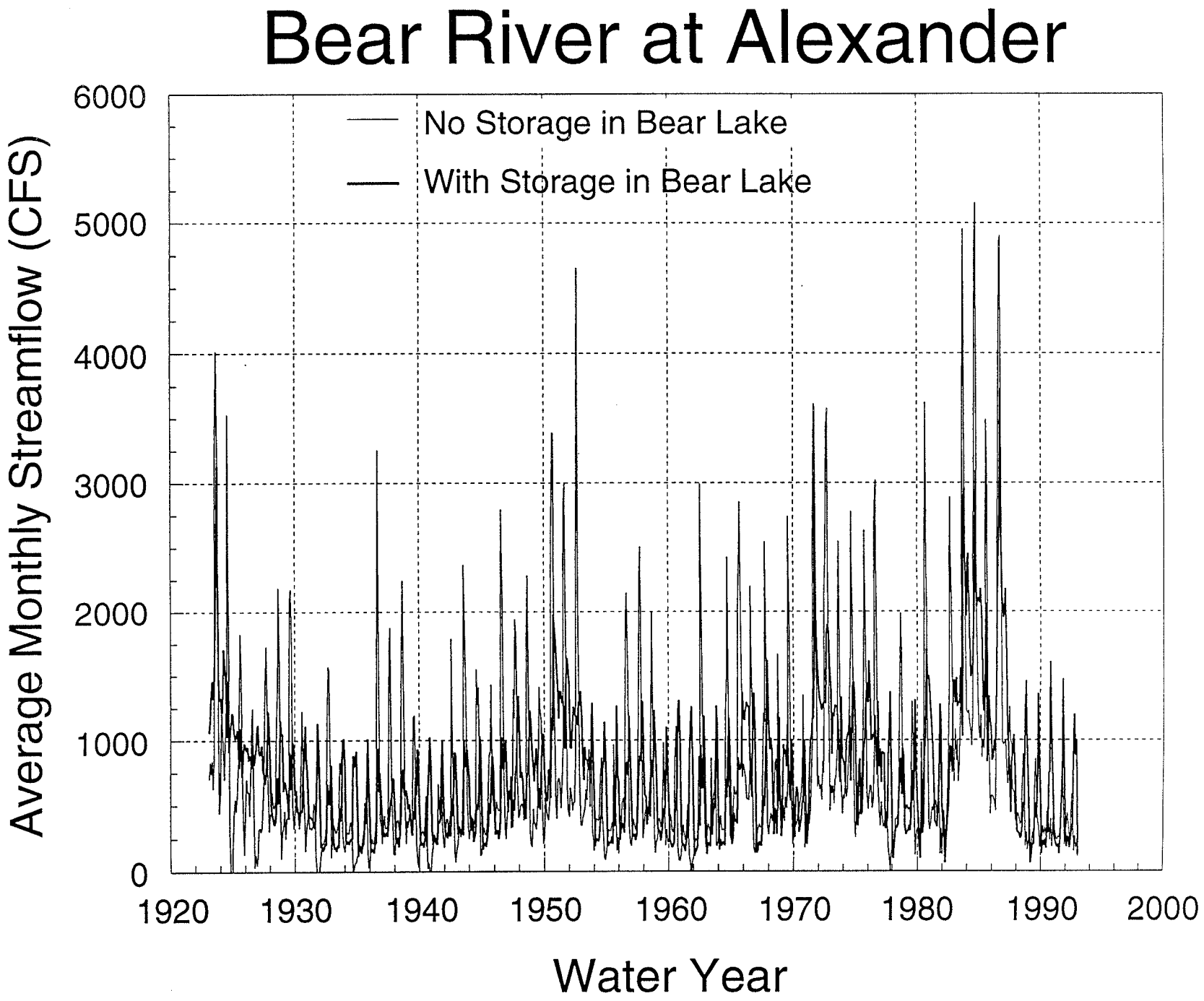


Figure 5. Bear River at Alexander, Idaho With and Without Bear Lake Irrigation Storage.

Figure 5. Bear River at Alexander, Idaho With and Without Bear Lake Irrigation Storage.

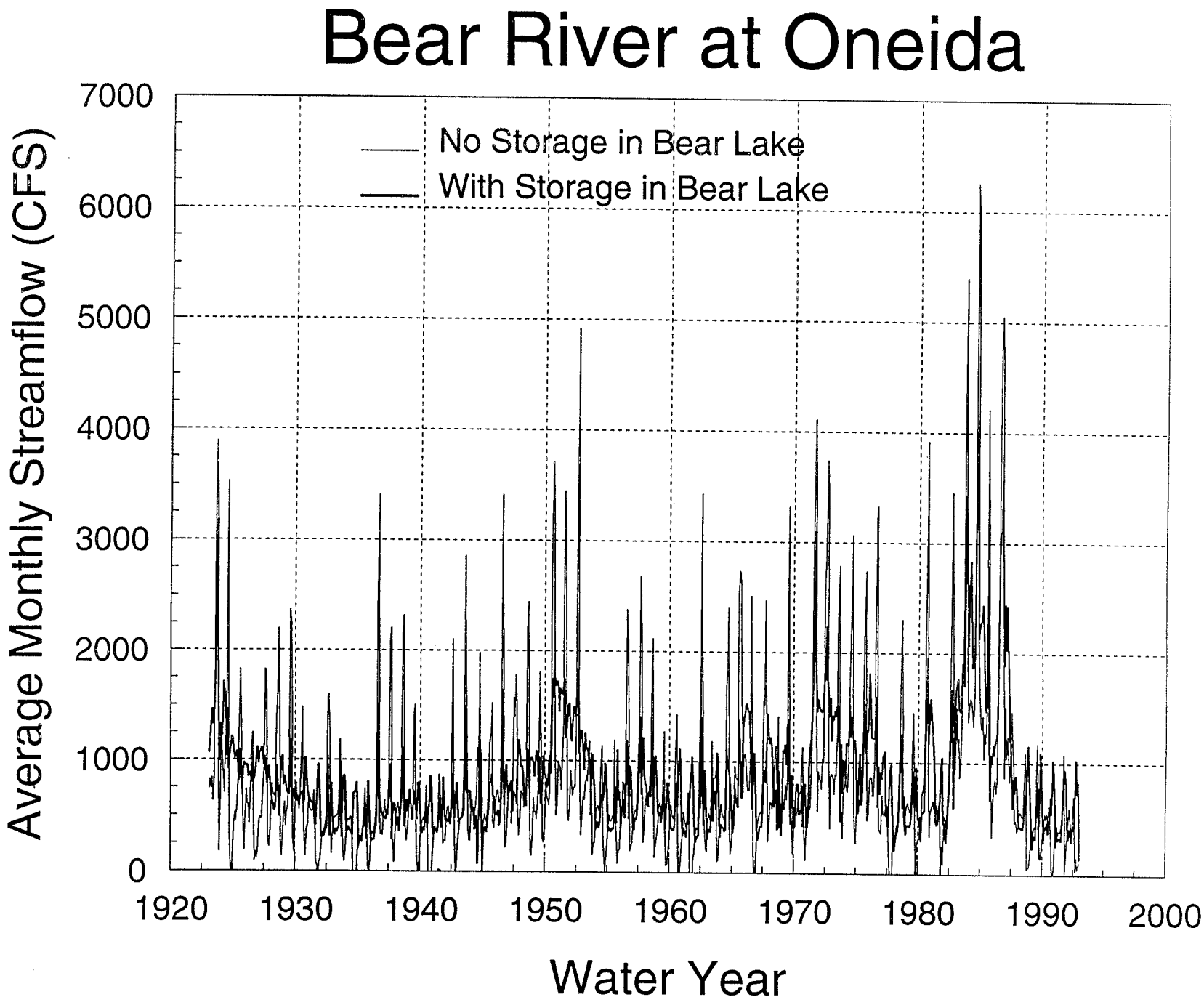


Figure 6. Bear River at Oneida, Idaho With and Without Bear Lake Irrigation Storage.

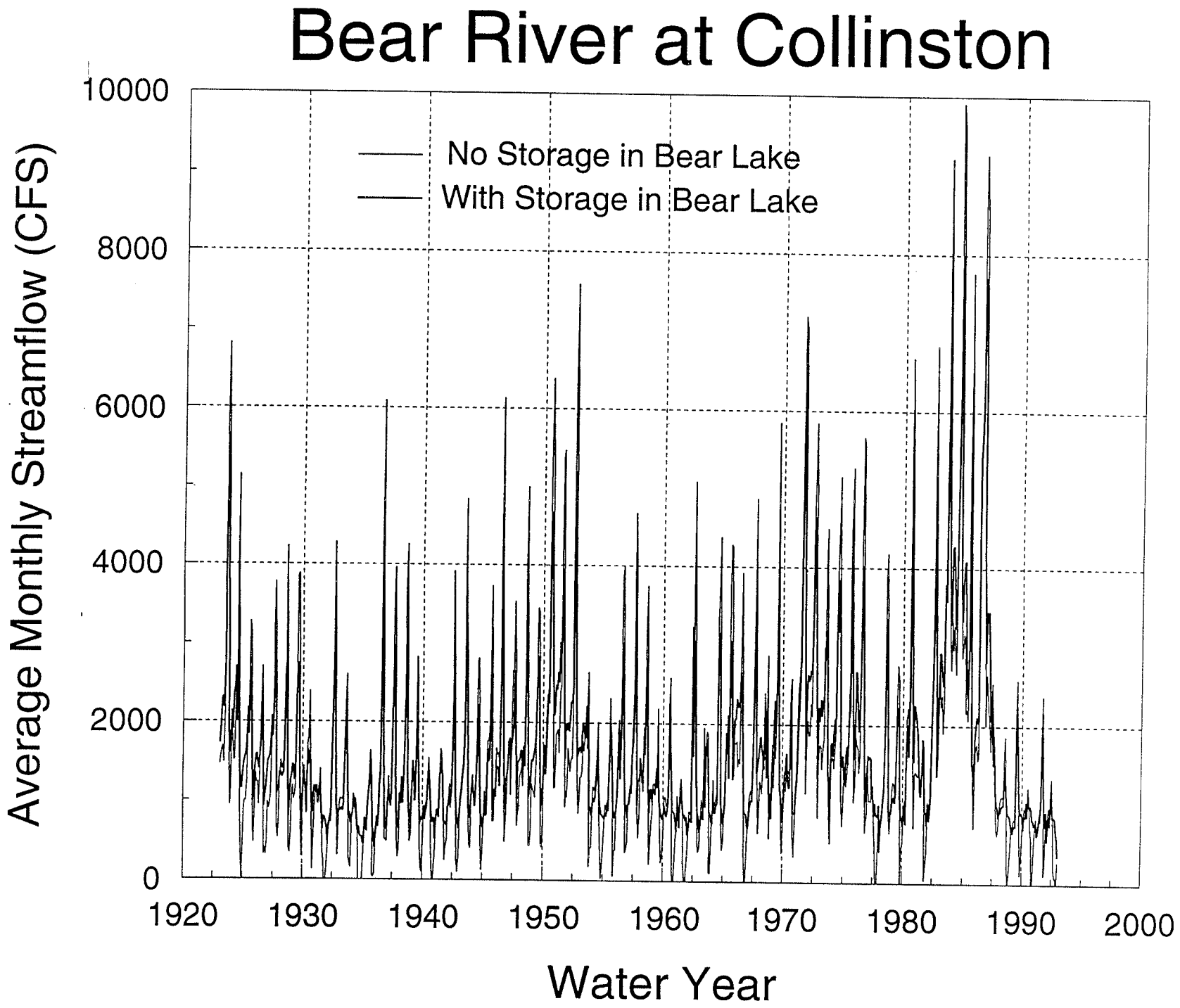


Figure 7. Bear River at Collinston, Utah With and Without Bear Lake Irrigation Storage.