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Cold Regions Research and Engineering Laboratory

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Ice Jam Formation Parameters in Selected U.S. Rivers

Steven F. Daly and Carrie Vuyovich

Month 2007

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Prepared for U.S. Army Corps of Engineers

Abstract: Ice jam formation parameters for the Platte, Yukon, Kuskokwim, Connecticut, Milk, Kankakee, Mohawk, and Salmon Rivers were determined. Information on the dates of jam occurrence and the latitude and longitude of each jam was found in the Ice Jam Database. Each ice jam was associated with the closest NWS meteorological station and the closest downstream USGS gaging station for which there were consistent records. The daily discharge and the accumulated freezing degree-days (AFDD) associated with each ice jam event were determined, along with the changes in discharge and AFDD in the time period immediately prior to each event. The type of jam was determined independently for each ice event based on the flow conditions immediately prior to the jam formation and the time of year that the jam occurred. Ice jams were classified as freezeup jams if the river discharge decreased prior to the ice jam formation, as indicated by the change in discharge over the previous five days. Any jam not classified as a freezeup jam was classified as a breakup jam. The ice jam parameter information is presented in the form of tables, histograms and overviews along the entire length of each river. Information on the day-of-year was used to classify the jam formation as progressive, semi-progressive, or non-progressive. Histograms of freezeup and breakup jams by the day-of-year and discharge show that the classification of jam type by discharge produces consistent and rational results. At select locations where ample ice jam data existed, detailed reviews of the ice jam formation parameters were conducted. These reviews separated the data for freezeup and breakup ice jams, and the breakup ice jams were then further divided into separate groups, with each group representing a range of AFDD.

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Contents

Preface ..... **viii**

1 Introduction **9**

2 Ice Jam Formation **13**

3 Ice Jam Database **15**

4 Parameters used in Analysis **16**

Accumulated Freezing Degree-Days. 16
DelA2, DelA5, DelA10. 17
Discharge 18
Days-to-peak 18
RBW Index 19

5 Present Analysis **20**

Presentation of the Analysis. 23
Overview of the river system and ice jam data *23*
Overviews of ice jam data along each river *24*
Detailed reviews of freezeup and breakup ice jam formation *26*

6 Ice Jam Locations **27**

Platte River 29
Introduction *29*
Overview *31*
Breakup jams on the Platte River *36*
Jams at the Platte River at Grand Island *39*
Yukon River 44
Introduction *44*
Overview *45*
Breakup jams on the Yukon River *46*
Kuskokwim River 51
Introduction *51*
Overview *52*
Breakup jams on the Kuskokwim River *53*
Connecticut River 56
Introduction *56*
Overview *59*
Breakup jams on the Connecticut River *63*
Jams at the Connecticut River at West Lebanon *66*
Milk River 71
Introduction *71*
Overview *72*

Breakup jams on the Milk River *76*
Kankakee River 79
Introduction *79*
Overview *80*
Ice jams on the Kankakee River at Wilmington *84*
Mohawk River 89
Introduction *89*
Overview *90*
Breakup jams on the Mohawk River *94*
Salmon River 97
Introduction *97*
Overview *99*

7 Summary 104

References 106

Appendix A. Bibliography 108
Connecticut River 108
Kuskokwim River 109
Milk River 109
Mohawk River 109
Allegheny River/Oil Creek 109
Platte River 110
Salmon River 111
Missouri River 112
Weiser River 113
Yukon River 114

APPENDIX B. Ice Jam Data 119
Platte River 119
Yukon River 129
Kuskokwim River 137
Connecticut River 144
Milk River 148
Kankakee River 153
Mohawk River 155
Allegheny River/Oil Creek 157
Missouri River at Williston, ND 159
Salmon River 161

Figures and Tables

Figures

Figure 1. Winter ice jam process overview. 21
Figure 2. Processes leading to freezeup ice jam events listed in the IJDB. 22
Figure 3. Processes leading to breakup ice jam events listed in the IJDB. 22
Figure 4. Location of selected ice jam sites throughout the United States. 28
Figure 5. Platte River. 30
Figure 6. All ice jam data for the Platte River 32
Figure 7. Histogram of ice events on the Platte River by date 34
Figure 8. Histogram of ice events on the Platte River watershed by AFDD. 35
Figure 9. Histogram of ice events on the Platte River watershed by discharge 36
Figure 10. Dates of ice events along the Platte River. 37
Figure 11. Discharges associated with ice events along the Platte River 38
Figure 12. AFDD's associated with ice events along the Platte River 39
Figure 13. Discharge recorded during ice events as a function of AFDD for the Platte River at Grand Island 41
Figure 14a-c. DelA10, DelA5, and DelA2 for ice events on the Platte River at Grand Island 42
Figure 15a-c. DelQ10, DelQ5, and DelQ2 for ice events on the Platte River at Grand Island 43
Figure 16. Yukon and Kuskokwim River. 44
Figure 17. All ice jam data for the Yukon River 45
Figure 18. Dates of ice events along the Yukon River. 47
Figure 19a-b. Discharges associated with ice events along the Yukon River 48
Figure 20. AFDD's associated with Ice Events along the Yukon River 51
Figure 21. All ice jam data for the Kuskokwim River 52
Figure 22. Dates of Ice Events along the Kuskokwim River. 54
Figure 23. Discharges associated with ice events along the Kuskokwim River 55
Figure 24. AFDD's associated with ice events along the Kuskokwim River 56
Figure 25. Connecticut River. 57
Figure 26. All ice jam data for the Connecticut River 59
Figure 27. Histogram of ice events on the Connecticut River by date 61
Figure 28. Histogram of ice events on the Connecticut River by AFDD. 62
Figure 29. Histogram of ice events on the Connecticut River Watershed by discharge. 63
Figure 30. Dates of ice events along the Connecticut River. 64
Figure 31. Discharges associated with ice events along the Connecticut River 65
Figure 32. AFDD's associated with ice events along the Connecticut River 66
Figure 33. Discharge recorded during ice events as a function of AFDD for the Connecticut River at West Lebanon 67

Figure 34a-c. DelA10, DelA5, and DelA2 for ice events on the Connecticut River at West Lebanon 69
Figure 35. DelQ10, DelQ5, and DelQ2 for ice events on the Connecticut River at West Lebanon 70
Figure 36. Milk River. 71
Figure 37. All ice jam data for the Milk River 72
Figure 38. Histogram of ice events on the Milk River watershed by day of year. 74
Figure 39. Histogram of ice events on the Milk River by AFDD. 75
Figure 40. Histogram of ice events on the Milk River watershed by discharge. 76
Figure 41. Dates of ice events along the Milk River. 77
Figure 42. Discharges associated with ice events along the Milk River 78
Figure 43. AFDD's associated with ice events along the Milk River 79
Figure 44. Kankakee River. 80
Figure 45. All ice jam data for the Kankakee River 81
Figure 46. Histogram of ice events on the Kankakee River Watershed by day of year. 82
Figure 47. Histogram of ice events on the Kankakee River by AFDD. 83
Figure 48. Histogram of ice events on the Kankakee River Watershed by discharge. 84
Figure 49. Discharge recorded during ice events as a function of AFDD for the Kankakee River 85
Figure 50. DelA10, DelA5, and DelA2 for ice events on the Kankakee River 87
Figure 51. DelQ10, DelQ5, and DelQ2 for ice events on the Kankakee River 88
Figure 52. Missouri River at Williston. ..... Error! Bookmark not defined.
Figure 53. All ice jam data for the MIssouri River at Williston, ND ..... Error! Bookmark not defined.
Figure 54. Histogram of ice events on the Missouri River at Williston by day of year. Error! Bookmark not defined.
Figure 55. Histogram of ice events on the Missouri River at Williston by AFDD. Error! Bookmark not defined.
Figure 56. Histogram of ice events on the Missouri River at Williston by discharge. Error! Bookmark not defined.
Figure 57. Relationship between AFDD and discharge associated with ice events for the Missouri River at Williston ..... Error! Bookmark not defined.
Figure 58. Mohawk River. 89
Figure 59. All ice jam data for the Mohawk River. All events are breakup jams. 91
Figure 60. Histogram of ice events on the Mohawk River watershed by day of year. 92
Figure 61. Histogram of ice events on the Mohawk River watershed by AFDD. 93
Figure 62. Histogram of ice events on the Mohawk River by discharge. 94
Figure 63. Dates of ice events along the Mohawk River. 95
Figure 64. Discharges associated with ice events along the Mohawk River 96
Figure 65. AFDD's associated with ice events along the Mohawk River 97
Figure 66. Salmon River in Idaho. 98
Figure 67. All ice jam data for the Salmon River 99
Figure 68. Histogram of ice events on the Salmon River watershed by day of year. 101
Figure 69. Histogram of ice events on the Salmon River by AFDD. 102
Figure 70. Histogram of ice events on the Salmon River by discharge. 103

Tables

Table 1. Number of ice jam events. 28
Table 2. Ice Jam, hydrologic and meteorologic information for the Platte River. 31
Table 3. Ice jam, hydrologic and meteorologic information for the Yukon River. 45
Table 4. Ice Jam, hydrologic and meteorologic information for the Kuskokwim River. 52
Table 5. Ice jam, hydrologic and meteorologic information for the Connecticut River. 58
Table 6. Ice jam, hydrologic and meteorologic information for the Milk River. 72
Table 7. Ice jam, hydrologic and meteorologic information for the Kankakee River. 80
Table 8. Ice Jam, hydrologic and meteorologic information for the Missouri River at Williston. ..... Error! Bookmark not defined.
Table 9. Ice jam, hydrologic and meteorologic information for the Mohawk River. 90
Table 10. Ice jam, hydrologic and meteorologic information for the Salmon River. 98

Preface

This report was prepared by Dr. Steven F. Daly and Carrie Vuyovich, Remote Sensing/GIS and Water Resources Branch and Ice Engineering Group, Cold Regions Research and Engineering Laboratory (CRREL), U.S. Army Engineer Research and Development Center (ERDC), Hanover, NH. Nathan Mulherin also contributed to this report.

The report was prepared under the general supervision of Timothy Pangburn, Chief, Remote Sensing/GIS and Water Resources Branch and Ice Engineering Group; Dr. Lance Hansen, Deputy Director; and Dr. Robert E. Davis, Director, CRREL.

The Commander and Executive Director of ERDC is COL Richard B. Jenkins. The Director is Dr. James R. Houston.

1 Introduction

The National Weather Service (NWS) is the federal agency charged with issuing "hydrologic ... forecasts and warnings for the United States ... for the protection of life and property and the enhancement of the national economy." Ice jams - initiated when myriad discrete ice pieces are concentrated in one reach of a river with a cumulative volume sufficient to impact the flow of the river - are widespread across the northern tier of the United States and Alaska and can potentially occur in all ice-forming rivers. Ice jams can cause sudden and devastating rises in water level that can lead to flooding with all its attendant woes and potential for disaster. Forecasting ice jams is an important component of wintertime hydrologic forecasting.

Ice jams result from the complex interplay of weather, river flow, river geometry, and the mechanical properties of ice; and as a result, are notoriously difficult to forecast. There is no standard procedure for forecasting ice jams at this time used by the NWS or any other agency. A variety of techniques have been tried, including threshold models (e.g. Shulyakovskii 1963, Wuebben et al., 1995, Tuthill et al 1996, White and Kay 1996, White and Daly 2002, Tuthill et al 2004, Vuyovich et al 2005); multiple regression models (e.g. Beltaos 1984); discriminant analysis (e.g. Zachrisson 1990, White and Daly 2002); artificial neural networks (ANN) (e.g. Massie et al. 2002); and fuzzy logic (e.g. Mahabir et al 2002). This variety of technique reflects the fact that, at this time, there is no clear consensus, or reason to expect that any clear consensus will develop, on the proper technique to be used for forecasting ice jams. In fact, it is not yet clear that any one technique could be applied to all situations. Certainly, one major bar to the widespread application of any or all of the techniques developed in the previous studies is their near complete lack of universality. The previous studies concentrated on jam formation at specific locations where flooding or other serious impacts occurred. The forecasting procedures they developed while often successful, are difficult, if not impossible, to apply beyond the specific location where they were developed. A review of the previous studies will show that the threshold parameters and their threshold values; the discriminant functions, regressions, and the "training" data for the ANN and fuzzy logic

procedures all reflect very site specific conditions and their utility over a broad range of river locations is unclear.

The goal of this report is to survey ice jam formation at a number of rivers across the continental United States and Alaska in a consistent manner, using parameters that are readily available at all locations. This report does not arrive at a standard procedure for forecasting ice jams, however desirable that aim may be. Rather it provides a consistent method for presenting the information on ice jams at a wide variety of locations. The hope is that this type of presentation will further understanding of the meteorological and hydrological conditions associated with ice jams, which in turn, will lead to improved forecasting of ice jam occurrence.

Three sources of information were used in this study. The first was the Ice Jam Database (IJDB) (White and Eames 1999) which includes information on ice jams reported by various sources in the United States. The IJDB provided two primary pieces of information: the dates of jam occurrence and their specific locations (the latitude and longitude of almost every jam is included in the IJDB). The second source of information was the NWS daily meteorological records for all CO-OP (NOAA 2001) and first-order stations (NOAA 1950–present). The NWS recorded provided one primary piece of information: the daily maximum and minimum temperature recorded at each station. This information was then used to estimate the accumulated freezing degree days (AFDD) for each day of each winter season. This data provides insight into the severity of the winter season; both seasonal, from the start of the winter season until the ice jam occurrence, and short term, in the immediate period prior to the ice jam occurrence The third and final source of information was the United States Geological Survey quality-assured records of daily average surface-water stream flow (USGS 2007). These records provided information on the discharge in the rivers and streams where the ice jams occurred. Generally the nearest downstream gage to the ice jam location was used to estimate the flow at the time of the ice jam. These three data sources were the exclusive sources of information on ice jams used in this study.

This information allowed the information in the IJDB to be investigated in a variety of ways; each designed to provide insight into the conditions of ice jam formation. First, each ice jam listed in the IJDB was associated

with the closest NWS meteorological station and the closest downstream USGS gaging station for which there were consistent records. These associations were made based on the location (latitude and longitude) of the ice jams provided by the IJDB and the locations (latitude and longitude) of the NWS meteorological stations and USGS gaging stations using GIS techniques. This allowed the meteorological conditions and flow conditions that occurred with each ice jam to be determined. Second, each jam included in the IJDB was determined to be either a freezeup jam or a breakup jam depending on the flow conditions immediately prior to the jam formation and the time of year that the jam occurred. (A discussion of freezeup and breakup jams is included below.) Some rivers are dominated exclusively by breakup jams; others are a varying mixture of breakup and freezeup. Histograms of the day of year, discharge, and AFDD that each type of jam occurs are shown for all jams for all rivers in the continental US. The essential differences under which freezeup and breakup jams occur can be seen. Third, an overview of the ice jam data along each river that had information for ice jams at a number of locations was developed. This allowed the day-of-year, the discharge, and the AFDD at which breakup ice jams tended to occur to be displayed according to their location along the river. This clearly indicated rivers along which ice jam formation was progressive (tending to move in time progressively downstream or upstream along the channel) or non-progressive (tending not to move in either direction). Progressive rivers tend to form jams at the end of the ice season, corresponding to the time of a “spring rise” in the discharge and a warming of air temperatures above freezing. Non-progressive rivers tend to form jams throughout the winter, and in some cases jams can occur starting from the time of the first ice cover formation. Fourth, at select locations where ample ice jam data existed, detailed reviews of the conditions under which freezeup and breakup ice jams occur were conducted. These reviews indicate the complex conditions that lead to ice jam formation.

Eleven known locations with known ice jam problems were originally selected for this study. These included the following rivers: the Platte, Yukon, Kuskokwim, Connecticut, Milk, Kankakee, Mohawk, Salmon (in Idaho), and Weiser; and two specific ice jam locations, the Missouri River at Williston and the Oil Creek confluence with the Allegheny River. Subsequent investigation revealed that the Weiser River lacked sufficient information, the Oil Creek confluence with the Allegheny River had highly

site-specific conditions involving the interaction of freezeup jams with breakup jams, and the Missouri River at Williston had continuously changing conditions due to aggradation and delta formation. As a result, these locations were ultimately not included in this study.

2 Ice Jam Formation

Ice jams are widespread phenomena that can potentially occur in all ice-forming rivers. Ice jams are initiated when myriad discrete ice pieces are concentrated in one reach of a river with a cumulative volume sufficient to impact the flow of the river. The formation of an ice jam reduces the conveyance capacity of the river channel for water flow by blocking a portion, or even all, of the flow area of the channel and increasing the overall hydraulic roughness of the channel wetted perimeter. This reduction in conveyance increases, often abruptly, the water surface elevation (stage) upstream of the jam. Sudden flooding can result when ice jams form or when they release. In addition to flooding, ice jams can destroy bridges, cause or induce bed and bank erosion, remove or damage channel bank vegetation, suspended navigation, and cause extensive damage to river training works and channel bank protection. In some areas ice jam flooding can be important source of water for upland marshes and wetlands. In areas where ice jams happen regularly they can be a necessary factor in creating and maintaining the near channel habitat. The impact of ice jams on fish and other aquatic river life has been little documented to date.

Two broad categories of ice jams can be defined based on the conditions in the river channel upstream of the jam location. *Freezeup jams* form where the upstream channel is largely ice-free. The steps of freezeup jam creation include ice formation, transport, and collection. The majority of ice collected in a freezeup jam—typically frazil ice, formed in fast flowing open reaches—is transported to the jam immediately after it has been created, without residing in any floating, upstream ice cover. The severity of a freezeup jam, as measured by its impact on stages, depends on the relative area of the river cross section in the collection zone that is blocked by ice. The general discharge and meteorological characteristics of freezeup jam are

- Tends to occur from early to mid winter when open water is available.
- The river discharge is decreasing with time.
- The air temperatures are below freezing. The below freezing air temperatures are required to generate the ice that is collected in the jam.

Breakup jams form where the upstream channel is largely ice-covered. In broad outline the steps of breakup jam creation include ice cover formation, ice cover breakup, ice floe transport, the convergence of transported floes, and flooding. Increases in river discharge, typically because of snowmelt, rainfall or releases from dams, tend to initiate breakup. Flow increases stress the river ice cover causing fractures and free the ice cover from the constraints of the channel banks. Once freed, the floes are transported downstream. The ice floes are broken into smaller floes as they are transported, reaching a final maximum dimension of roughly three to fives times the ice thickness. Ice jams occur at locations where the river's ability to transport the ice floes is exceeded by the volume of transported floes, and the ice floes converge and begin to collect. This can occur at abrupt decreases in channel slope, sharp bends, natural or man-made channel constrictions, or where an intact river ice cover remains in place. The severity of a breakup jam, as measured by its impact on stages, depends on the degree to which the jam reduces the channel conveyance capacity for water flow. Breakup jams are especially dangerous because they can form rapidly, causing up stream stages to rise quickly. The general discharge and meteorological characteristics of breakup jam are

- Generally tends to occur from mid winter to late winter but can potentially occur anytime during the winter after a stationary ice cover has formed.
- The river discharge is increasing prior to the formation of a jam. The increasing discharge stresses the stationary ice cover, lifts the cover removing the bank constraints, and causes the ice cover to fail and collapse. The pieces of the collapsed ice cover comprise the breakup jam.
- The air temperatures are generally at or above freezing. There is a general tendency for increases in discharges to be associated with warmer temperatures during which rain can fall or snowmelt occur.

3 Ice Jam Database

An on-going ice jam database developed by White and Eames (1999) includes the date, location (latitude and longitude), river, municipality, type and other information on over 14,000 ice jams and other river ice cover events that have occurred in the continental United States and Alaska. Although the ice jam type is one of the descriptors included in the ice jam database, the majority of entries in the database have been entered with "Unknown" type. This usually means that not enough information was available on the ice jam event to allow the type of jam to be determined directly from the IJDB itself. Historical information on river ice jams is limited. The major sources of data were the United States Geological Survey (USGS) report series that provides gaging station data collected for a study of the magnitude and frequency of floods (e.g., Green 1964); the annual USGS Water-Data Reports (e.g., Toppin et al. 1993); and in recent years, National Weather Service flood alerts. Additional sources include newspaper and historical records, such as town histories and government agency reports, and anecdotal reports by local residents obtained from personal interviews. In addition, focused collection efforts were conducted of specific regions. These regions include New Hampshire (Herrin et al 2000), Vermont (White 1995), Montana (Eames et al 1998), the Susquehanna River Basin (White 1999a), and within the boundaries of the St. Louis District of the Corps of Engineers (White 1999b).

4 Parameters used in Analysis

Accumulated Freezing Degree-Days.

The value of the accumulated freezing degree-days recorded at a site is a good indicator of the severity of the winter with respect to surface ice growth, frost penetration, and other impacts that arise through heat transfer to the atmosphere. The AFDD is a monotonically increasing function calculated as the sum of the positive difference between freezing and the average daily temperature for each day of the winter season. (If the average daily temperature is greater than freezing, the difference is ignored.) The AFDD on any day of the winter season, $AFDD_n$, represents the accumulated difference between freezing and the average daily temperature for the previous n days. The accumulation process starts each fall before the average daily temperature has dropped below freezing.

$$AFDD_n = \sum_{i=0}^{n} \left(T_m - T_i\right) \quad \text{for } \left(T_m - T_i\right) \geq 0 \tag{1}$$

where n = the number of days since the start of the winter season and T_m = the ice/water equilibrium temperature (32°F or 0°C). The average daily temperature T_i was estimated as the mean of the maximum temperature, T_{imax}, recorded on that day and minimum temperature, T_{imin}.

To demonstrate the utility of $AFDD_{max}$ to estimate maximum ice thickness, we start with the equation for surface ice growth on water bodies:

$$\frac{\partial \eta}{\partial t} = \frac{\phi}{\rho \lambda} = \frac{k_i}{\rho \lambda \eta}\left(T_m - T_s\right) \tag{2}$$

where

η = ice thickness
t = time
ϕ = heat transfer rate per unit area from the ice to the atmosphere
ρ = ice density
λ = latent heat of ice
k_i = thermal conductivity of the ice
T_s = temperature of the surface of the ice.

Note we are explicitly assuming that the ice growth occurs at the bottom surface; that the rate-controlling step is heat conduction through the ice cover; and that the temperature profile through the ice is linear. These assumptions are discussed elsewhere (US Army 2002); in general, they lead to useful and accurate estimates of ice thickness. If the surface temperature of the ice is assumed to be at the air temperature (a reasonable assumption if the heat transfer is effectively controlled by conduction through the ice cover), equation (2) can be solved as

$$\eta_n = \sqrt{\frac{2k_i}{\rho\lambda} \int_0^{t=n\,days} \left(T_m - T\right) dt} = \alpha\sqrt{AFDD_n} \tag{3}$$

where α varies depending on the physical location of the site of interest. For example, α varies from 0.2 for a small sheltered river to 0.8 for a windy lake with no snow cover, if AFDD is calculated using degrees Fahrenheit and the ice thickness is in inches (US Army 2002). The maximum ice thickness expected over the course of a winter can be found by using $AFDD_{max}$ in equation (3).

The annual maximum accumulated freezing degree-day were previously determined (Jones, et al 2004) for the continental United States using the daily maximum and minimum temperatures recorded at first-order National Weather Service stations and cooperative stations. (National Climatic Data Center 2001). This allowed us to determine the number of accumulated freezing days that had been measured at each NWS station associated with ice jam event.

DelA2, DelA5, DelA10.

The number of accumulated freezing degree days (AFDD) provides information on the severity of the entire winter up to the time of the ice jam event. It does not provide any information on the distribution of the freezing degree days throughout the proceeding winter. The distribution may be important, especially in the days immediately prior to the event. Periods of intense cold weather, as indicated by relatively large accumulations of freezing degree days, combined with open water often lead to massive ice production and the formation of freezeup jams. In order to investigate the distribution of AFDD's in the period immediately before each ice jam event, we determined the change in AFDD's over the

prior two days, *DelA2*; the prior five days, *DelA5*; and the prior ten days, *DelA10*.

$$DelA2 = AFDD_n - AFDD_{n-2} = \sum_{i=n-2}^{n} \left(T_m - T_i\right) \quad \text{for } \left(T_m - T_i\right) \geq 0 \tag{4}$$

$$DelA5 = AFDD_n - AFDD_{n-5} = \sum_{i=n-5}^{n} \left(T_m - T_i\right) \quad \text{for } \left(T_m - T_i\right) \geq 0 \tag{5}$$

$$DelA10 = AFDD_n - AFDD_{n-10} = \sum_{i=n-10}^{n} \left(T_m - T_i\right) \quad \text{for } \left(T_m - T_i\right) \geq 0 \tag{6}$$

Discharge

The average daily discharge associated with each ice jam event could be found from the USGS records at the nearest downstream gage as described above. The river discharge often is changing rapidly when ice events occur, and at time scales significantly shorter than one day. Unfortunately, access to discharge information at time scales shorter than one day was not possible in this study. Longer-term changes in discharge were determined for each ice event by finding the change in daily average discharge over the prior two days, *DelQ2*, the prior five days, *DelQ5*, and the prior 10 days, *DelQ10*. If the daily average discharge, Q_i, occurs on day i, then

$$DelQ2 = Q_i - Q_{i-2}$$

$$DelQ5 = Q_i - Q_{i-5}$$

$$DelQ10 = Q_i - Q_{i-10}\,.$$

Days-to-peak

The number of days required for the discharge to increase to the value recorded on the day of the ice event was determined in the following manner. The days-to-peak was set to zero at the beginning of the winter season. Each day that occurred on which the discharge was greater than the proceeding day by at least 50 cfs and greater than the base flow estimated for that winter, the days-to-peak was incremented by one. If these conditions were not satisfied on any day, the days-to-peak was reset

to zero and the accumulation restarted. The base flow for each winter was estimated as the average of the 40 lowest days recorded for that winter.

RBW Index

A variety of indices have been developed to characterize the flow regime of rivers. Generally, these indices are used to characterize natural flow regimes, the degree of alteration, and progress in remediation. There has been little effort in developing flow indices specifically to address ice jam formation although breakup ice jam formation is the often associated with a rapid change in discharge. The characteristic of "flashiness" is directly related to the change of flow – "flashy" streams have rapid rates of change and "stable" streams have slow rates of change. The dimensionless Richards-Baker Flashiness Index (*RB Index*) was developed to characterize the flashiness of a river flow regime (Baker et al 2004). The index is estimated as

$$RB\ Index = \frac{\sum_{i=1}^{n} \left| Q_i - Q_{i-1} \right|}{\sum_{i=1}^{n} Q_i}$$

Usually the index is applied over the period of one year. In this study, the *RB Index* was modified to cover just the winter period. The winter period was defined by the first day of AFDD greater than zero, and ended on the day when the AFDD reached 98% their maximum value for that year. This time range would vary from winter season to winter season. The resulting index, termed the *RBW index* (*RB-Winter Index*), was found over all the years in the period of record. In general, the closer the *RBW Index* is to zero, the more stable, and less flashy the flow regime of the river.

5 Present Analysis

The analysis was carried out in the following manner. First, the IJDB was interrogated to provide information on all ice events in the selected rivers and locations. This information included the date, location (latitude and longitude), type, etc. The date and location of each ice event were the only information used from the IJDB. As described above, the majority of entries in the database have been entered with "Unknown" type. As a result, the type of jam was determined independently for each ice event based on the flow conditions immediately prior to the jam formation and the time of year that the jam occurred, as described below. The jam locations then formed a GIS coverage that was combined with other GIS coverages including the locations of the NWS meteorological stations, USGS gaging stations, river layouts, and state boundaries. Each ice jam retrieved from the IJDB was then associated with the closest NWS meteorological station and the closest downstream USGS gaging station for which there were consistent records. The daily AFDDs recorded at all the NWS stations were calculated based on the recorded air temperature record and stored in a HEC-DSS database. The complete historical recorded for all the selected USGS gages were also stored in a HEC-DSS database. The DSS databases could be conveniently and efficiently searched to determine the meteorological conditions and flow conditions that occurred on the same day and immediately prior to each ice jam. All the parameters described in the previous section were then determined for each ice jam retrieved from the IJDB. At this point the following analyses of the data could be developed:

Each ice jam was classified as either a breakup jam or a freezeup jam using the flow chart in Figure 1 as a guide. The basic assumption was made that each jam listed in the IJDB was either a freezeup jam, and had followed the pattern in Figure 2; or was a breakup jam, and had followed the pattern in Figure 3. If the event had not followed either of these patterns, then it was assumed that it would not have been recorded in the IJDB. The first screen for determining freezeup jams was to select all ice jams for which the discharge had been consistently dropping immediately prior to the ice jam formation. This selection was made by including only those jams that had *delQ5* less than zero. This indicated that the discharge on

the day of the jam was less than the discharge five days before the jam had occurred. It was found that in the vast majority of cases, the *delQ10* and *delQ2* were also less than zero for these cases. As will be shown below, this criterion produces consistent results when the meteorological and other data is compared between the freezeup and breakup ice jams. All jams that were not classified as freezeup jams were classified as breakup jams. An additional criterion is required to rule out the possibility of freezeup jams on the Yukon, Kuskokwim, and Milk Rivers. As will be shown below, ice jams occur exclusively at the end of the ice seasons on these rivers. At this time, the rivers are largely ice covered and the jams form during relatively warm air temperatures; two conditions that are not conducive for freezeup jams to form. However, a few of ice jams on these rivers do have *delQ5* less than zero. Typically, these jams were located far from a discharge gage, so that the recorded discharge did not necessarily reflect the conditions at the jam site. These jams were eliminated as potential freezeup jams and included as breakup jams.

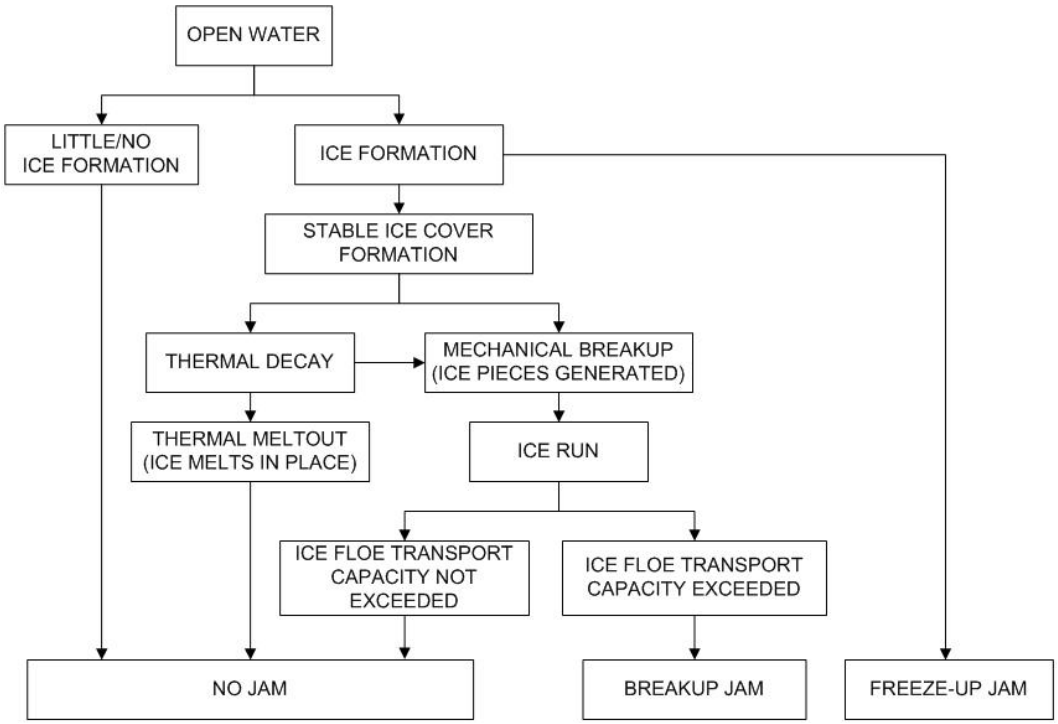

Figure 1. Winter ice jam process overview.

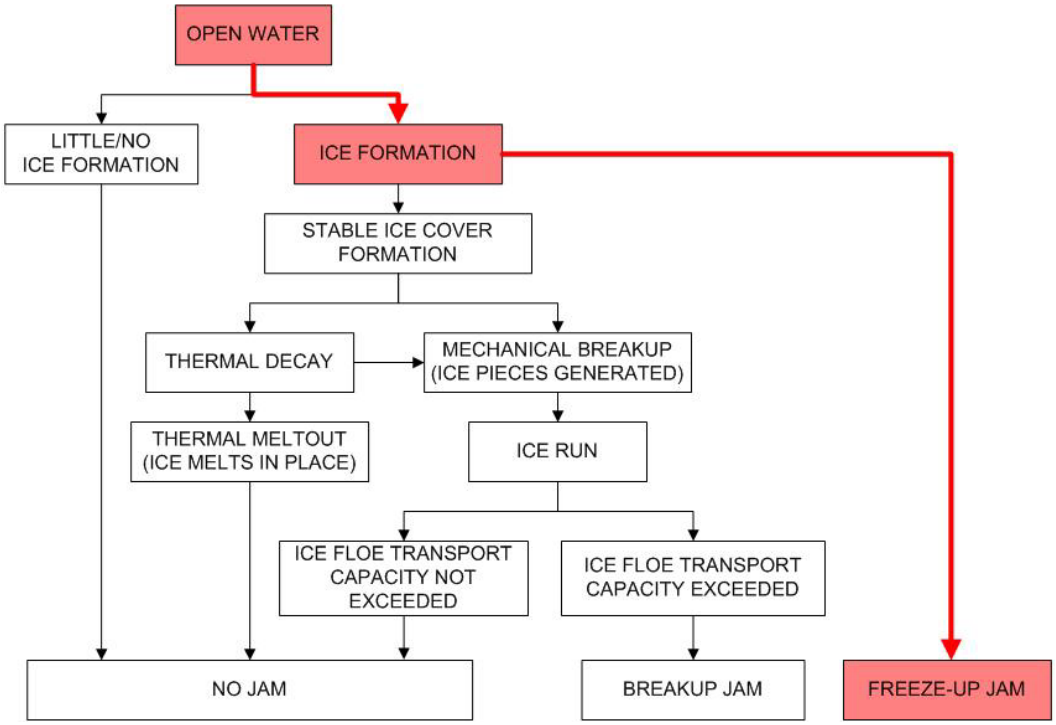

Figure 2. Processes leading to freezeup ice jam events listed in the IJDB.

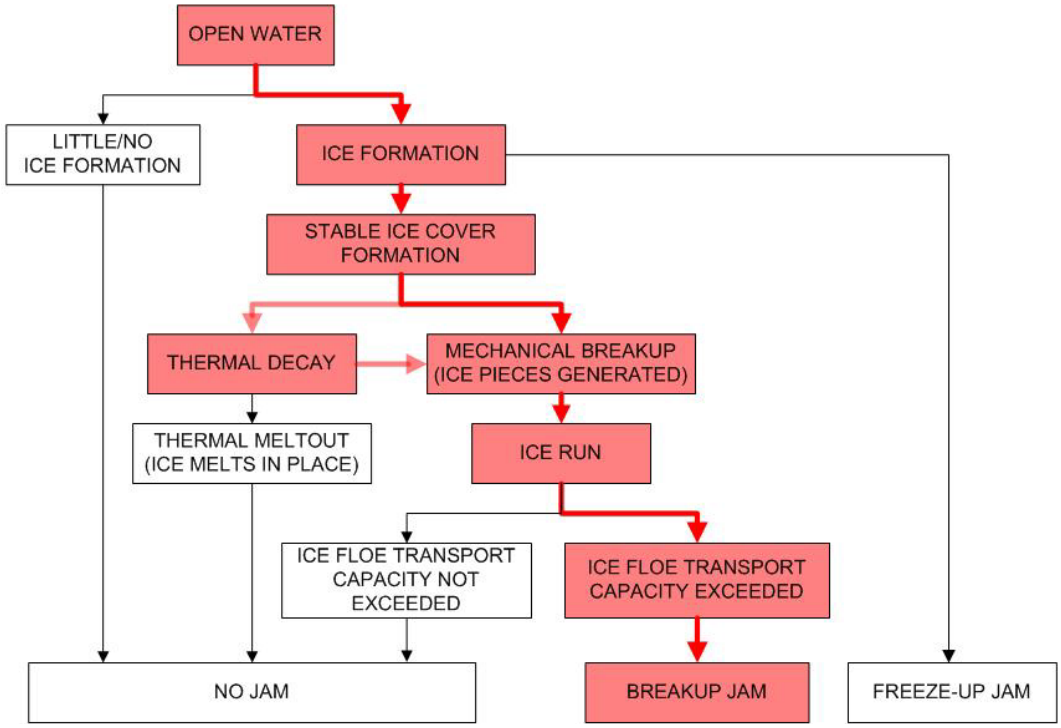

Figure 3. Processes leading to breakup ice jam events listed in the IJDB.

Presentation of the Analysis.

The ice jam data is presented in a consistent manner for each river system. First, the river system is briefly described. A map of the river system displaying jam locations, discharge gages, and NWS stations is presented. The information contained in the IJDB is also described and a chart showing the distribution of jams by year and day is presented. Then three sections are presented: an overview of the river system and ice jam data; the distribution of breakup jams along the river; and detailed reviews of freezeup and breakup ice jam formation at specific locations. These three sections are now described.

Overview of the river system and ice jam data

The existence of hydraulic structures, such as dams, and other conditions that could impact ice jam formation are briefly described first. The ice jam data is briefly reviewed and presented in the form of two tables. The first table divides the river into reaches defined by the discharge gage associated each reach. The number of freezeup jams, breakup jams and unknown jam types recorded in that reach is listed. Generally, jams are of unknown type if the discharge gage associated with that reach was not operational during the recorded jam event. Information is also presented on the contributing drainage area at the gage; the recorded long term average discharge at the gage, the average annual maximum accumulated freezing degree days in the area of the gage; and the RBW Index estimated for the flow recorded at that gage. The second table presents specific information on the ice jams recorded in each reach. In the case of the Yukon and Kuskokwim Rivers, where the distances between gages is large, the information is presented for each specific location along the rivers where ice jams were recorded. The information is divided between breakup jams and freeze up jams. Breakup jam information includes the average day-of-year that the jams occurred; the average AFDD recorded when the jam occurred; the average time to peak; the daily average discharge on the day that the jam occurred; and the estimated base flow. Freezeup jam information includes the average day-of-year that the jams occurred; the average AFDD recorded when the jam occurred; the daily average discharge on the day that the jam occurred; and the change in AFDD's over the prior two days, *DelA2*; the prior five days, *DelA5*; and the prior ten days, *DelA10*.

Next, histograms of the day-of-year, the discharge, and the AFDD at which all the breakup and freezeup jams for that river system occurred were developed for each river except for the Yukon and Kuskokwim Rivers. For these rivers it was felt that the overview of the ice jam data along the river provided comparable and better information. In all cases, the ice jam data from all sites on each river was included the histograms. The data for freezeup and breakup ice jams was kept separate, but shown on the same graph. The size range of the bins used in the histograms was adjusted to provide a balance between the number of bins and the number of events per bin.

Overviews of ice jam data along each river

An overview of the ice jam data along each river that had information for ice jams at a number of locations is then presented. These included the Platte, Yukon, Kuskokwim, Connecticut, Milk and Mohawk Rivers. The criteria for developing an overview was that at least two or more breakup ice jams had to be recorded for three or more sites along the river. The overviews of ice jam data are displayed in three separate graphs for each river. Each graph displays the river extending from the upstream reaches on the left side of the graph to downstream reaches on the right side. The first graph displays the average day-of-year when ice jams occurred along the river and the standard deviation around that value. The second graph displays the average discharge and the standard deviation around that value. Also shown in the second graph are the average *DelQ10* (red line), average *DelQ2* (black line), and annual average discharge at each location (pink triangle).The third graph displays the average AFDD and standard deviation associated with the events, and the average annual maximum AFDD at each location (Orange triangles).

Any overall pattern in the average dates of breakup ice jams along the river channels can be revealed by the first graph. Rivers with a trend in the average dates of ice jams along the channel can be labeled as “progressive”. By progressive it is meant that the average dates tend to occur consecutively in time in a consistent downstream or upstream direction. As applied in this report, the term “progressive” does not require that the average dates be strictly consecutive in time along the channel – some variation in the dates is allowed - as long as the overall trend along the channel is consistent. Alternatively, a river can be labeled “non-progressive” if the average dates do not consistently occur consecutively in

either direction. Further, a river can be labeled “semi-progressive” if ice jams occur progressively only along a portion of its length but not the entire length included in this study. It is important to remember that the patterns are based on the average dates of breakup ice jams and indicate general trends. Any progressivity shown in the graphs may or may not occur in any specific year.

The second overview presents the distribution along the river of the average of the discharges recorded on the same day as the breakup ice jams. The discharges are based on the recorded daily average flows measured by the USGS gages at the downstream end of each reach of the river in which ice jams were recorded. Rivers with few gages present a problem in determining the discharge at each ice jam location, especially if the distances along the channel are great; both the Yukon and Kuskokwim Rivers fall into this category. Special efforts are made to overcome this problem along the Yukon by estimating the discharge at ice jams locations using an interpolation scheme presented below. Unfortunately, no interpolation scheme was forthcoming for the Kuskokwim with the limits of this study. The *DelQ10* (red line) and *DelQ2* (black line) provide information on the average change in flow prior to the ice jam. The relative magnitude of the *DelQ10* and *DelQ2* compared to the ice jam discharge are indicative of the pattern of flow changes leading up to the ice jam. If both are relatively small compared to the discharge at breakup, the discharge was increasing relatively slowly prior to the ice jam. If the *DelQ10* is a relatively large fraction of the discharge at breakup, then the discharge increased relatively quickly, with the time scale of the average rise indicated by the relative fraction of the ice jam discharge formed by the *DelQ10* and *DelQ2*. Also shown on this overview is the annual average discharge at each gage location based on the period of record of the gage. This information can be used as a scale to place the ice jam discharges in the context of the overall range of discharges recorded at each gage. As will be seen, with some notable exceptions, most ice jams occur at discharges at or below the average annual discharge.

The third overview presents the distribution along the river of the average of the seasonal AFDD’s recorded on the same day as the breakup ice jam. The AFDD’s are based on the recorded air temperatures at the NWS station associated with each ice jam location. Also shown is the average annual maximum AFDD’s for each NWS station based on the period of

record of the station. Recall that the AFDD's as developed for this report are monotonically increasing with time and reach a maximum each season on the day that the daily average air temperature rises above 0°C (32°F) for the final time in the spring. As before, this information can be used as a scale to place the ice jams in the context of the overall range of AFDD's recorded at that station.

Detailed reviews of freezeup and breakup ice jam formation

At select locations where ample ice jam data existed, detailed reviews of the conditions under which freezeup and breakup ice jams occur were conducted. These reviews separated the data for freezeup and breakup ice jams. At these locations, the breakup ice jams generally occurred throughout the winter season. To further analyze the data, the breakup ice jams were then divided in separate groups, with each group representing a range of AFDD. The jams that fell into each group were then analyzed as a group. The results are then presented for the freezeup jams and four or five groups of breakup jams. The data provided includes the discharge, delQ10, delQ5, delQ2, AFDD, delAFDD10, delAFDD5, and delAFDD2 for the freezeup jams and each group of breakup jams. Each graph displays the mean, extremes, and limits of the first and third quartiles of the data in each group. It was felt that quartiles would provide a better representation of the data than other measures such as standard deviation, given the large variability of the data.

6 Ice Jam Locations

Eleven known locations with known ice jam problems were originally selected for this study. These included the entire length or major portions of the following rivers: the Platte, Yukon, Kuskokwim, Connecticut, Milk, Kankakee, Mohawk, Salmon (in Idaho), and Weiser; and two specific ice jam locations, the Missouri River at Williston and the Oil Creek confluence with the Allegheny River (Figure 4). Subsequent investigation revealed that while the Weiser River has 19 events listed in the IJDB, only five of the events occurred during period when USGS surface water information was available. As a result, there was not enough information on ice jams for this river to warrant an investigation. It was also decided not to include the Oil Creek confluence with the Allegheny River and the Missouri River at Williston, SD, in this study. The Oil Creek confluence with the Allegheny is a highly site-specific ice jam site involving the interaction of freezeup jams on the Allegheny River with breakup jams forming at the mouth of Oil Creek. This location has also been the object of several previous studies (Deck and Gooch 1981, Massie et al. 2002). Williston, North Dakota, is located very near the upstream end of Lake Sakakawea, the reservoir formed by Garrison Dam on the Missouri River. It has been observed that aggradation and delta formation has occurred in the Lake Sakakawea headwaters since construction of the Garrison Dam project in 1953 and the filling of Lake Sakakawea in about 1965. These changing conditions are continuing through at least 2004 (US Army 2004). There is little likelihood that the IJDB results would reflect the present day conditions, and as a result, this location was not included in the study. There is one study on ice jams at this location (Wuebben et al. 1995).

Table 1. Number of ice jam events.

River	Date First Event	Date Last Event	Events
Platte	2/26/1905	2/4/2004	255
Yukon	5/10/1936	5/9/2003	210
Kuskokwim	5/1/1953	5/2/2004	191
Connecticut	12/19/1903	1/1/2001	94
Milk	3/5/1914	3/11/2004	51
Kankakee	1/21/1916	12/31/2001	39
Missouri at Williston*	2/24/1925	3/28/2004	38
Mohawk	3/28/1914	3/8/2004	35
Oil Creek*	3/26/1913	1/9/2001	31
Salmon	1/26/1920	1/17/1997	26
Weiser*	1/6/1923	1/10/1995	19

* Not included in present study

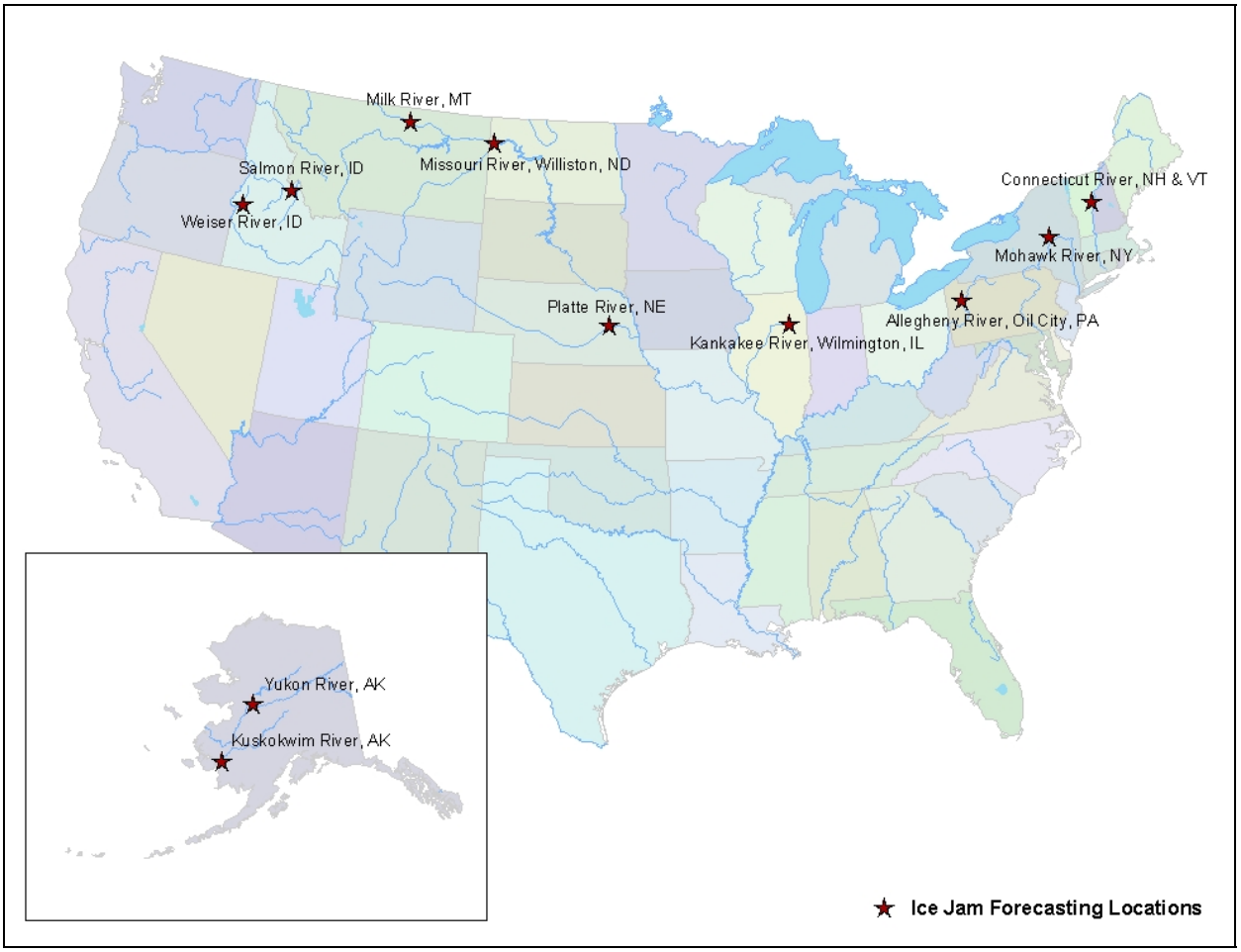

Figure 4. Location of selected ice jam sites throughout the United States.

Platte River

Introduction

The Platte River (Figure 5) is a tributary of the Missouri River, approximately 310 mi. (499 km) long. It drains 90,000 square miles including a large portion of the central Great Plains in Nebraska and the eastern Rocky Mountains in Colorado and Wyoming. It is formed in western Nebraska east of the city of North Platte by the confluence of its two tributaries, the South Platte and the North Platte rivers, both of which rise in the eastern Rockies near the continental divide. It flows in a large arc across Nebraska.

At the time of this study, there were 255 entries in the IJDB for the Platte River and its two major tributaries, the North Platte and the South Platte Rivers, making it one of the best-documented rivers for ice jams in the United States (Table 2A). The active data collection program (Nebraska Department of Natural Resources 2006) undoubtedly contributed to the large number of IJDB entries. The dates of the jams recorded in the IJDB range more or less uniformly from the 1940's to the early 2000's. The day-of-year recorded in the IJDB ranges from early December through the middle of March (Figure 6). The Platte also has a relatively large number of discharge gages located along its length (Figure 5) and NWS meteorological stations (Figure 5) providing good documentation of the discharge and air temperature conditions during the winter.

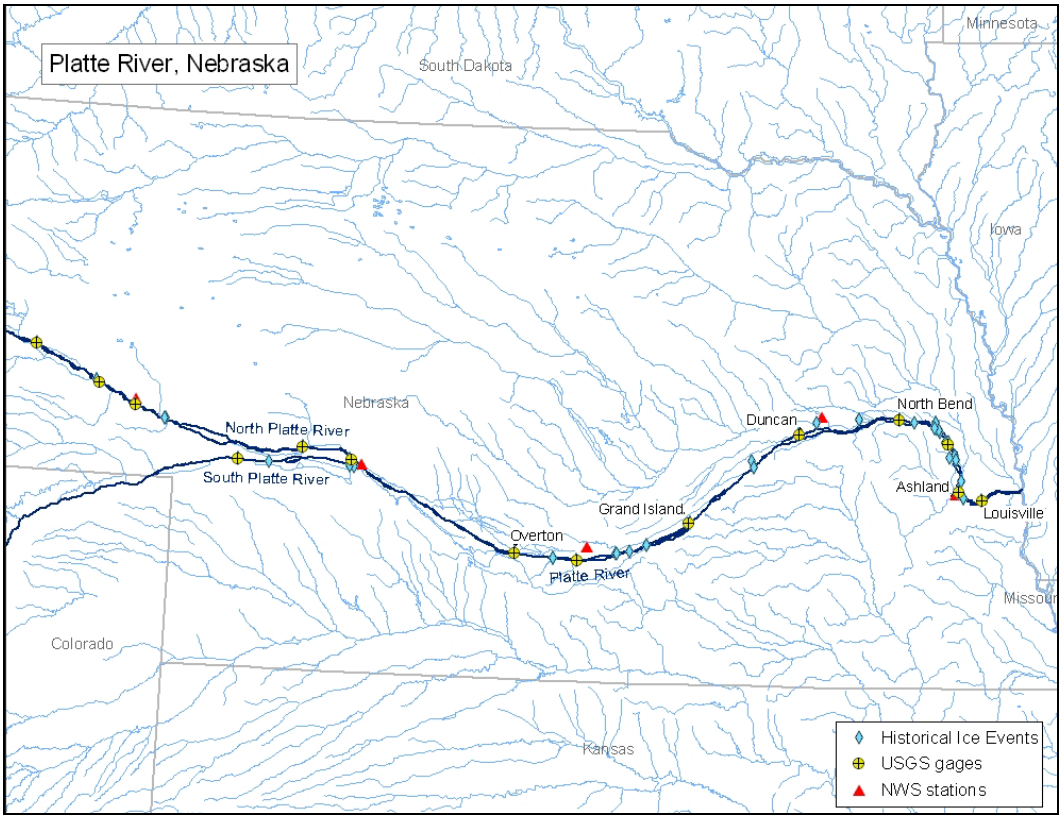

Figure 5. Platte River.

Table 2a. Ice Jam, hydrologic and meteorologic information for the Platte River.

River	Gage	Freezeup Events	Breakup Events	Unknown	DA (sq.mi)	Average flow (cfs)	Average Max AFDD's (°F)	RBW Index
N. Platte	Bridgeport	1	0	0	23300	1237	787	0.035
	N. Platte	9	1	1	26300	830	966	0.059
	Lisco	8	4	0	26700	1355	787	0.043
	Sutherland	1	2	0	29800	534	966	0.065
	Oshkosh	0	1	4	31400	1218	787	0.061
South Platte	Roscoe	2	1	17	23900	924	967	0.060
Platte	Overton	4	10	0	56300	1587	914	0.091
	Kearney	5	1	27	57260	2078	914	0.066
	Grand Island	7	35	1	57650	1542	914	0.107
	Duncan	5	30	0	59300	1788	970	0.094
	N. Bend	2	31	0	70400	4645	979	0.105
	Ashland	2	12	1	84200	2646	979	0.103
	Leshara	0	8	20		5673	979	0.083
	Louisville	0	2	0	85370	7078	979	0.100

Overview

Flows in the North Platte and South Platte Rivers are heavily impacted by dams and irrigation withdrawals. Flows in both rivers tend to be flat or slightly declining throughout the winter. These rivers rate as relatively "unflashy" on the RBW index. There is generally no spring rise on either river that coincides with the end of sub-freezing weather and the onset of snow melt. Winters in Nebraska in the areas of both rivers tend to be moderate with average recorded annual maximum AFDD's of approximately 900 AFDD (F). Ice jams on the North Platte tend to be largely freezeup jams (59%) with some breakup jams (29%). The remainder of the reported ice jams (16%) is of unknown type. A jam is generally classified as unknown when the gage associated with the jam was not reporting information at the time of the ice jam. Unfortunately, most of the ice jams reported for the South Platte are of unknown type.

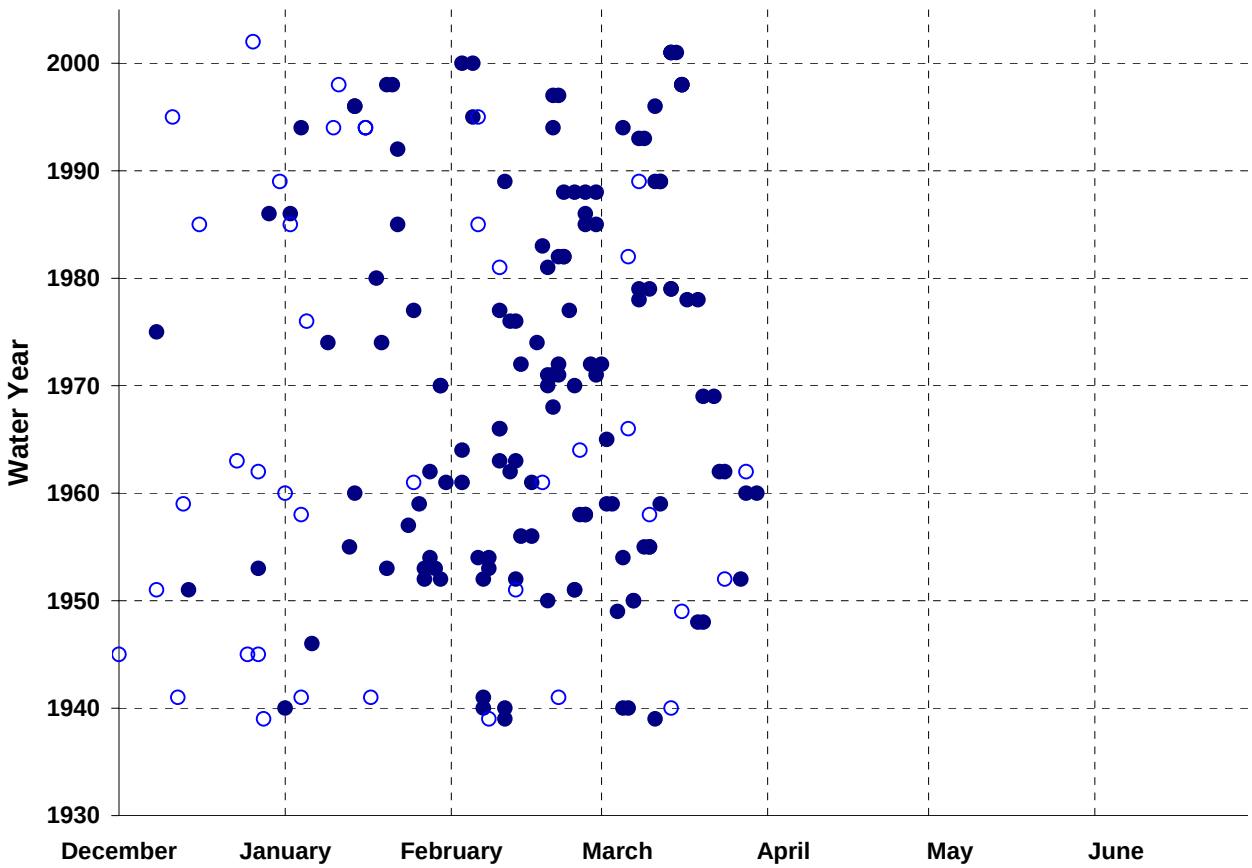

Figure 6. All ice jam data for the Platte River. Freeze up jams are open circles, breakup jams are solid.

There are no projects on the main stem of the Platte River. The flows in the main stem tend to decline starting in autumn until mid-January. In mid-January the flow begins to increase until a spring rise occurs, generally in mid to late March. The Platte is slightly more "flashy" on the RBW index. The majority of reported ice jams on the Platte River are breakup jams (64%) along with some freezeup jams (12%). The remaining jams are of an unknown type. The intensity of the winters is similar to that of the North and South Platte Rivers with average recorded annual maximum AFDD's of approximately 900- 1000 AFDD (F).

A general overview of ice jams on the on the North, South, and main stem of the Platte River are shown using three histograms that combines both the freezeup jams and breakup jams (Table 2B). The day-of-year when the ice jams occurred are shown first. (Figure 7). The histogram of freezeup jams peaks in late December and early January, although freezeup jams can occur throughout the winter season, from mid November through March. Breakup jams can also occur throughout the winter season,

starting in mid December through early April. The histogram of breakup jams peaks in late February through late March. This peak of the histogram for breakup jams coincides with the general peak of the spring rise.

Table 2b. Ice Jam Data for the Platte River.

River	Gage	Breakup Jams					Freezeup Jams					
		Average Day-of-Year	Average AFDD (F)	Average Time To Peak (Days)	Average Discharge (CFS)	Average Base flow (CFS)	Average Day-of-Year	Average AFDD (F)	Average Discharge (CFS)	DelA2 (F)	DelA5 (F)	DelA10 (F)
N. Platte	Bridgeport											
	N. Platte						1/14	364	686	22	29	34
	Lisco	2/3	456	1.2	1327	569	12/14	177	1021	25	62	86
	Sutherland	2/11	600		590	38						
	Oshkosh											
South Platte	Roscoe						12/29	233	1465	28	54	66
Platte	Overton	1/24	526	1.2	1360	479	1/19	539	1458	20	36	88
	Kearney						1/16	413	1630	31	77	124
	Grand Island	2/15	815	3.6	3865	619	12/28	439	1264	33	65	108
	Duncan	2/23	873	4.7	4671	620	12/20	793	1228	23	61	85
	N. Bend	2/25	882	6.3	15717	2164	11/28	343	3800	20	25	35
	Ashland	2/22	883	6.3	8550	2471	3/9	1066	3121	6	6	10
	Leshara		764	6.0	8513	3872						
	Louisville	2/25	1011	7.0	28500	3198						

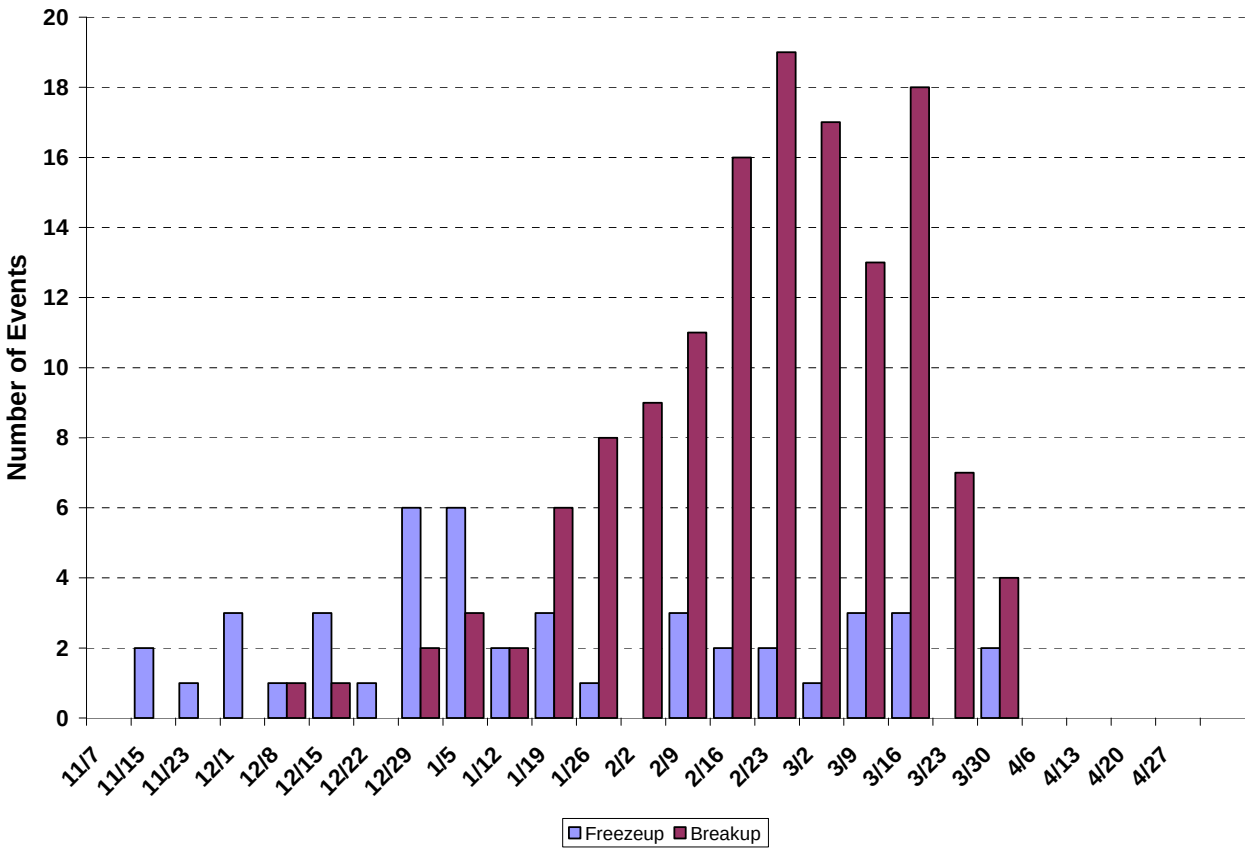

Figure 7. Histogram of ice events on the Platte River by date

The recorded AFDD's when all ice jams occurred is shown next. The histogram of AFDD associated with freezeup jams peaks much earlier, 200-300 AFDD (F), compared to the histogram associated with breakup jams, 700-900 AFDD (F) (Figure 8).

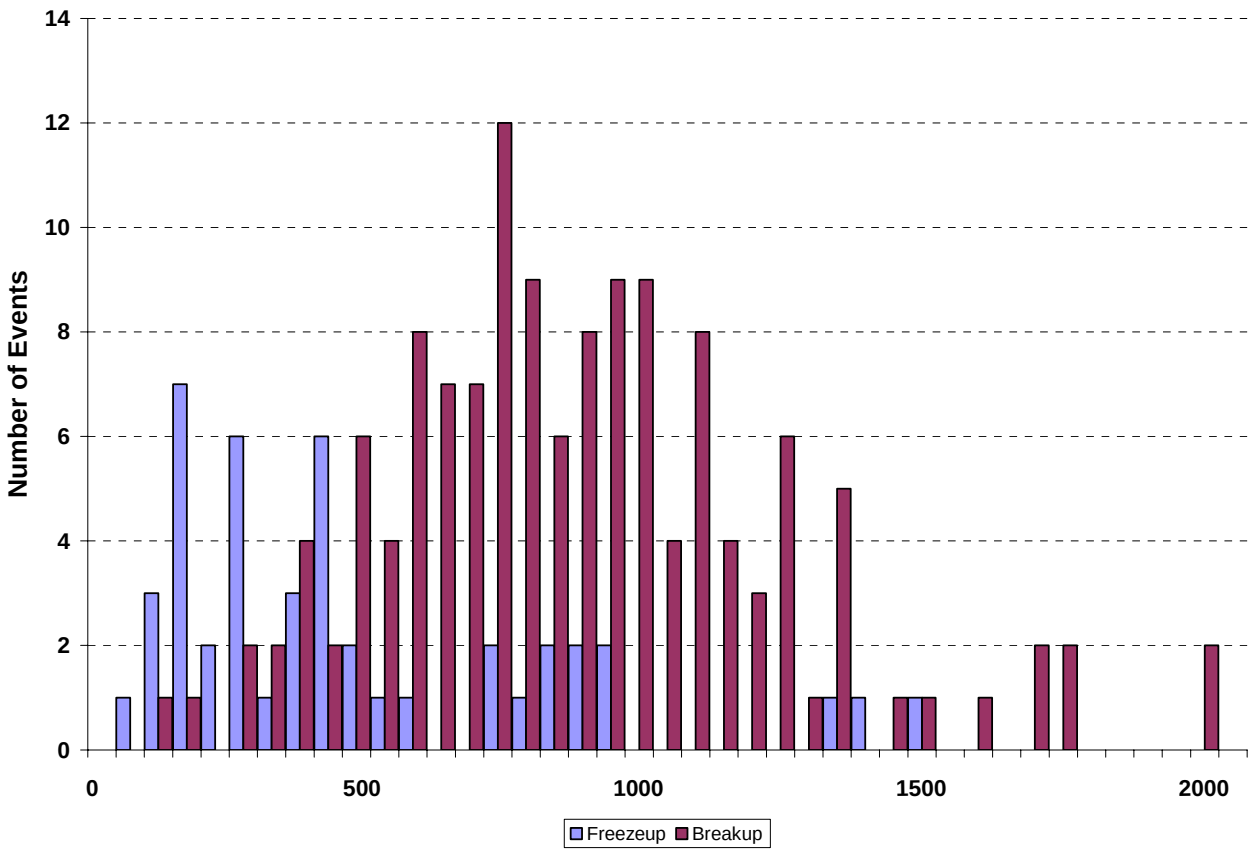

Figure 8. Histogram of ice events on the Platte River watershed by AFDD.

The histogram of discharges associated with freezeup jams peaks between 1000-2000 CFS (Figure 9). The histogram of discharges associated with breakup jams peaks between 3000-4000 CFS. The range of discharges for breakup jams is much larger than that of freezeup jams, extending from 500 CFS to 23,000 CFS, while the range for freezeup jams is much smaller, extending from 500 CFS to about 5,500 CFS. In summary, freezeup jams tend to occur earlier in the winter season, at fewer seasonal AFDD, and at lower discharges than breakup jams. However, there is considerable overlap of the ranges for all three of these parameters between freezeup and breakup jams.

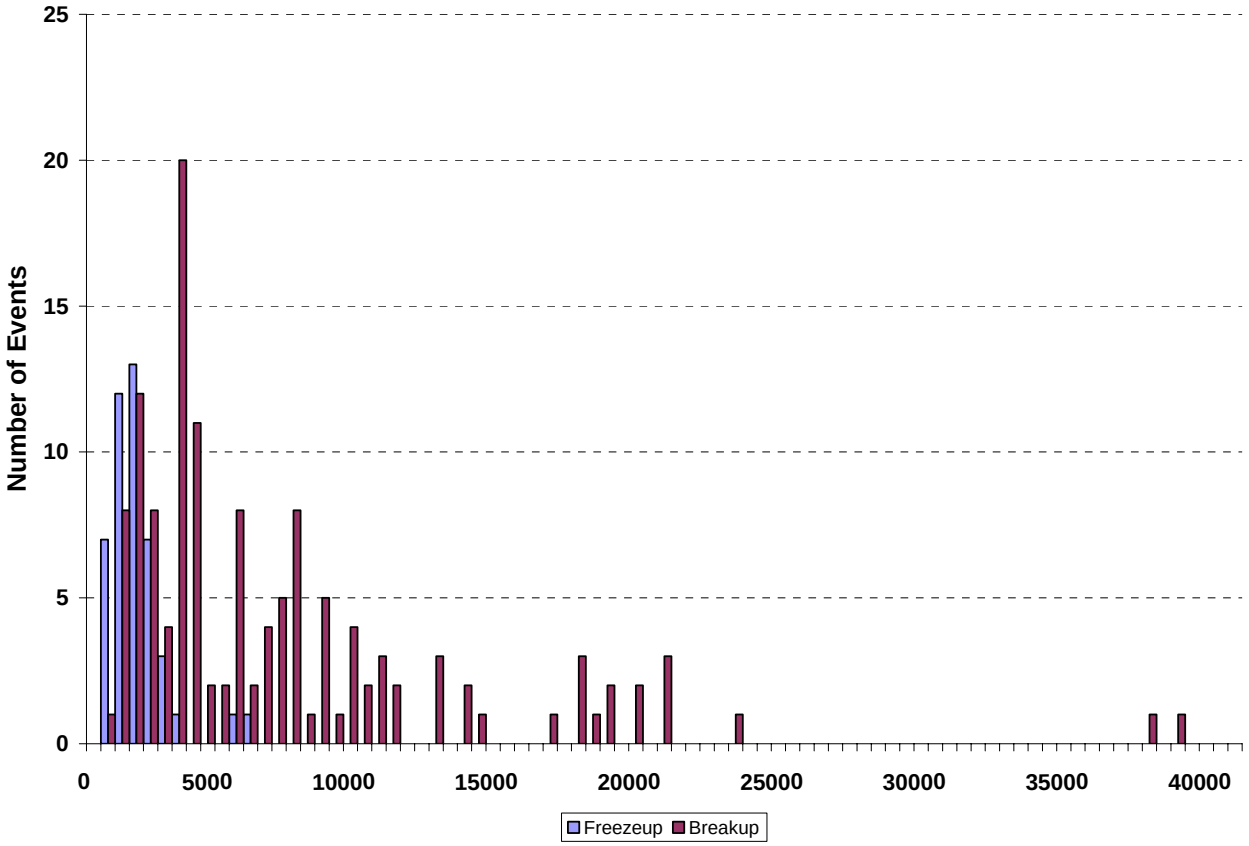

Figure 9. Histogram of ice events on the Platte River watershed by discharge

Breakup jams on the Platte River

Breakup ice jam formation on the Platte River can be considered to be partially-progressive as shown by the average day-of-year when breakup ice jams occurred (Figure 10); the vertical bars indicating the standard deviation of the data show the ranges of recorded ice jam dates. There is a definite trend in formation starting upstream from Overton through Grand Island to Duncan but there is no consistent progression in the reaches downstream of Duncan. The average day-of-year for breakup jam occurrence is approximately 24 February downstream of Duncan. The average discharge associated with breakup ice jams increases from upstream to downstream (Figure 11). In every case, the discharge was increasing prior to the formation of a breakup ice jam at the gage associated with the jam. Comparing the *DelQ10* (red line) and *DelQ2* (black line) with the average discharge provides insight into the rate of increase of discharge prior to breakup ice jam formation. It can be seen that the increase in flow over the previous ten days (*DelQ10*, red line) formed a large portion of the discharge at the time of the jam. The increase

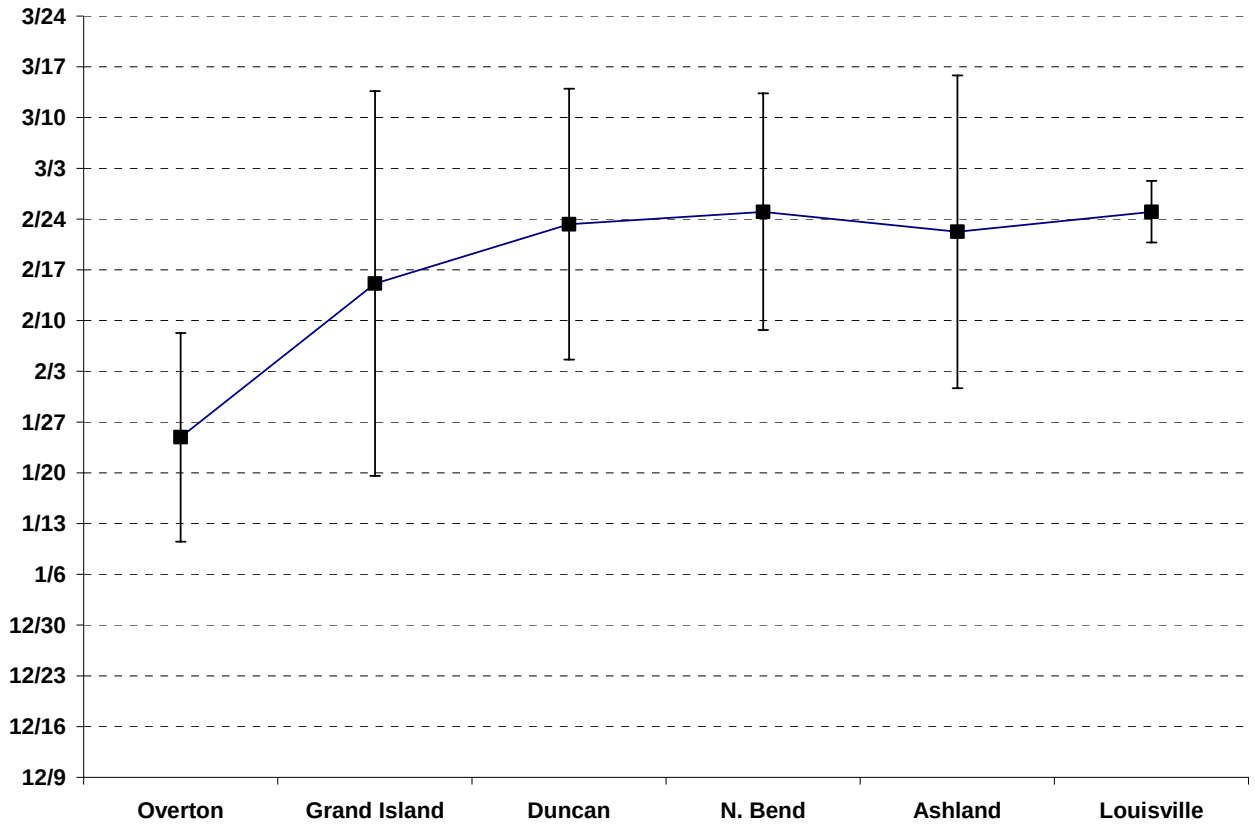

Figure 10. Dates of ice events along the Platte River.

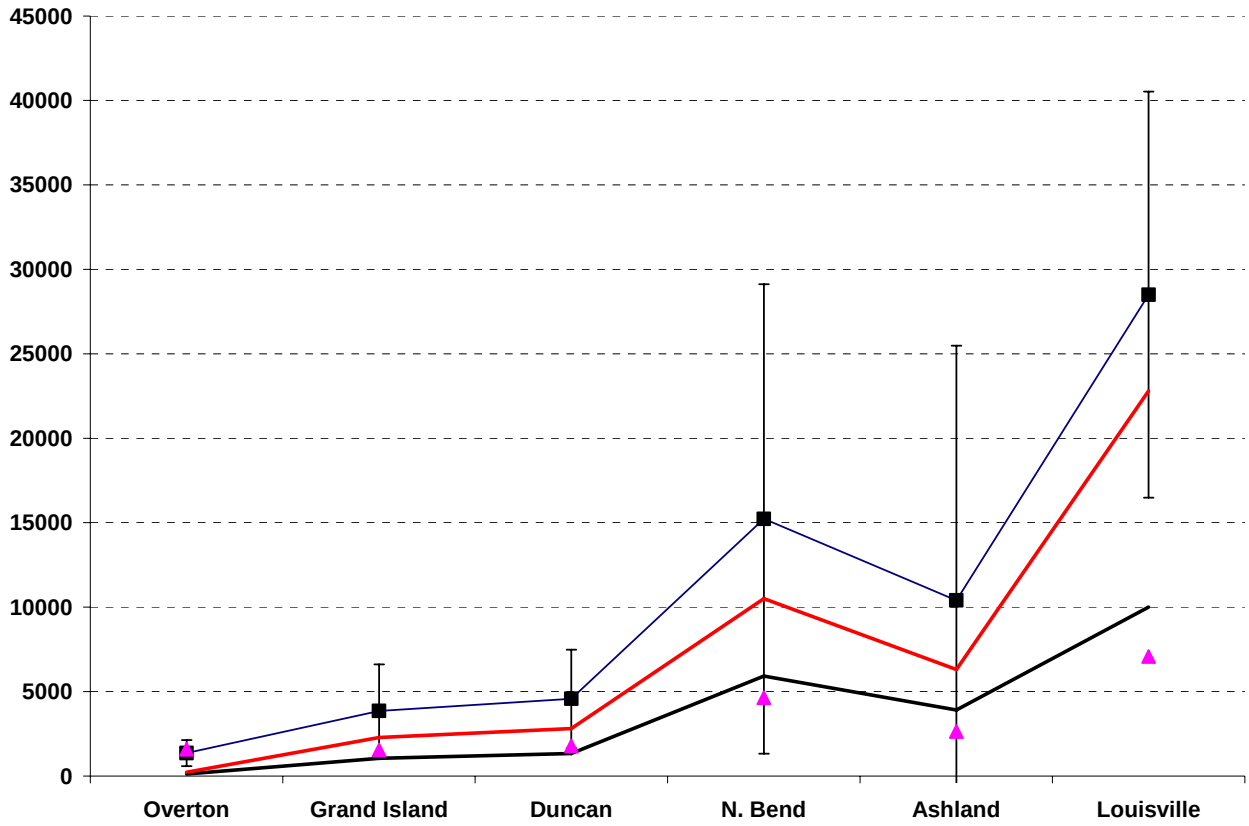

Figure 11. Discharges associated with ice events along the Platte River. Shown are the average discharge and standard deviation associated with the events, the average DelQ10 (red line), DelQ2 (black line), and annual average discharge each location (pink triangle).

over the previous two days (*DelQ2*, black line) formed a relatively small portion. The average discharge associated with breakup jams can also be compared to the long-term annual average discharge (pink triangles). This shows that breakup ice jam formation in the upstream reaches tends to occur at an average discharge approximately equal to the long-term annual average discharge; and at discharges much greater than the long-term annual average discharge in the downstream reaches. This result is consistent with the relative time of year at which the breakup jams occur. In the downstream reaches the jams tend to occur later and are associated with the general spring rise in discharge. The discharges associated with the spring rise tend to the largest discharges of the year, typically larger than the annual average discharge. The average seasonal AFDD associated with breakup ice jams (Figure 12) also shown a trend to increase in the downstream direction. Upstream at Overton, the average AFDD is only about one half of the average annual maximum AFDD recorded at the Overton meteorological gage. This reflects the tendency of the jams at

Overton to form earlier in the winter season. Moving downstream, the breakup jams occur later in the season, when more AFDD have been recorded.

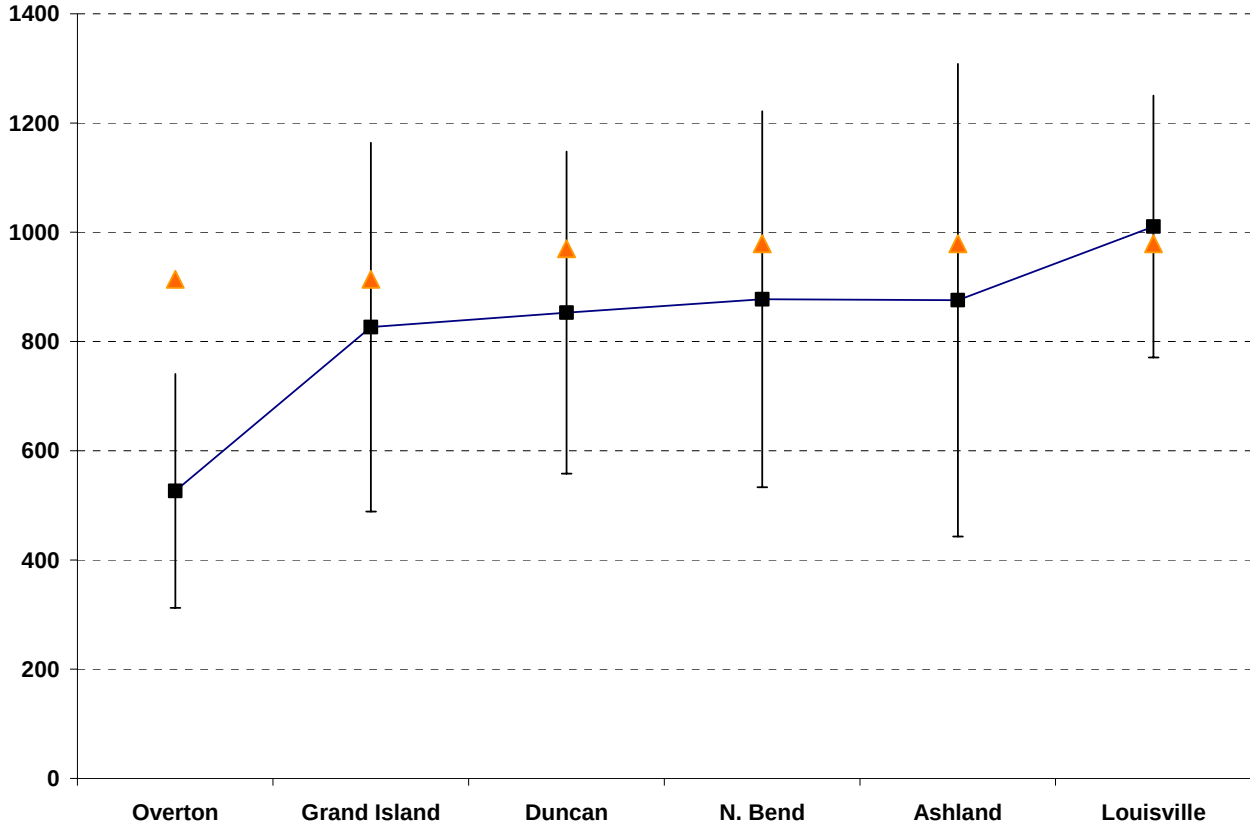

Figure 12. AFDD's associated with ice events along the Platte River. Shown are the average AFDD and standard deviation associated with the events, and the average annual maximum AFDD at each location (Orange triangles).

Jams at the Platte River at Grand Island

The Platte River at Grand Island was selected for a detailed review of the conditions under which freezeup and breakup ice jams occur because there was sufficient data for analysis at this site, and the differences between the mean discharge of each group of breakup jams was statistically significant as determined by a F Test. The statistics of the discharge associated with each ice jam are shown in Figure 13. The discharge has been combined into six separate groups; all freezeup jams are combined into one group and there are five groups of breakup jams. The ranges of the breakup jams are 0-600 AFDD (F), 600-800 AFDD (F), 800-1000 AFDD (F), 1000-1200 AFDD (F), and 1200 and greater AFDD (F). The ranges of AFDD are somewhat arbitrary, and were selected to provide a more-or-less equal

number of breakup jams for each group. The general trend is for median discharge to increase with increasing AFDD. The median discharge of all the breakup ice jam groups is larger than the discharge associated with freezeup group. The AFDD recorded immediately prior to the jam formation is shown in Figure 14. The AFDD recorded in the prior ten days (*delA10*), the prior five days (*delA5*), and the prior two days (*delA2*) are shown for each group. There is no significant difference between the groups for the prior 10 days, while there are significant differences between the freezeup group and the breakup groups for the prior five days and two days. The median AFDD for all the breakup groups tends to be at or very near zero for the prior 5 days and two days. This suggests that breakup jams tend to occur during relatively warm periods, when the air temperature is above freezing, at least for the five days preceding the formation of the jam. The AFDD recorded for the freezeup jams over ten, five and two days periods prior to the formation of the freezeup jams tend to relatively large. This suggests that freezeup jams tend to occur after relatively cold periods, when the air temperature is below zero. The change in discharge recorded immediately prior to the jam formation is shown in Figure 15. The change in discharge recorded in the prior ten days (*delQ10*), the prior five days (*delQ5*), and the prior two days (*delQ2*) are shown for each group. The median change in discharge for the freezeup jams is always less than zero. Recall that the criteria for freezeup jams was that the change in discharge over the prior five days was less than zero, so it is no surprise that *delQ5* is less than zero. The change over the prior 10 days and five days are relatively equal in magnitude; while the change over the previous two days is relatively small. This suggests that the rise in discharge occurred over the five to ten days prior to the ice jam formation.

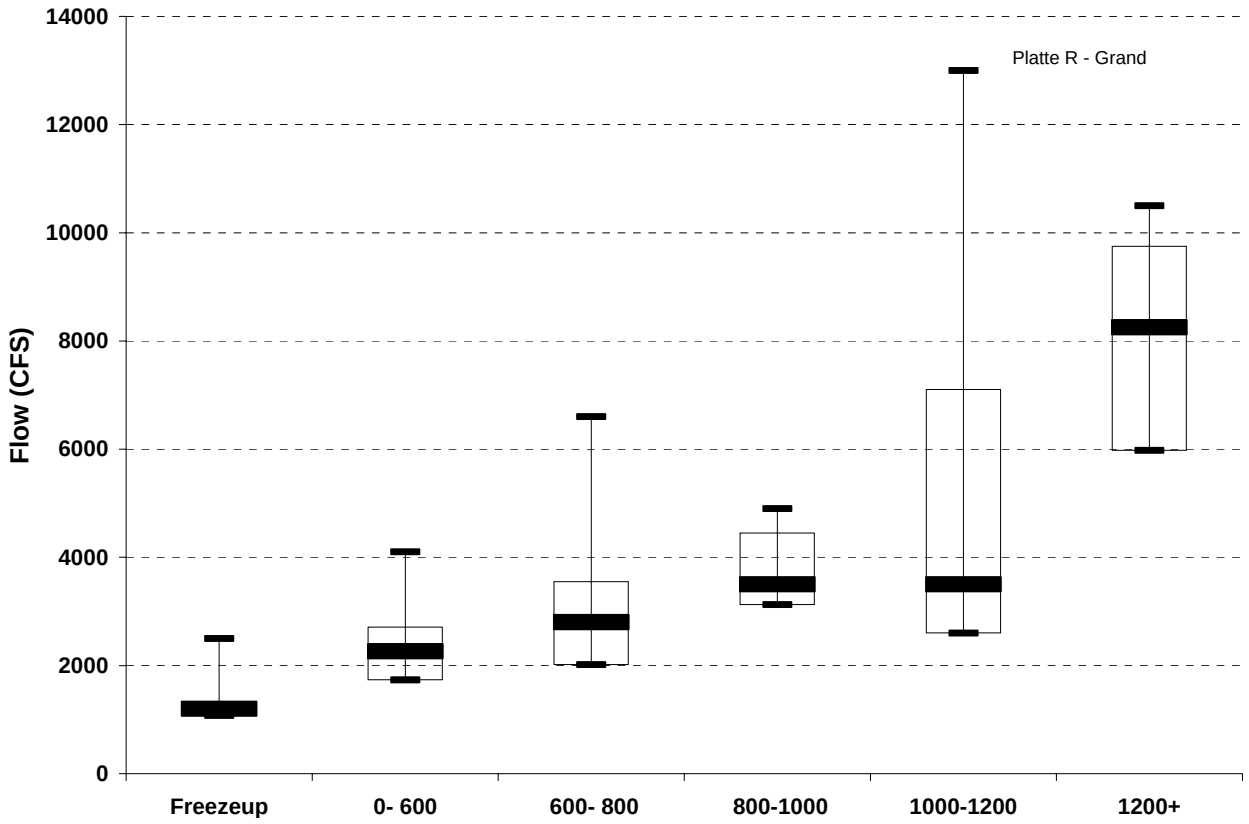

Figure 13. Discharge recorded during ice events as a function of AFDD for the Platte River at Grand Island. Shown are the flows for freezeup events, and for breakup events in five separate AFDD bins.

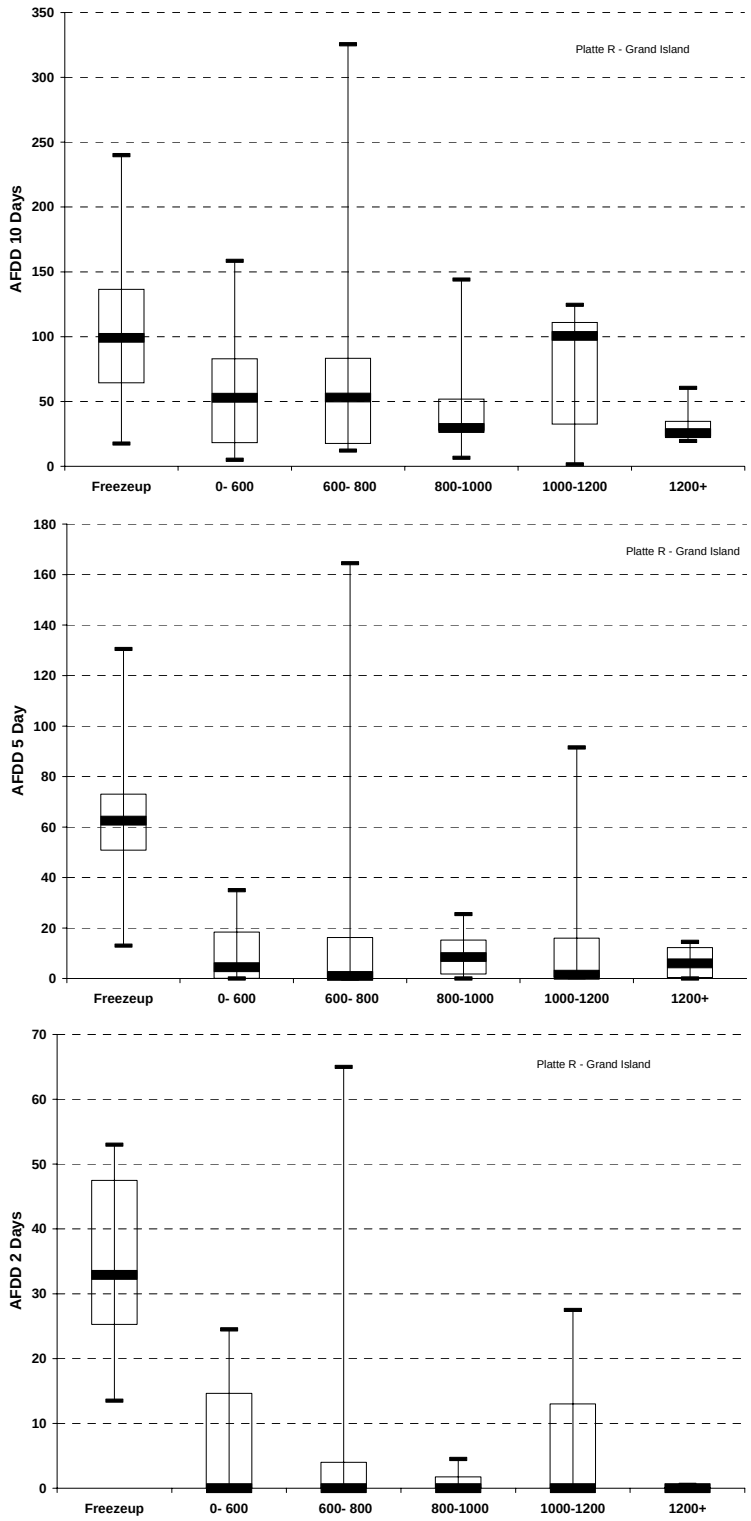

Figure 14a-c. DelA10, DelA5, and DelA2 for ice events on the Platte River at Grand Island. Shown are the DelA10, DelA5, and DelA2 for freezeup events, and for breakup events in four separate AFDD bins.

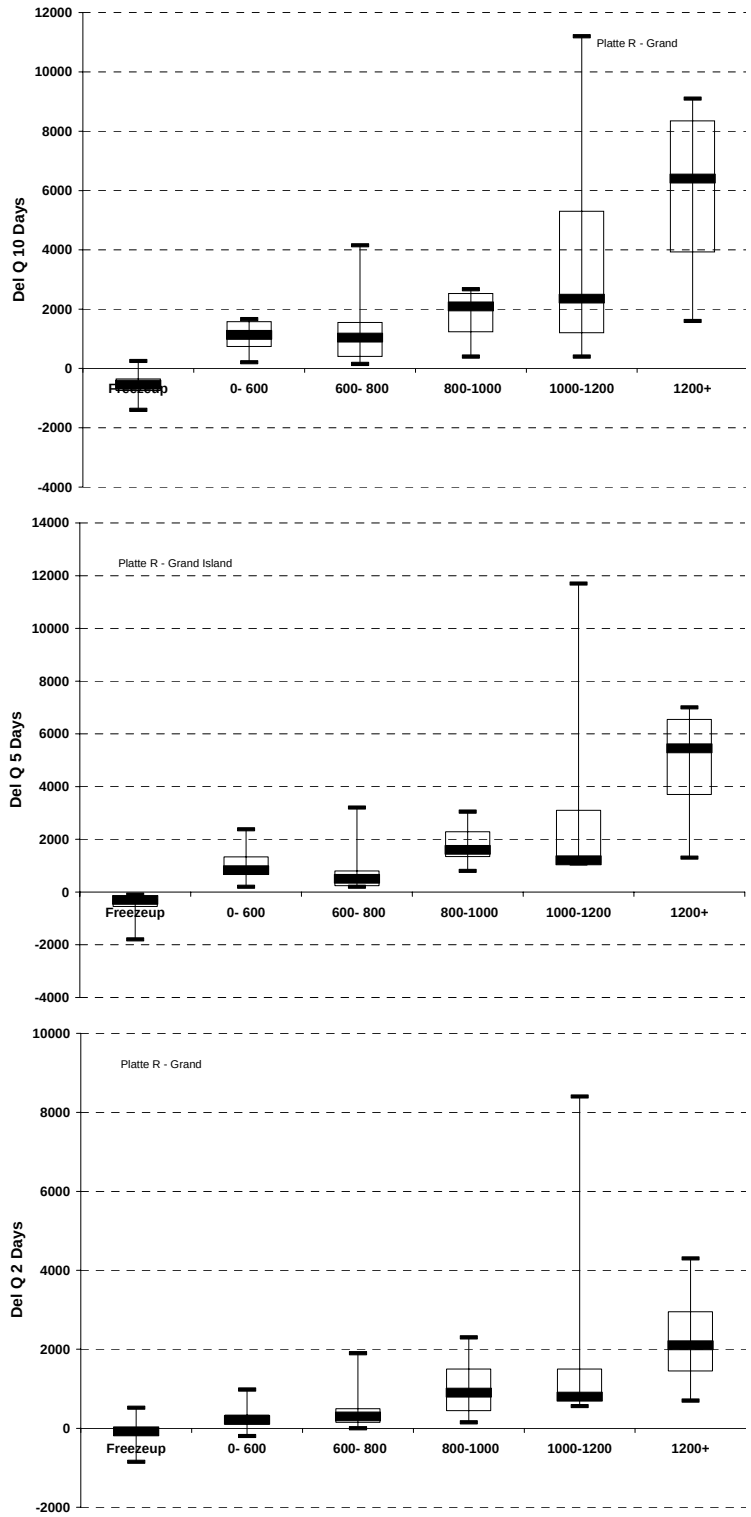

Figure 15a-c. DelQ10, DelQ5, and DelQ2 for ice events on the Platte River at Grand Island. Shown are the DelA10, DelA5, and DelA2 for freezeup events, and for breakup events in five separate AFDD bins.

Yukon River

Introduction

Rising in the Yukon province of Canada, the Yukon River crosses Alaska from east to west and empties into the Bering Sea at the Yukon-Kuskokwim Delta (Figure 16). The river is 3,185 kilometers (1,980 mi) long and has a total drainage area of 840,000 km² (327,600 mi²), of which 516,200 km² (201,300 mi²) is in Alaska.

Figure 16. Yukon and Kuskokwim River.

At the time of this study, there were 210 entries in the IJDB for the Yukon River making it one of the better-documented rivers for ice jams in the United States (Table 3A). The dates of the jams recorded in the IJDB range more or less uniformly from the 1970's to the mid 1990's with a few jams recorded in the 2000's. The day-of-year recorded in the IJDB occurs exclusively in May (Figure 17). All jams recorded in the IJDB for the Yukon River were classified as breakup jams. The Yukon has only three discharge gages located along its length (Figure 16) and few NWS meteorological stations (Figure 16) providing documentation of the discharge and air

temperature conditions during the winter. The relatively few discharge gages makes it difficult to estimate the discharge occurring at the jam locations when the location may be a considerable distance (hundreds of miles) from the nearest gage.

Table 3a. Ice jam, hydrologic and meteorologic information for the Yukon River.

Gage	Freezeup Events	Breakup Events	Unknown	DA (sq.mi)	Average Flow (cfs)	Average Max AFDD's (F)	RBW Index
Eagle	0	38	1	113500	84500	6524	0.016
Stevens	0	55	12	196300	119667	5859	0.017
Pilot	0	85	19	321000	230723	4275	0.016

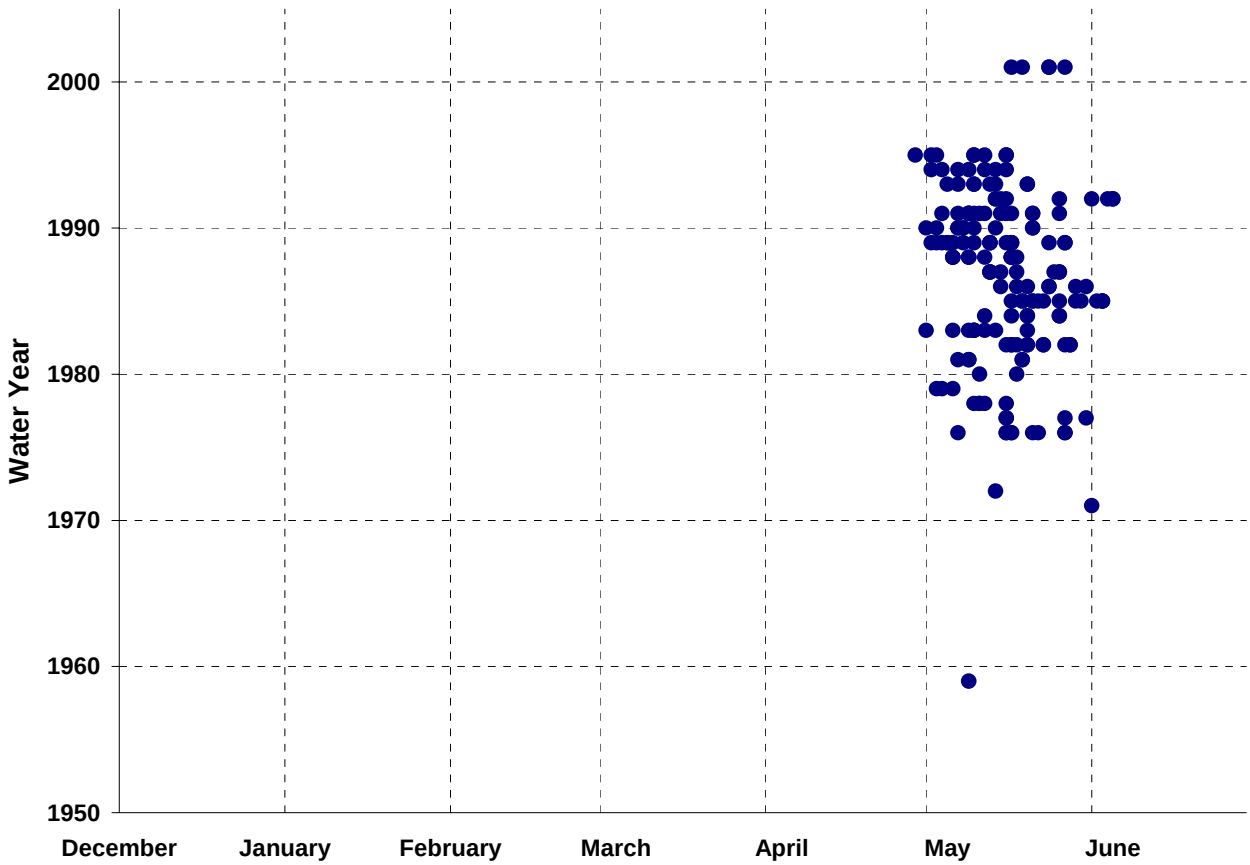

Figure 17. All ice jam data for the Yukon River. All events are breakup jams.

Overview

Flows in the Yukon River are not impacted by dams or any significant withdrawals. Flows tend to decline continuously throughout the winter season until the onsite of the spring rise in late April and early May. The

Yukon River rates as very “unflashy” on the RBW index. In fact, the Yukon River is the least flashy of the all the rivers in this study. The winters in Alaska along the Yukon River are severe with over 6500 AFDD (F) recorded at the upstream at Eagle, Alaska, and over 4200 AFDD (F) recorded downstream at Pilot Station (Table 3B).

Table 3b Ice jam data for the Yukon River.

River Location	Number of Jams	River Mile	Breakup Jams				
			Average Day-of-Year	Average AFDD (F)	Average Time To Peak (Days)	Average Discharge* (CFS)	Average Base flow (CFS)
Eagle	8	1204	5/8	5801	-	130125	-
Circle	14	1057	5/8	5228	13.1	161109	12443
Fort Yukon	10	990	5/9	5357	13.3	181085	6696
Stevens Village	8	836	5/14	6018	-	198750	-
Rampart	4	769	5/14	6355	15.5	275215	19044
Tanana	7	694	5/10	5864	14.9	264717	24180
Galena	15	525	5/15	5964	14.6	267718	20323
Koyukuk	7	497	5/13	6336	20.4	392403	18560
Nulato	8	470	5/12	6041	17.9	302341	20039
Anvik	9	310	5/18	4479	18.0	391061	28799
Russian Mission	8	200	5/19	4651	16.7	376870	34821
Pilot Station	8	115	5/19	4803	3.2	336365	38473
Saint Marys	6	92	5/19	5005	7.6	304286	39475
Mountain Village	10	79	5/21	5822	8.9	360556	39475
Alakanuk	14	15	5/24	4239	13	338929	35150
Emmonak	15	8	5/23	4340	13	352867	35150

* Discharges estimated by interpolating between gages as described.

Breakup jams on the Yukon River

None of the events included in the IJDB were identified as freezeup jams. This was due to the fact the all events included in the IJDB for the Yukon River occur in May, when there is little likelihood of a freezeup jam occurring. Breakup jams occurred along the entire river length. Breakup ice jam formation on the Yukon River can be considered to be progressive as shown by the average day-of-year when breakup ice jams occurred

(Figure 18); the vertical bars indicate the standard deviation of the data. There is a definite trend in breakup ice jam formation starting upstream at Eagle and Circle and proceeding downstream with some small variation to Alakanuk and Emmonak. The average day-of-year for breakup jam occurrence is approximately 8 May at the upstream reaches to 24 May at the downstream reaches. The progressive nature of ice jams on the Yukon has been remarked upon previously. It should be noted that while the average day-of-year recorded in the IJDB show the progressivity of the Yukon, a progressive breakup does not occur every year on the Yukon. In fact, there can be a wide year-to-year variation in the pattern of breakup.

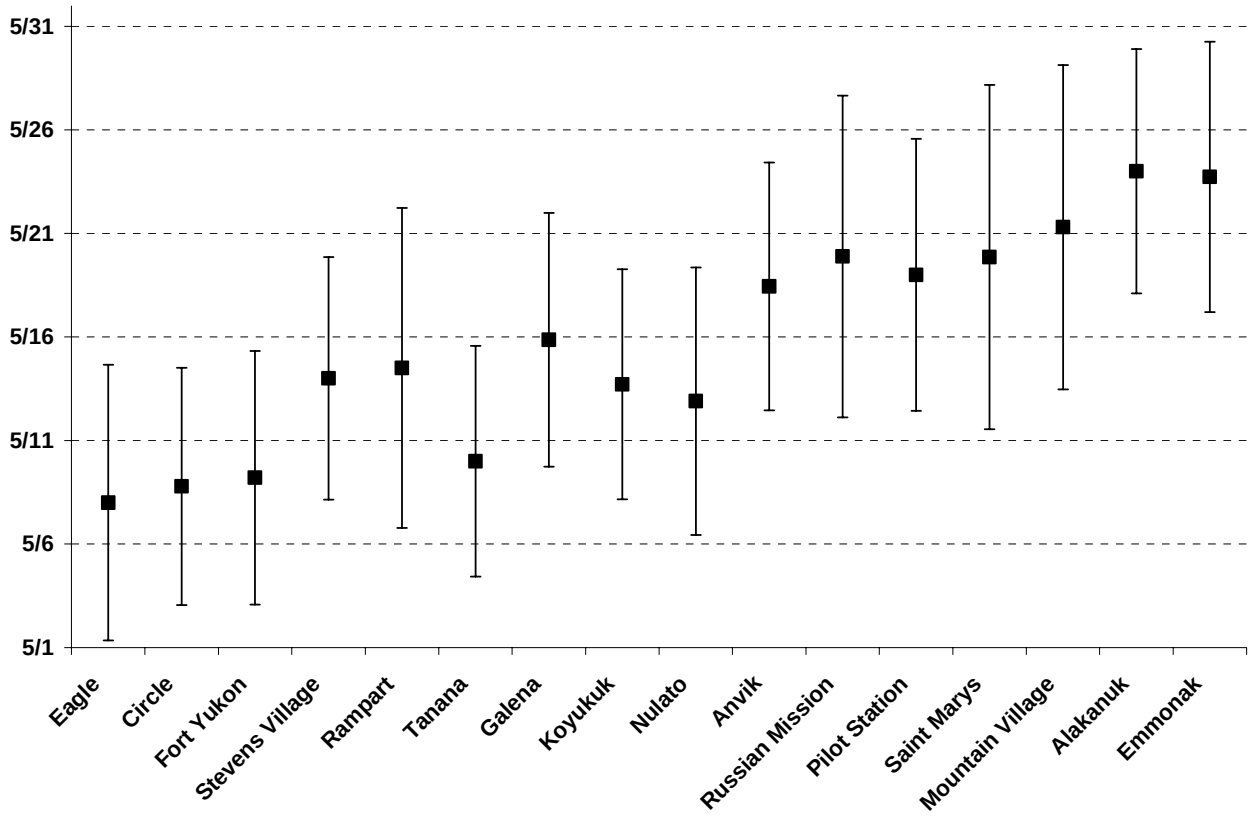

Figure 18. Dates of ice events along the Yukon River.

The average discharge associated with breakup ice jams increases from upstream to downstream (Figure 19). Two alternative approaches were used to determine the discharge to associate with the jams recorded in the IJDB. In the first approach, every location along the Yukon was associated with one of the three discharge gages. The discharge then associated with the jams was the discharge recorded at one of three gages on that same day (Figure 19a). In general, the jams occurred on the rising limb of the spring rise in the Yukon flow caused by precipitation and snowmelt. Systematic

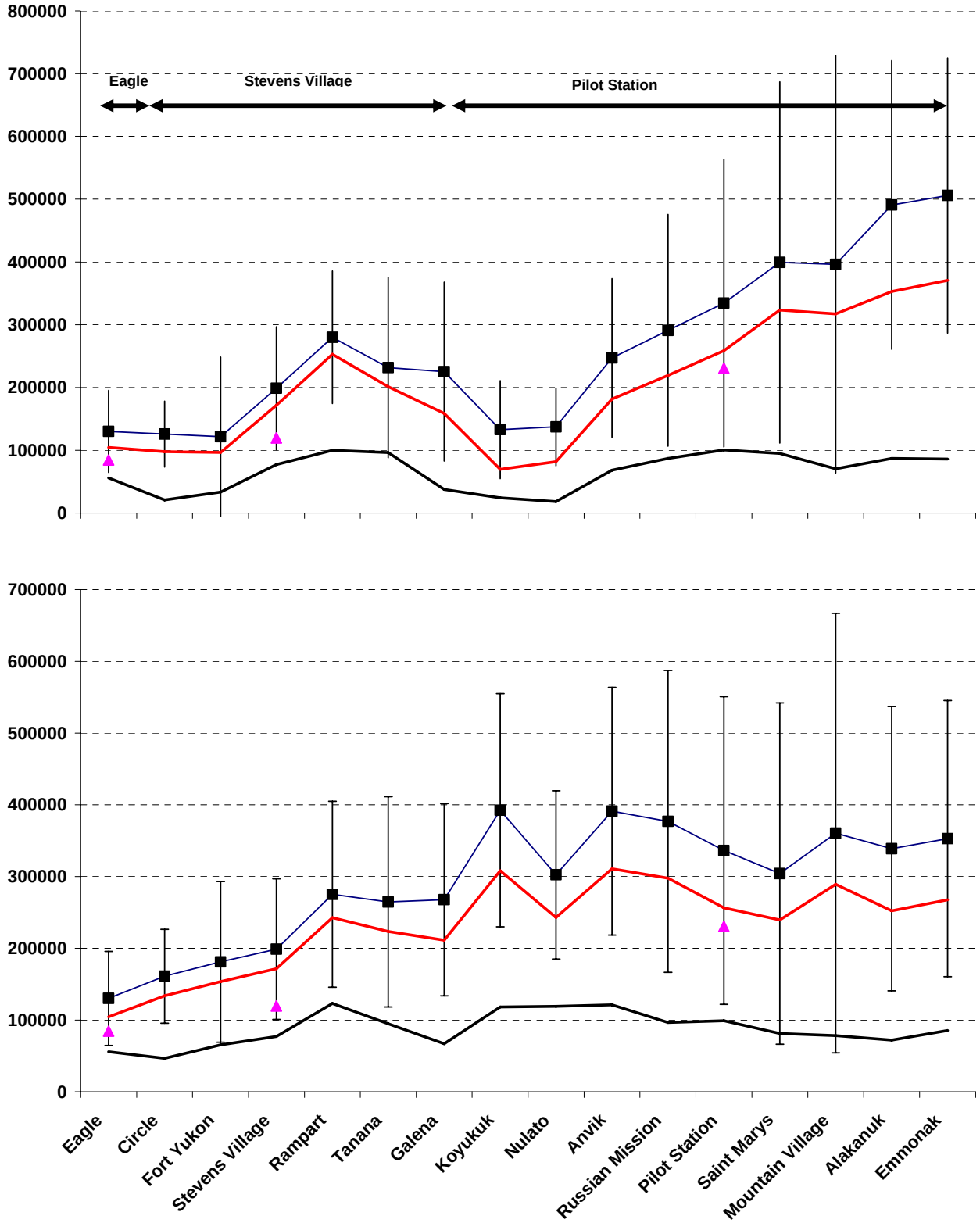

Figure 19a-b. Discharges associated with ice events along the Yukon River. Shown are the average discharge and standard deviation associated with the events, the average DelQ10 (red line), DelQ2 (black line), and annual average discharge each location (pink triangle).

inaccuracies result because of the large distances between jam locations and discharge gages and the rapidly changing flow conditions that can occur during the spring rise. For example, estimated discharges at jam locations located upstream of an associated gage tended to be relatively low and those located downstream of a gage tended to relatively high, as can be seen (Figure 19a). A second approach was developed to overcome these problems. In this approach, the discharge at the jam location was estimated by linearly interpolating between the recorded discharges at gages located upstream and downstream of the jam location and accounting for the travel time of the hydrographs.

$$Q_j^i = \frac{Q_{upstream}^{i-u_{travel}} \left(D_{us}\right)^{-1} + Q_{downstream}^{i+d_{travel}} \left(D_{ds}\right)^{-1}}{\left(D_{us}\right)^{-1} + \left(D_{ds}\right)^{-1}}$$

where Q_j^i = the discharge at location *j* along the Yukon River on the *i*th day; $Q_{upstream}^{i-u_{travel}}$ = the discharge recorded at the upstream gage on the i-u_{travel} day, where u_{travel} is the travel time from the upstream gage to the jam location in days; $Q_{downstream}^{i+d_{travel}}$ = discharge recorded at the downstream gage on the $i+d_{travel}$ day, where d_{travel} is the travel time from the jam location to the downstream gage in days; and D_{us} and D_{ds} are the distances from the jam location to the upstream and downstream gages, respectively. The travel times were based on the ice jam occurrence matrix developed by White (1999). For locations downstream of the Pilot Station gage, there was obviously no downstream gage available, so only the travel time from the Pilot Station gage to the jam location was taken into account. The results are shown in Figure 19b. The mean discharge increases uniformly in the downstream direction to approximately the Nulato location, and then is more or less constant downstream of that location, ranging between 300,000 and 400,000 cfs.

In almost every case, the discharge was increasing prior to the formation of a breakup ice jam at the gage associated with the jam. Comparing the *DelQ10* (red line) and *DelQ2* (black line) with the average discharge provides insight into the rate of increase of discharge prior to breakup ice jam formation. It can be seen that the increase in flow over the previous ten days (*DelQ10*, red line) formed a large portion of the discharge at the time of the jam and that this portion was relatively larger in the upstream reaches than the downstream. The increase over the previous two days

(*DelQ2*, black line) formed a relatively small portion. The average discharge associated with breakup jams can also be compared to the long-term annual average discharge (pink triangles). This shows that breakup ice jam formation tends to occur at an average discharge greater than the long-term annual average discharge throughout the river. This result is consistent with the May occurrence of the ice jams. At this time of year, the jams are associated with the general spring rise in discharge. The discharges associated with the spring rise tend to be the largest discharges of the year; typically the peak of the spring rise is larger than the annual average discharge. The average seasonal AFDD associated with breakup ice jams (Figure 20) tend to decrease in the downstream direction. This probably reflects in large part, the general decrease in annual maximum AFDD in the downstream direction as measured by the meteorological stations. Upstream at Eagle and Circle, the average AFDD is slightly less than the average annual maximum AFDD recorded at the Eagle meteorological station. Further downstream at Stevens, the average AFDD is about equal to the average annual maximum AFDD recorded at the Stevens meteorological station. Even further downstream at Pilot Station, the average AFDD is greater than the average annual maximum AFDD recorded at the Pilot Station meteorological station. This reflects the tendency of the jams to form earlier in the winter season in the upstream reaches and later in the downstream reaches when more AFDD have been recorded.

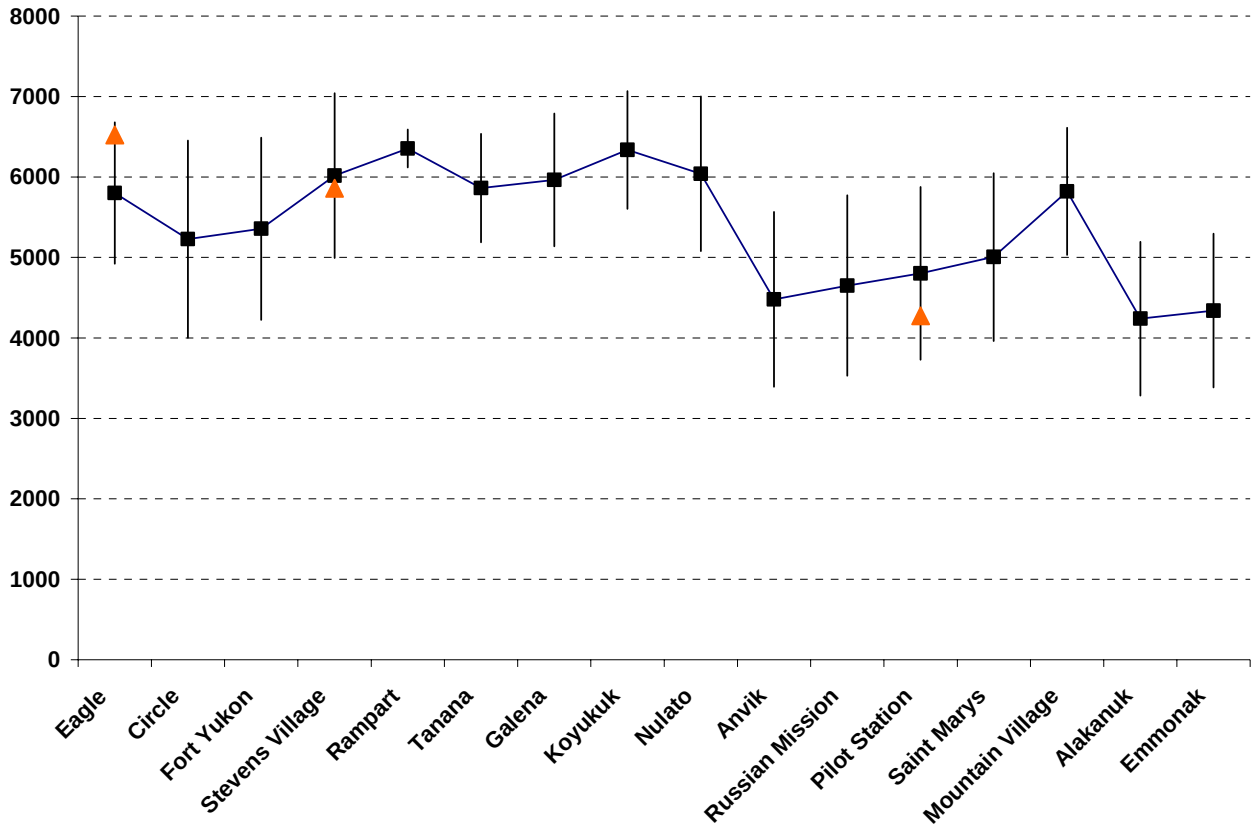

Figure 20. AFDD's associated with Ice Events along the Yukon River. Shown are the average discharge and standard deviation associated with the events, and the average annual maximum AFDD at each location (orange triangles).

Kuskokwim River

Introduction

The Kuskokwim River, approximately 650 mi (1,110 km) long, is located in southwest Alaska (Figure 16) and provides the principal drainage for an area of the remote Alaska Interior on the north and west side of the Alaska Range, flowing southwest into Kuskokwim Bay on the Bering Sea.

At the time of this study, there were 191 entries in the IJDB for the Kuskokwim River (Table 4a). The dates of the jams recorded in the IJDB range from the 1960's to the mid 1990's (Figure 21). There is an apparent tendency for the date of the last ice jam to occur earlier every year starting in the mid 1980's. It is unclear whether this reflects actual changes in the river or the vagaries of the IJDB. The day-of-year recorded in the IJDB occurs almost exclusively in May, with a few jams occurring in late April and early June. The Kuskokwim has only two discharge gages located

along its length (Figure 16) and two NWS meteorological stations (Figure 16) providing documentation of the discharge and air temperature conditions during the winter.

Table 4. Ice Jam, hydrologic and meteorologic information for the Kuskokwim River.

Gage	Freezeup Events	Breakup Events	Unknown	DA sq.mi	Average Flow cfs	Average Max AFDD's (F)	RBW Index
Crooked Creek	0	151	14	31100	42555	3676	0.019
McGrath	0	7	19	11700	13977	5301	0.023

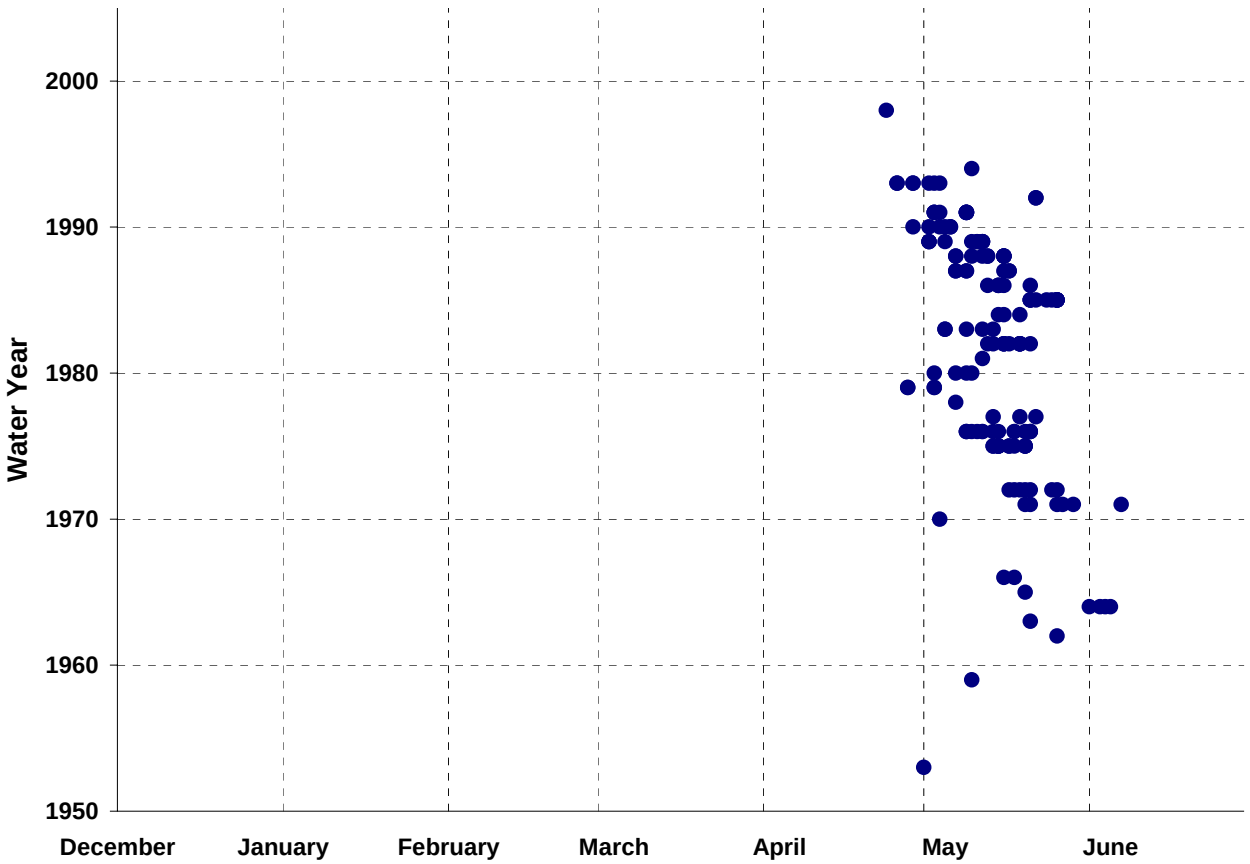

Figure 21. All ice jam data for the Kuskokwim River. All events are breakup jams.

Overview

Flows in the Kuskokwim River are not impacted by dams or any significant withdrawals. The flow regime in the Kuskokwim is similar to the Yukon River in that the flows tend to decline continuously throughout the winter season until the onsite of the spring rise in late April and early May. The

Kuskokwim River rates as very "unflashy" on the RBW index. In fact, only the Yukon River is less flashy then the Kuskokwim. The winters in Alaska along the Kuskokwim River are severe with over 5300 AFDD (F) recorded at the upstream McGrath, Alaska, and over 3600 AFDD (F) recorded further downstream at Crooked Creek (Table 4B).

Table 4b. Ice jam data for the Kuskokwim River

	Number of Jams	Breakup Jams				
		Average Day-of-Year	Average AFDD (F)	Average Time To Peak (Days)	Average Discharge (CFS)	Average Base flow (CFS)
Mcgrath	4	5/18	5699	6.0	33750	4268
Sleetmute	10	5/11	5307	7.4	51100	10972
Red Devil	12	5/9	5235	6.8	52750	11241
Crooked Creek	7	5/6	5357	3.9	37429	11116
Aniak	22	5/11	5242	7.4	71500	10549
Kalskag	10	5/16	3951	10.5	105400	10045
Tuluksak	8	5/13	4005	6.9	75375	10419
Akiak	11	5/16	3834	9.3	105955	10395
Akiachak	11	5/16	3892	5.1	117909	9966
Kwethluk	9	5/14	3353	8.1	98556	11817
Bethel	22	5/16	3857	5.1	114305	10519
Oscarville	7	5/18	4133	8.7	106843	10901
Napaskiak	8	5/14	3943	9.9	96363	11351
Napakiak	9	5/13	3704	8.9	91989	11101

Breakup jams on the Kuskokwim River

As with the Yukon River, all jams recorded in the IJDB for the Kuskokwim River were classified as breakup jams. Breakup jams occurred along the lower two thirds of the Kuskokwim's length. The lack of ice jam data in the upper third may represent the lack of observers in that region. Overall, breakup ice jam formation on the Kuskokwim River cannot be considered to be progressive as shown by the average day-of-year when breakup ice jams occurred (Figure 22), although the upper reaches probably can be.

There is no trend in breakup ice jam formation downstream of about Kalskag where the average dates of breakup range between May 12 and 18. The southern downstream reach of the river is also influenced by the tides of the Pacific Ocean through much of its length. Upstream of Crooked Creek the breakup dates are progressive, starting from downstream at Crooked Creek on about 6 May and progressing upstream to Magrath on 18 May. This upstream progression can be contrasted with the Yukon's downstream progression and probably reflects the general north to south orientation of the river.

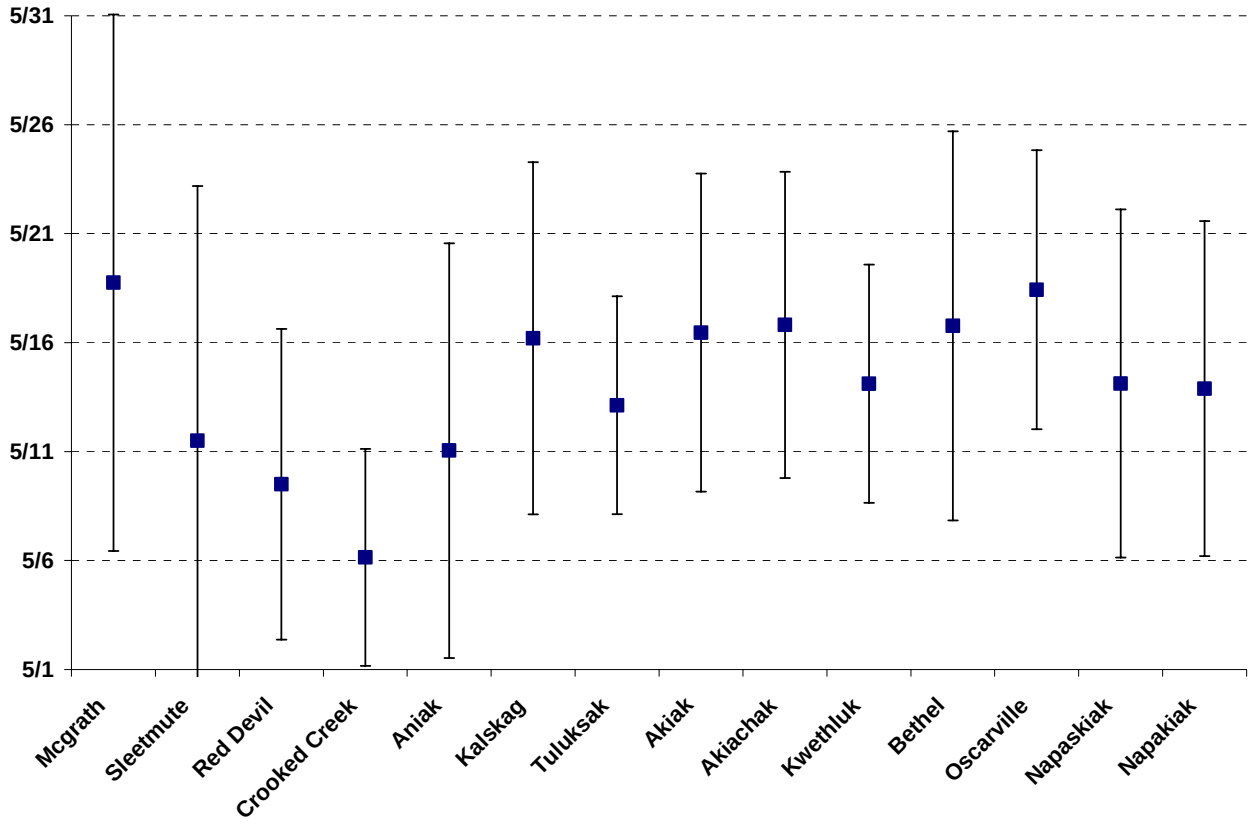

Figure 22. Dates of Ice Events along the Kuskokwim River.

The distances between the gages and the ice jam sites are not as extreme as on the Yukon River but still presents a problem in estimating discharges that occurred during the ice jams. Unlike the Yukon, there is no clear cut procedure to interpolate or lag the discharges observed at the gage to estimate the actual discharge at the jam location on the day when the jam occurred. Unfortunately, many of the ice jam are located downstream of the last gage on the river at Crooked Creek. As a result, the discharges for all the jams located downstream of Crooked Creek were estimated based

on the discharge recorded at Crooked Creek on the same day as the ice jam occurred. The discharges for the two sites between Magrath and Crooked Creek are estimated based on the discharge at Magrath on the same day. The average discharge associated with breakup ice jams increases from upstream to downstream (Figure 23) to about Kalskag, and if fairly constant downstream of that point, varying around 100,000cfs.

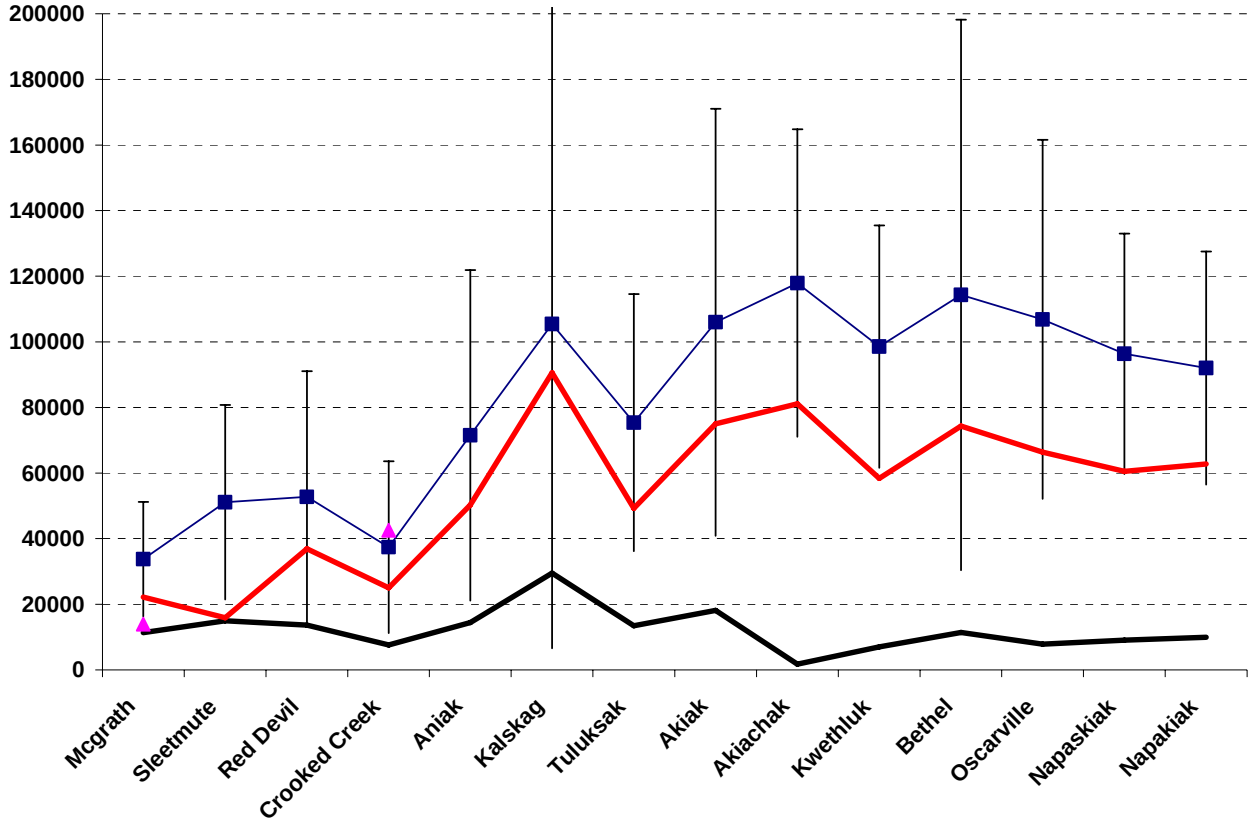

Figure 23. Discharges associated with ice events along the Kuskokwim River. Shown are the average discharge and standard deviation associated with the events, the average DelQ10 (red line), DelQ2 (black line), and annual average discharge each location (pink triangle).

As with the Yukon, the discharge was increasing prior to the formation of almost all the breakup ice jams. Comparing the *DelQ10* (red line) and *DelQ2* (black line) with the average discharge provides insight into the rate of increase of discharge prior to breakup ice jam formation. It can be seen that the increase in flow over the previous ten days (*DelQ10*, red line) formed a significant portion of the discharge at the time of the jam and that this portion was relatively larger in the upstream reaches than the downstream. The increase over the previous two days (*DelQ2*, black line) formed a relatively small portion. Breakup ice jam formation tends to

occur at an average discharge greater than the long-term annual average discharge at both of the gage sites of Magrath and Crooked Creek. This result is consistent with the late spring occurrence of the ice jams. The average seasonal AFDD associated with breakup ice jams (Figure 24) tend to decrease in the downstream direction. This probably reflects in large part, the general decrease in annual maximum AFDD in the southern reaches of the river. Upstream at Magrath and downstream at Bethel, the average AFDD associated with ice jams is slightly greater than the average annual maximum AFDD recorded at those gages.

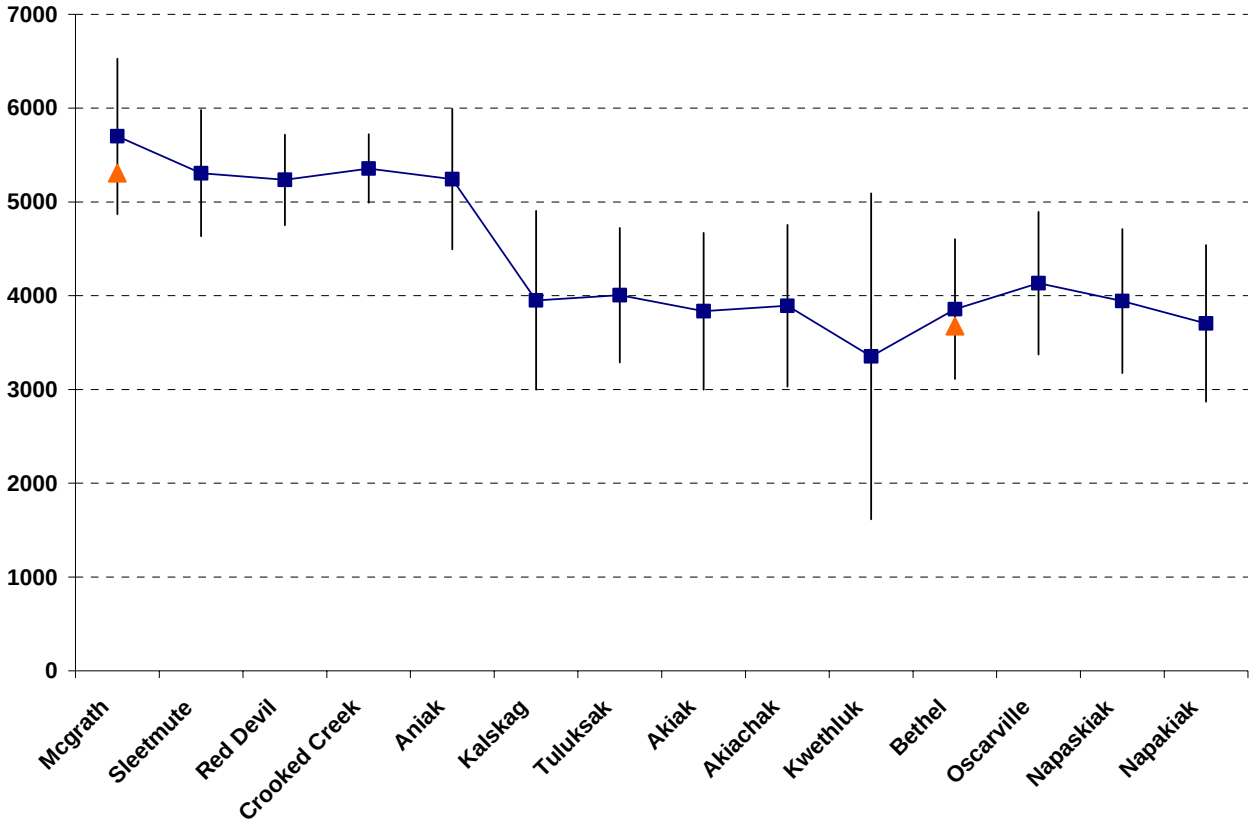

Figure 24. AFDD's associated with ice events along the Kuskokwim River. Shown are the average discharge and standard deviation associated with the events, and the average annual maximum AFDD at each location (Orange triangles).

Connecticut River

Introduction

The Connecticut River is the largest river in New England, flowing south from the Connecticut Lakes in northern New Hampshire, along the border between New Hampshire and Vermont, through Western Massachusetts

and central Connecticut into Long Island Sound (Figure 25). It has a total length of 405 miles (640 km), and a drainage basin extending over 11,250 mi² (29,138 km²).

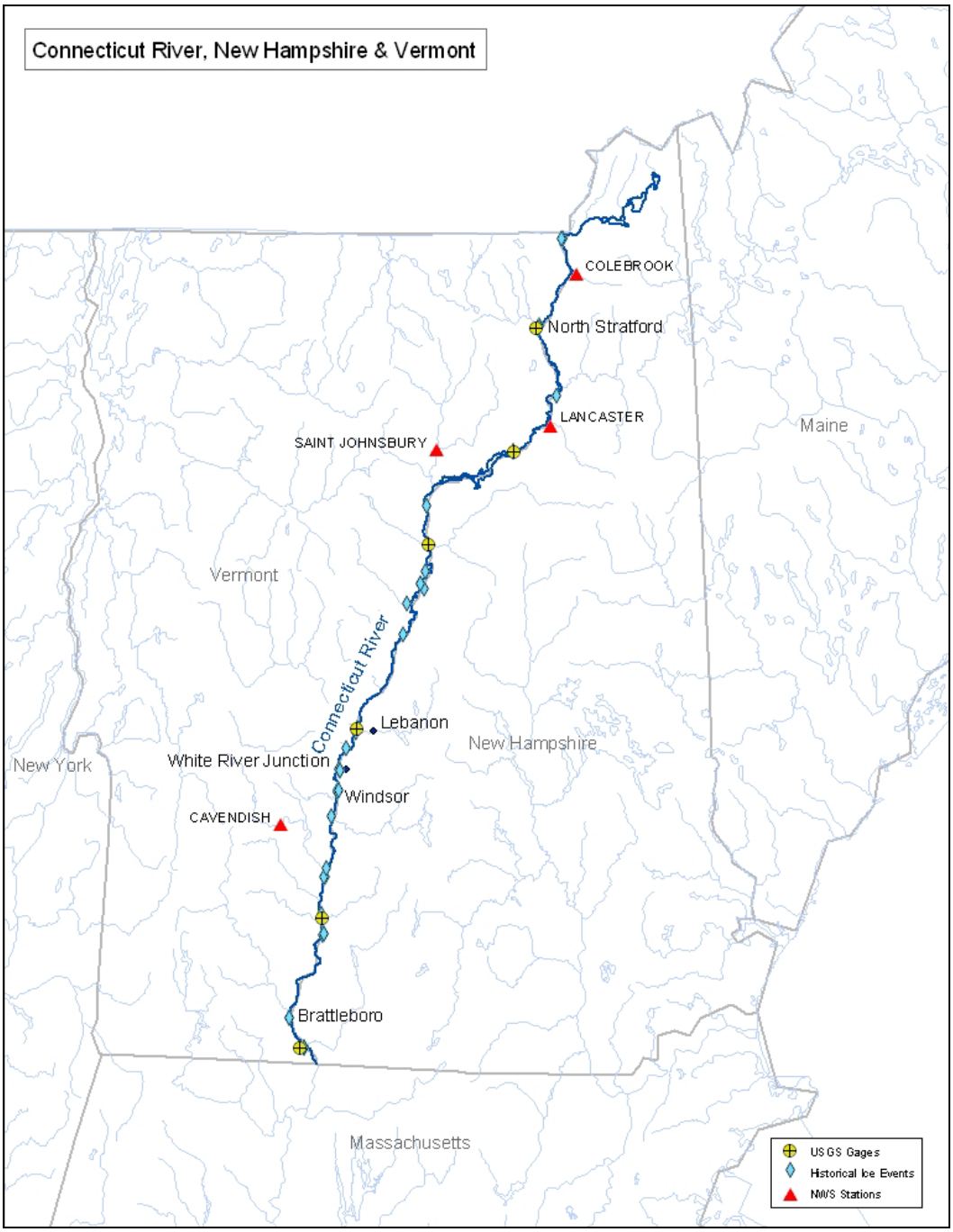

Figure 25. Connecticut River.

At the time of this study, there were 94 entries in the IJDB for the Connecticut River north of the state of Massachusetts of which 83 were useable (Table 5A). There were very few entries for the Connecticut River south of the northern border of Massachusetts, and the reaches of the river south of that line was not included in this study. (Vuyovich et al 2005). The dates of the jams recorded in the IJDB range more or less uniformly from the mid 1930's to the early 2000's (Figure 26). The day-of-year recorded in the IJDB ranges throughout the winter from early December through the middle of March. The Connecticut River also has a number of discharge gages located along its length (Figure 25) and NWS meteorological stations (Figure 25) providing good documentation of the discharge and air temperature conditions during the winter.

Table 5a. Ice jam, hydrologic and meteorologic information for the Connecticut River.

River	Gage	Freezeup Events	Breakup Events	Unknown	DA (sq.mi)	Average Flow (cfs)	Average Max AFDD's (F)	RBW Index
Connecticut	N. Stratford	7	34	0	799	1577	1872	0.159
	Dalton	2	2*	0	1514	2892	1406	0.161
	Wells River	1	4**	2	2464	4991	1406	0.242
	W Lebanon	1	25	0	4092	7198	1151	0.249
	N. Walpole	1	3***	4	5493	9574	1318.	0.221
	Vernon	0	3	5	6266	10512	1318	0.256

*Occurred on same day at separate locations

** 3 of 4 occurred on same day at separate locations

*** 2 of 3 occurred on same day at separate locations

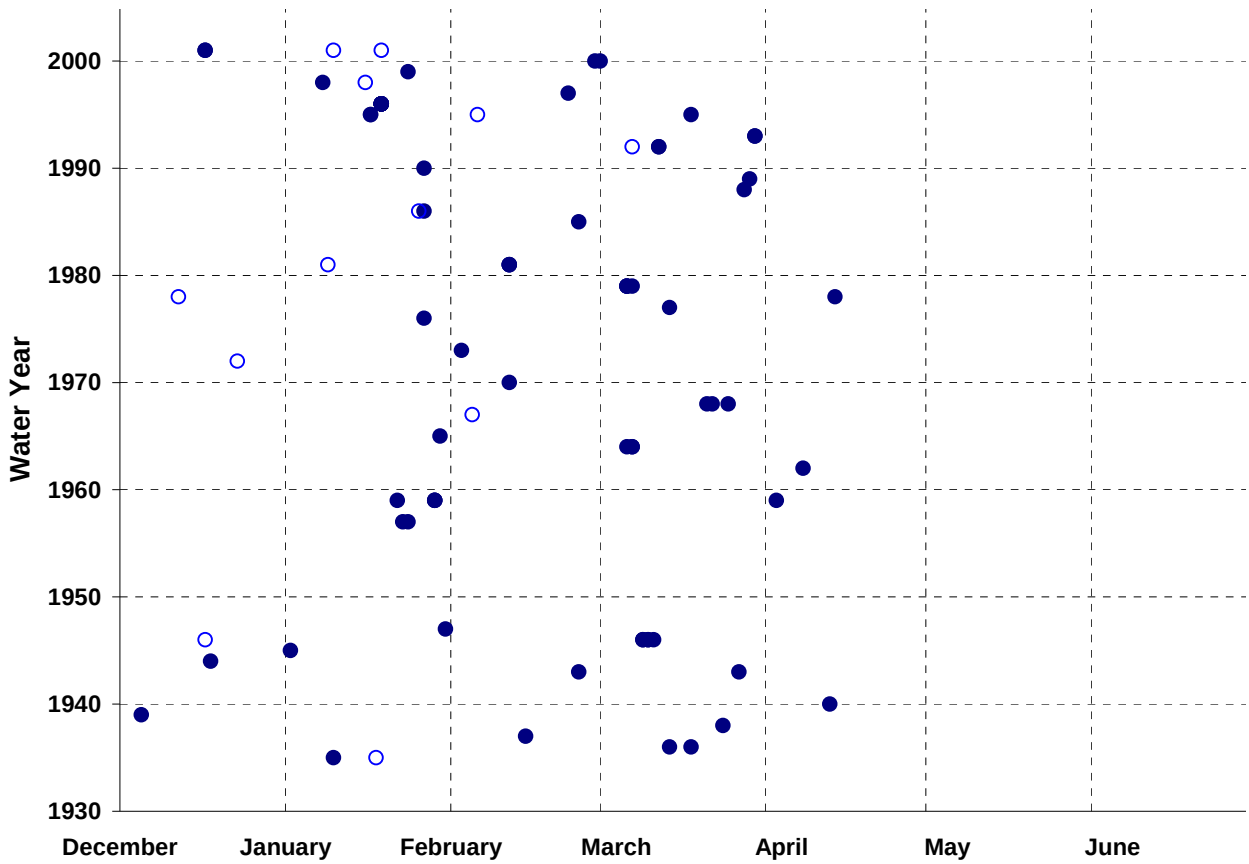

Figure 26. All ice jam data for the Connecticut River. Freeze up jams are open circles, breakup jams are solid.

Overview

Flows in the Connecticut River are affected by a series of 16 hydroelectric dams that extend along its length. There are a number of dams on tributaries as well. Flows in the Connecticut River tend to increase throughout autumn until late November through early December and then decline throughout the winter until the spring rise begins in early March. The peak of the spring rise is often the maximum flow of the year. The Connecticut River rates as relatively "flashy" on the RBW index and discharge events consisting of a rapid rise and fall in flow caused by a combination of precipitation and snowmelt are common in winter. Winters along the Connecticut can be harsh with average annual maximums of over 1800 AFDD's (F) recorded in the north and 1100 AFDD's (F) in the south. Ice jams on the Connecticut tend to be largely breakup jams (76%) along with some freezeup jams (18%) (Table 5B).

Table 5b. Ice jam data for the Connecticut River.

Gage	Location	Breakup Jams					Freezeup Jams					
		Avg. Day-of-Year	Avg. AFDD (F)	Avg. Time To Peak (Days)	Avg. Discharge (CFS)	Avg. Base flow (CFS)	Avg. Day-of-Year	Avg. AFDD (F)	Avg. Discharge (CFS)	DelA2 (F)	DelA5 (F)	DelA10 (F)
North Stratford NH		2/15	1379	2.6	3876	684	36904	654	1116	47	96	169
Dalton												
Wells River												
W. Lebanon NH		2/15	1076	3.5	24133	2545	2/11	1067	1647	26	90	145
	Hartford/ White River Junction	2/4	1083	2.3	12514	2501						
	Plainfield NH	2/23	1321	3.5	13100	1578						
	Windsor VT	2/23	1130	3.2	26480	2271						
North Walpole		2/13	1132	4.0	29300	4941						
Vernon		2/25	1355	2.7	48900	4047						

A general overview of ice jams on the on the Connecticut River are shown using three histograms that combines both the freezeup jams and breakup jams The dates when all ice jams occurred on the Connecticut River are shown using a histogram that combines both the freezeup jams and breakup jams (Figure 27). The location of the breakup jams, either northern (upstream of Lebanon, NH) or southern (downstream of Lebanon, NH) is indicated. The histogram of freezeup jams peaks in early January, although freezeup jams can occur throughout the winter season, from mid December through early March. . Breakup jams can also occur throughout the winter season, starting in mid December through late April. The histogram of breakup jams appears to have two peaks, one in early January and a second in late March. The first peak, in January, corresponds to the “January thaw” a period of highly variable weather. The second peak corresponds with the general spring rise due to precipitation and snowmelt. The histogram of AFDD associated with freezeup jams peaks much early than the histogram associated with breakup jams (Figure 28). The histogram of freezeup jams peaks around 700 AFDD (F) and the histogram of breakup jams peaks around 1500 AFDD (F). The

histogram of discharges associated with freezeup jams peaks between 1000-2000 CFS (Figure 29). The histogram of discharges associated with breakup jams peaks between 4500 CFS. The range of discharges for breakup jams is much larger than that of freezeup jams, extending from 1500 CFS to 30,000 CFS, while the range for freezeup jams is much smaller, extending from 1000 CFS to about 6000 CFS. In summary, freezeup jams tend to occur earlier in the winter season, at fewer seasonal AFDD, and at lower discharges than breakup jams. However, there is considerable overlap of the ranges for all three of these parameters between freezeup and breakup jams.

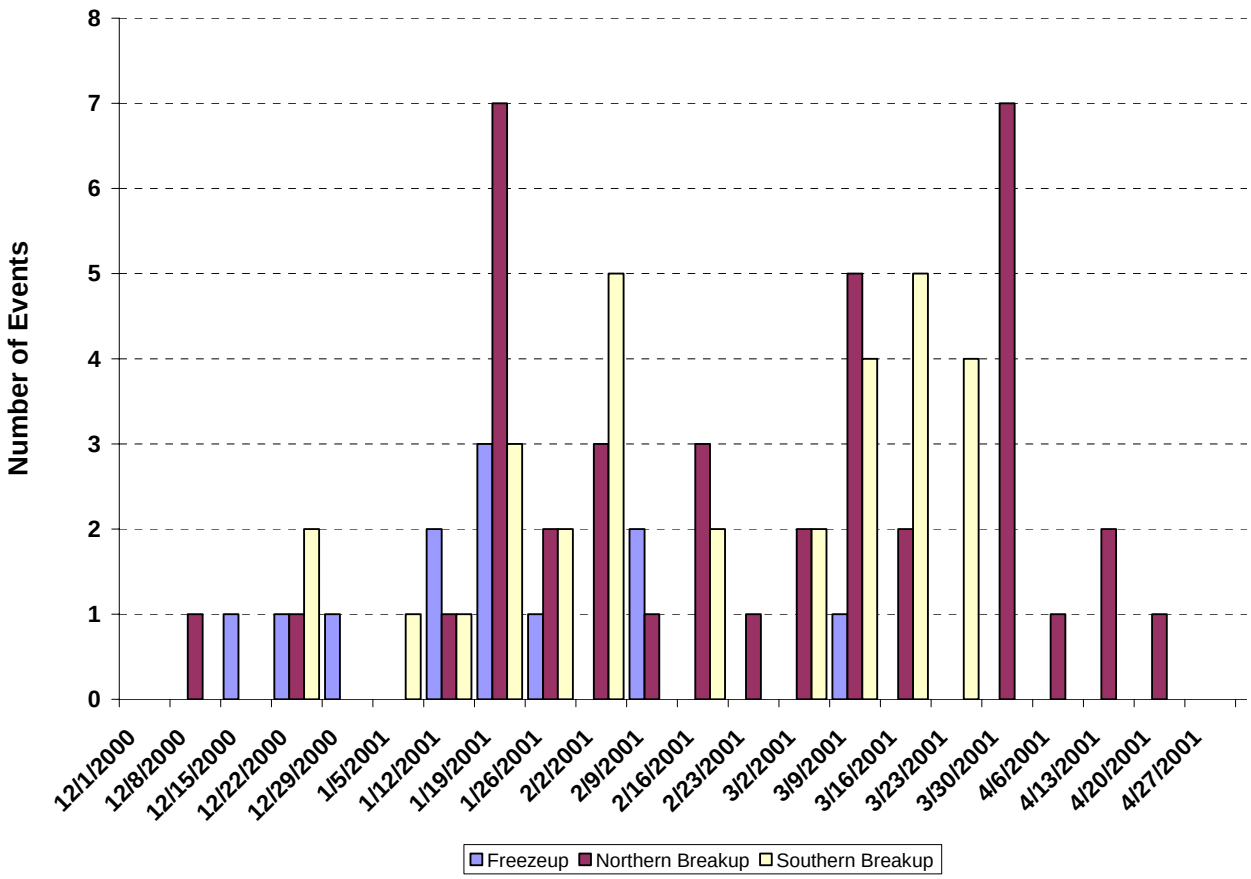

Figure 27. Histogram of ice events on the Connecticut River by date

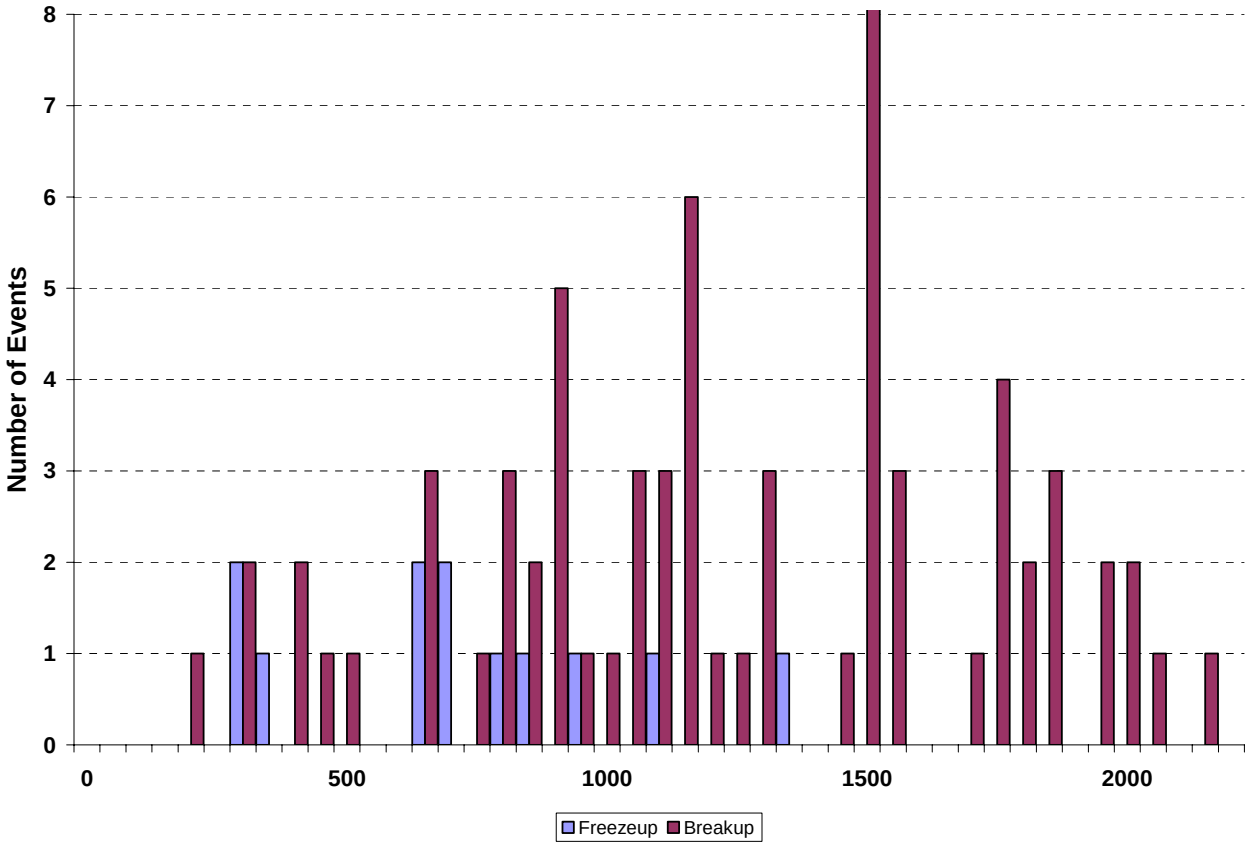

Figure 28. Histogram of ice events on the Connecticut River by AFDD.

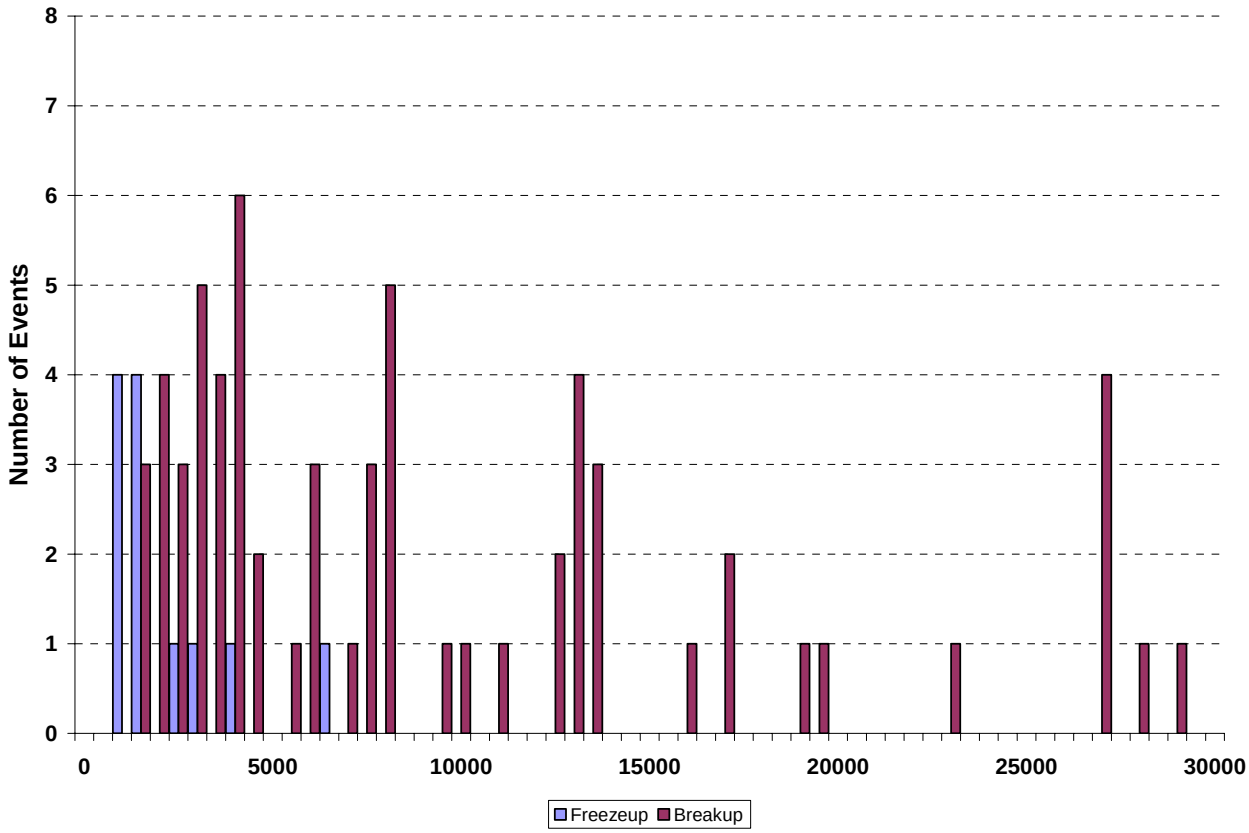

Figure 29. Histogram of ice events on the Connecticut River Watershed by discharge.

Breakup jams on the Connecticut River

Overall, breakup ice jam formation on the Connecticut River can not be considered to be progressive as shown by the average day-of-year when breakup ice jams occurred (Figure 30). There is a trend in formation starting downstream at Hartford/White River Junction and proceeding upstream but there is no consistent progression downstream of Hartford/White River Junction. This upstream progression probably reflects the general north to south orientation of the river. The average discharge associated with breakup ice jams generally increases from upstream to downstream (Figure 31), with an anomalous peak in West Lebanon. In every case, the discharge was increasing prior to the formation of a breakup ice jam at the gage associated with the jam. It can be seen that the increase in flow over the previous ten days (*DelQ10*, red line) and the increase over the previous two days (*DelQ2*, black line) formed a large portion of the discharge at the time of the jam. This suggests the relatively rapid rise in flow before the formation of the jams. The average discharge associated with breakup jams can also be compared

to the long-term annual average discharge (pink triangles). In general, breakup ice jam formation in the upstream reaches tends to occur at an average discharge greater than the long-term annual average discharge. This result is not consistent with the relative time of year when breakup jams occur, but rather suggests that the discharges during ice jams are relatively large events. The average seasonal AFDD associated with breakup ice jams (Figure 32) tend to be less than the annual maximum AFDD. This reflects the fact that the ice jams are recorded throughout the winter and not just at the end of the winter in the spring rise.

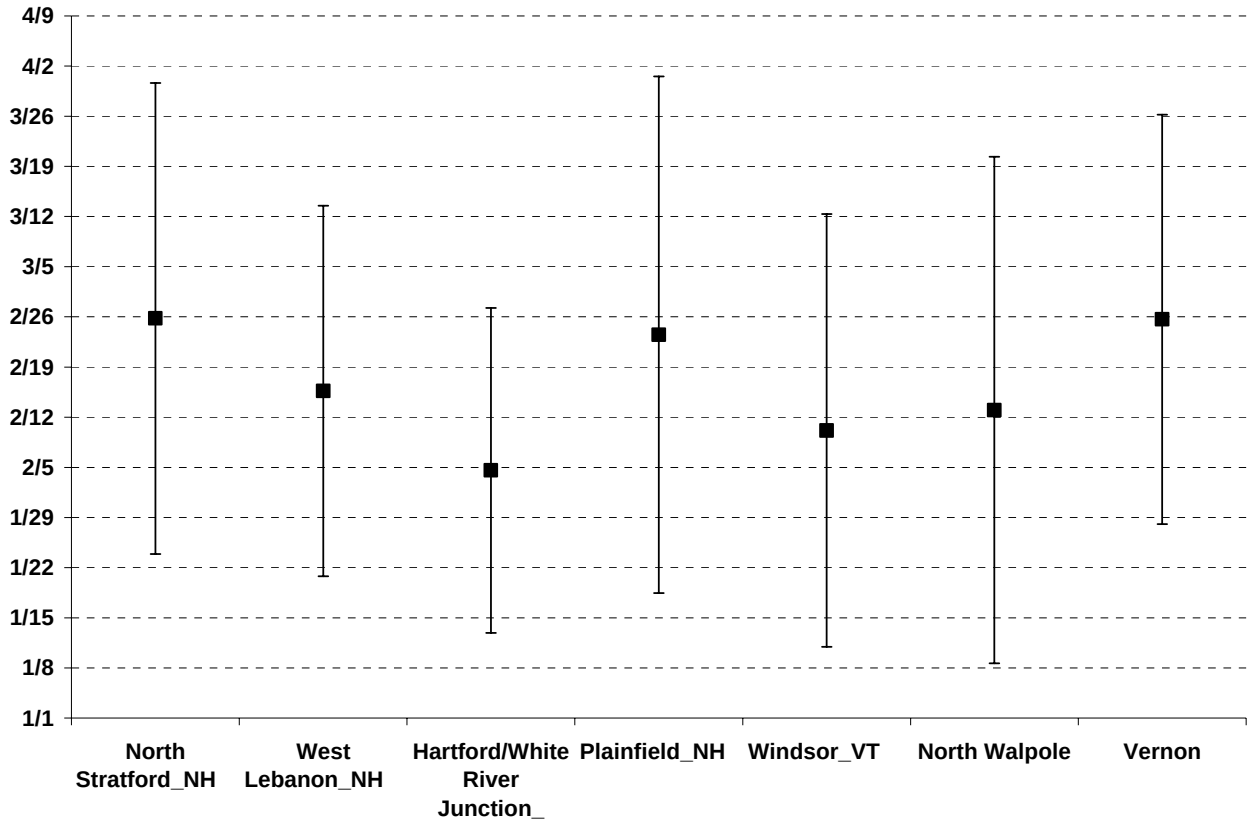

Figure 30. Dates of ice events along the Connecticut River.

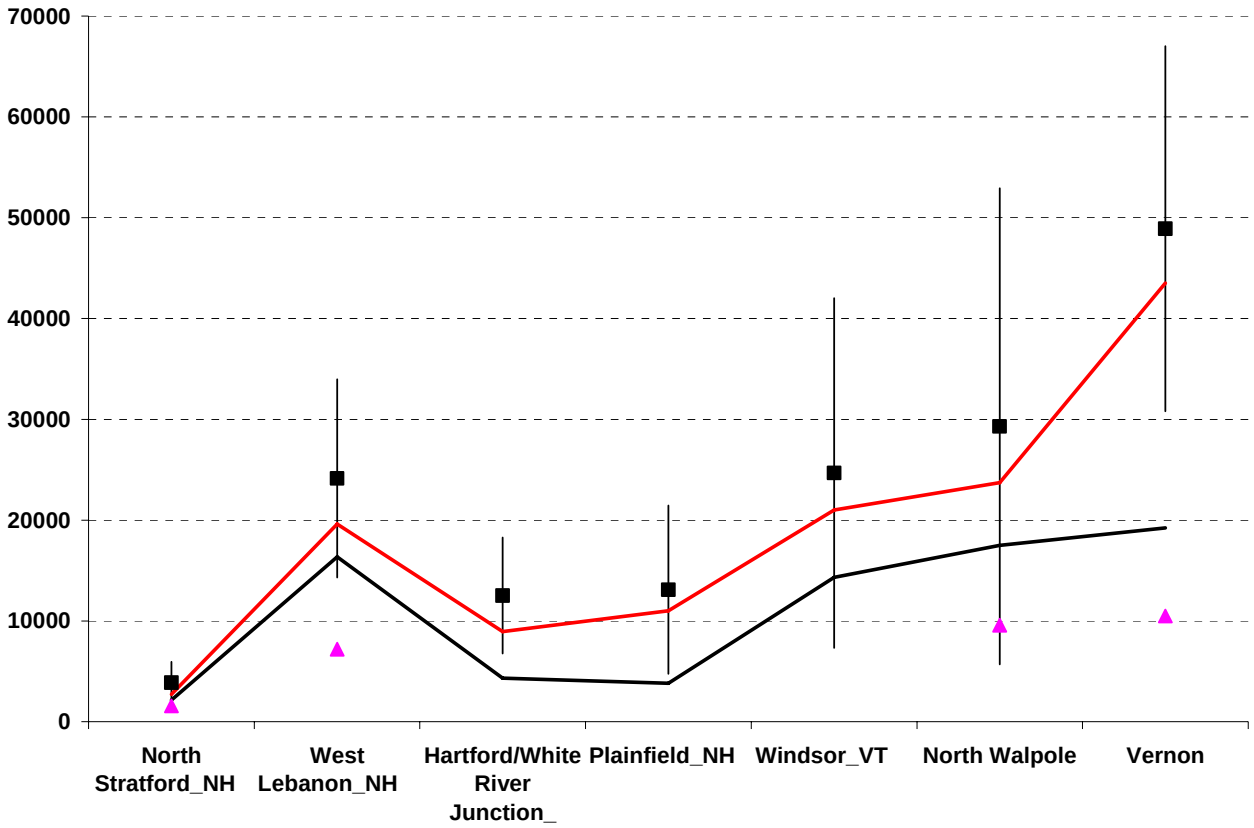

Figure 31. Discharges associated with ice events along the Connecticut River. Shown are the average discharge and standard deviation associated with the events, the average DelQ10 (red line), DelQ2 (black line), and annual average discharge each location (pink triangle).

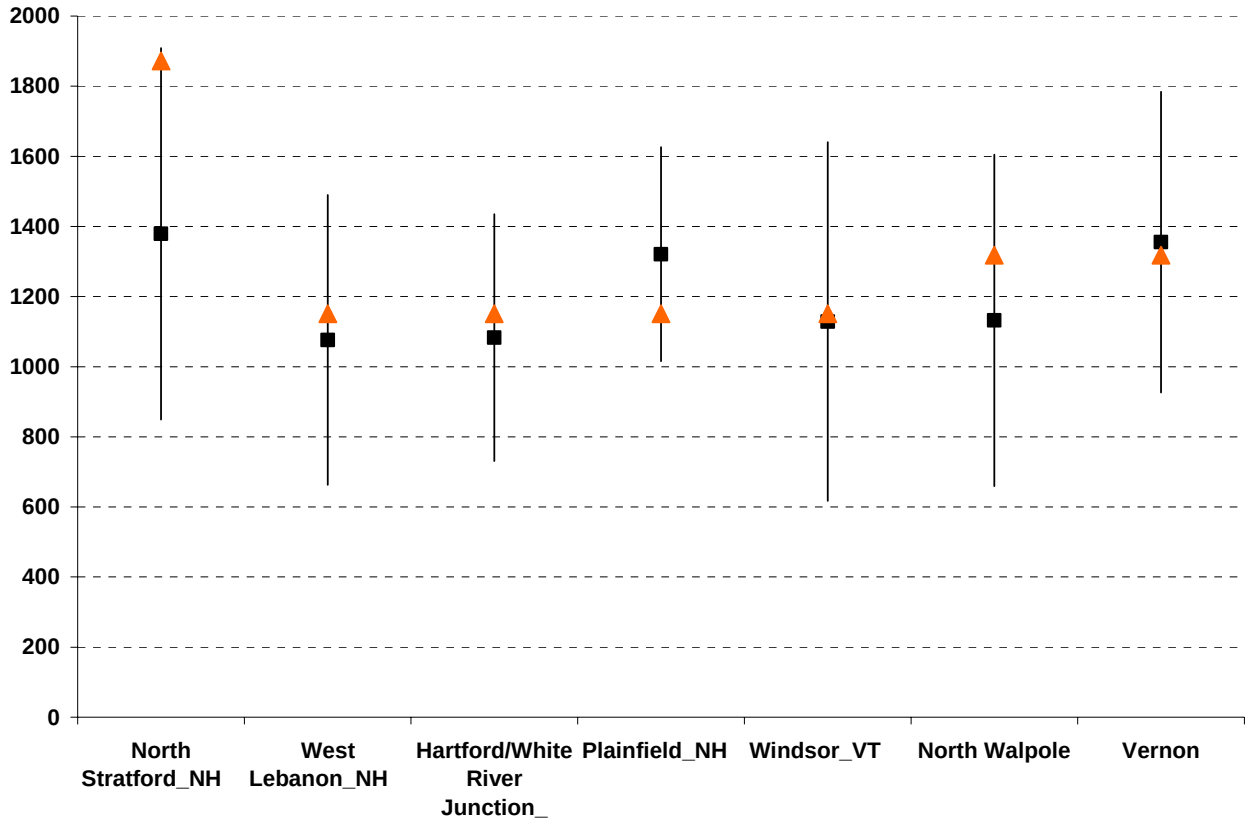

Figure 32. AFDD's associated with ice events along the Connecticut River. Shown are the average discharge and standard deviation associated with the events, and the average annual maximum AFDD at selected locations (Orange triangles).

Jams at the Connecticut River at West Lebanon

The Connecticut River at West Lebanon was selected for a detailed review of the conditions under which freezeup and breakup ice jams occur because there was sufficient data for analysis at this site, and the differences between the mean discharge of each group of breakup jams was statistically significant as determined by a F Test. Recall that each group of discharges represented a range of AFDD. The statistics of the discharge associated with each ice jam are shown in Figure 33. The discharge has been combined into four separate groups; all freezeup jams are combined into one group and there are three groups of breakup jams. The ranges of the breakup jams are 0-1000 AFDD (F), 10000-1200 AFDD (F), and 1200 and greater AFDD (F). The ranges of AFDD are somewhat arbitrary, and were selected to provide a more-or-less equal number of breakup jams for each group. The general trend is for median discharge to increase with increasing AFDD. The median discharge of all the breakup ice jam groups is larger than the discharge associated with freezeup group.

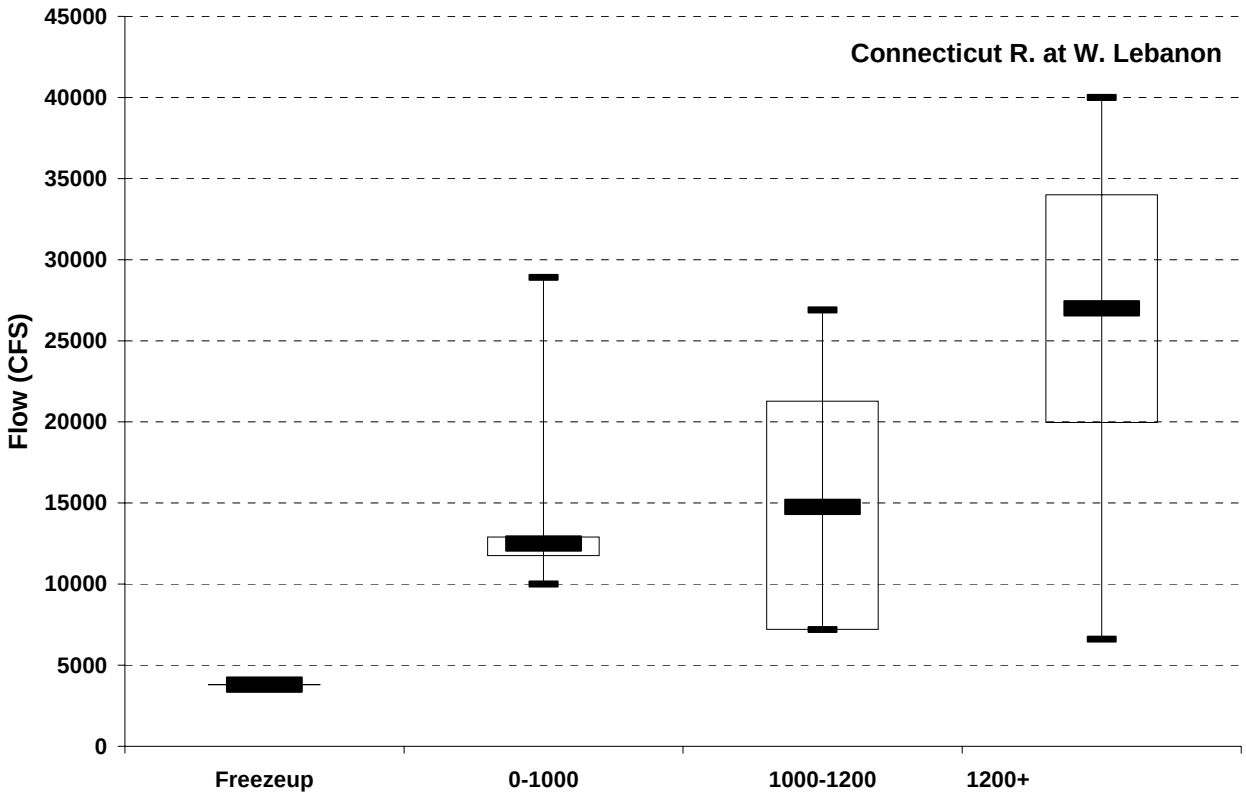

Figure 33. Discharge recorded during ice events as a function of AFDD for the Connecticut River at West Lebanon. Shown are the flows for freezeup events, and for breakup events in three separate AFDD bins.

The AFDD recorded immediately prior to the jam formation is shown in Figure 34. The AFDD recorded in the prior ten days (*delA10*), the prior five days (*delA5*), and the prior two days (*delA2*) are shown for each group (Figure 34a-c). The results here are different than the results for the Platte River at Grand Island, presented earlier. First of all, it is evident that for breakup jams that occurred at less than 1000 AFDD, the *delA10* and *delA5* can be as large as those for the freezeup jams. It is not until the previous two days that a significant difference is seen between this group of breakup jams and the freezeup jams. Many of the breakup jams included in this group probably occurred early in the winter season during brief warm periods, many as short as two days. The two groups larger than 1000 AFDD both are similar and significantly different that the group less than 1000 AFDD and the freezeup jams. The median AFDD for these breakup groups tended to be at or very near zero for the prior 5 days and two days. This suggests that these breakup jams tend to occur during relatively warm periods, when the air temperature is above freezing, at least for the five days preceding the formation of the jam.

The change in discharge recorded immediately prior to the jam formation is shown in Figure 35. The change in discharge recorded in the prior ten days (*delQ10*), the prior five days (*delQ5*), and the prior two days (*delQ2*) are shown for each group. Recall that the criteria for freezeup jams was that the change in discharge over the prior five days was less than zero, so it is no surprise that *delQ5* is less than zero for freezeup jams. The change over the prior 10 days, five days, and two days are nearly equal, suggesting that the rises were relatively rapid and occurred over two days or less

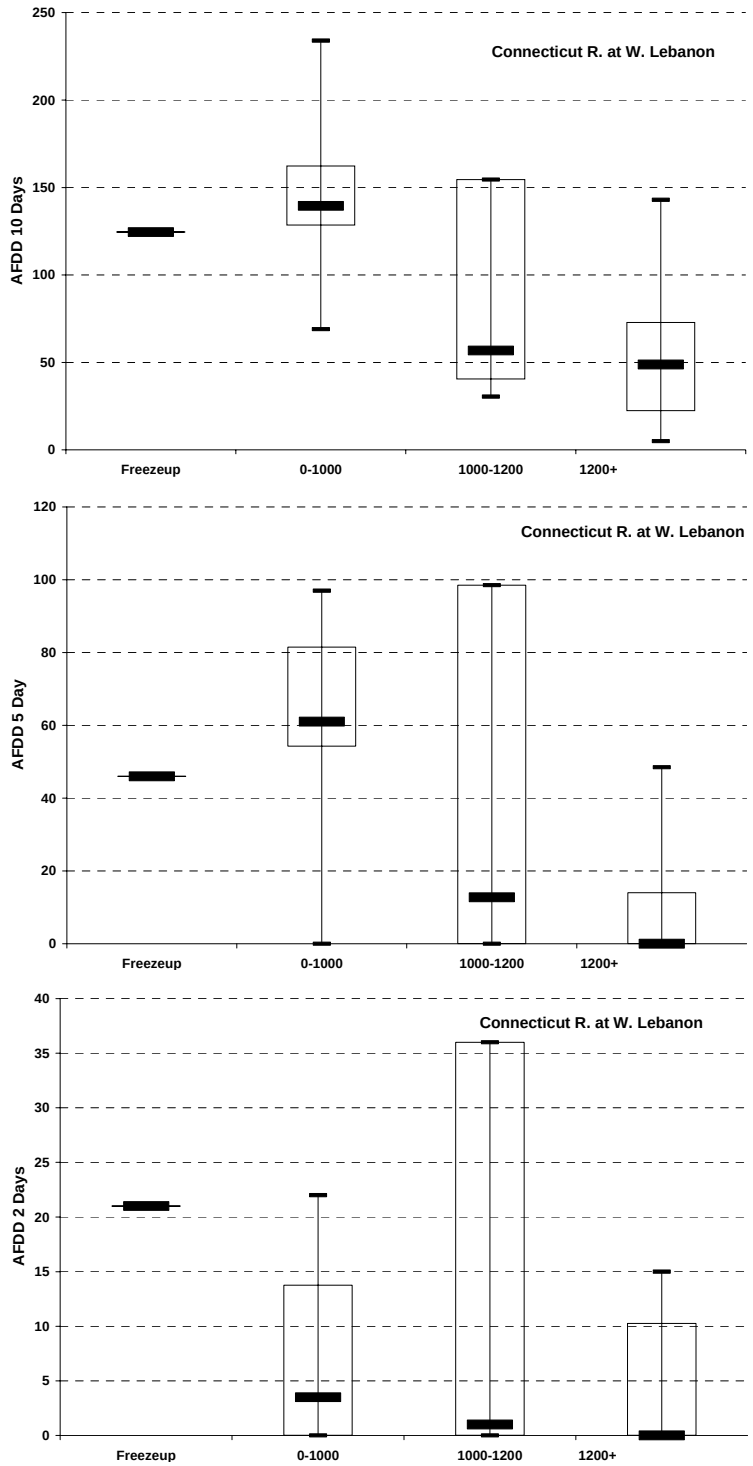

Figure 34a-c. DelA10, DelA5, and DelA2 for ice events on the Connecticut River at West Lebanon. Shown are the DelA10, DelA5, and DelA2 for freezeup events, and for breakup events in four separate AFDD bins.

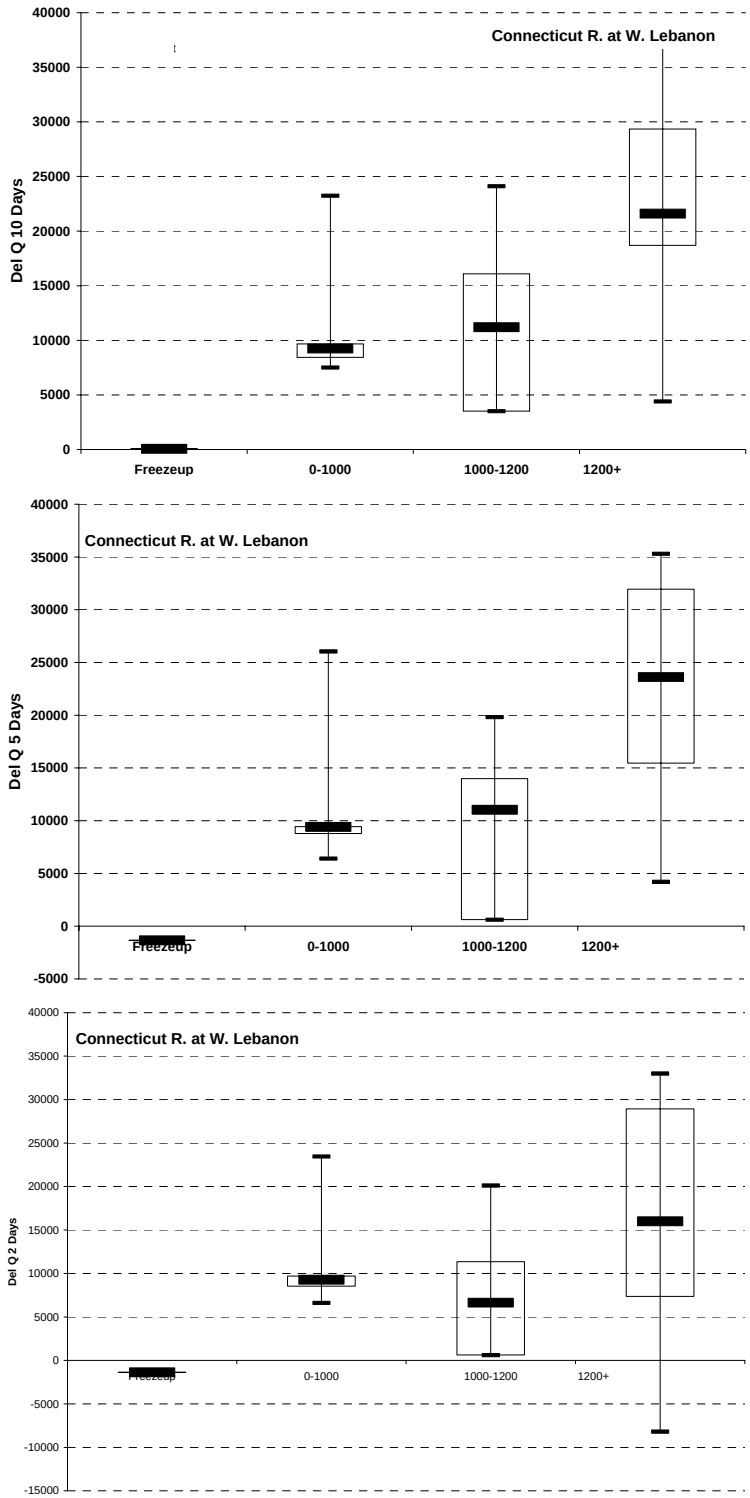

Figure 35. DelQ10, DelQ5, and DelQ2 for ice events on the Connecticut River at West Lebanon. Shown are the DelA10, DelA5, and DelA2 for freezeup events, and for breakup events in five separate AFDD bins.

Milk River

Introduction

The Milk River is a tributary of the Missouri River, 729 mi (1,173 km) long in the U.S. state of Montana and the Canadian province of Alberta (Figure 36). The Milk is the northernmost major tributary of the Missouri, and thus its drainage area forms the rough northern extent of the Mississippi watershed

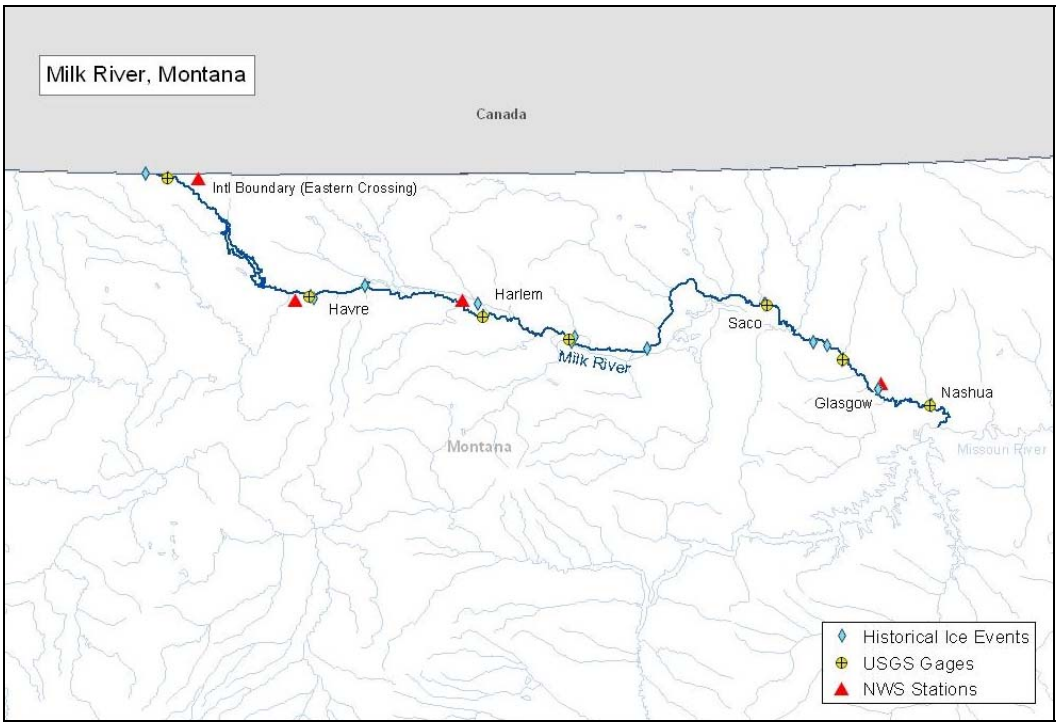

Figure 36. Milk River.

At the time of this study, there were 52 entries in the IJDB for the Milk River (Table 6A). The dates of the jams recorded in the IJDB range from the early 1950's to the mid 1990's (Figure 37). The data falls into two rough groups, with the first group ranging from the early 1950's to the early 1970's. Then there is a gap until the mid 1990's, with only two ice jams recorded during the period from the early 1970's to the mid 1990's. The day-of-year recorded in the IJDB occurs largely in March, with a few jams occurring in February and early April.

Table 6a. Ice jam, hydrologic and meteorologic information for the Milk River.

Gage	Freezeup Events	Breakup Events	Unknown	DA (sq.mi)	Average Flow (cfs)	Average Max AFDD's (F)	RBW Index
Eastern Crossing	0	9	0	2525	482	2157	0.056
Havre	0	5	0	5785	383	1578	0.097
Harlem	0	3	0	9822	375	1815	0.090
Dodson	0	2	5	11192	187	1815	0.111
Juneberg	0	2	0	17670	375	1886	0.083
Tampico	0	4	9	21078	438	1886	0.102
Nashua	0	13	0	22332	642	1886	0.087

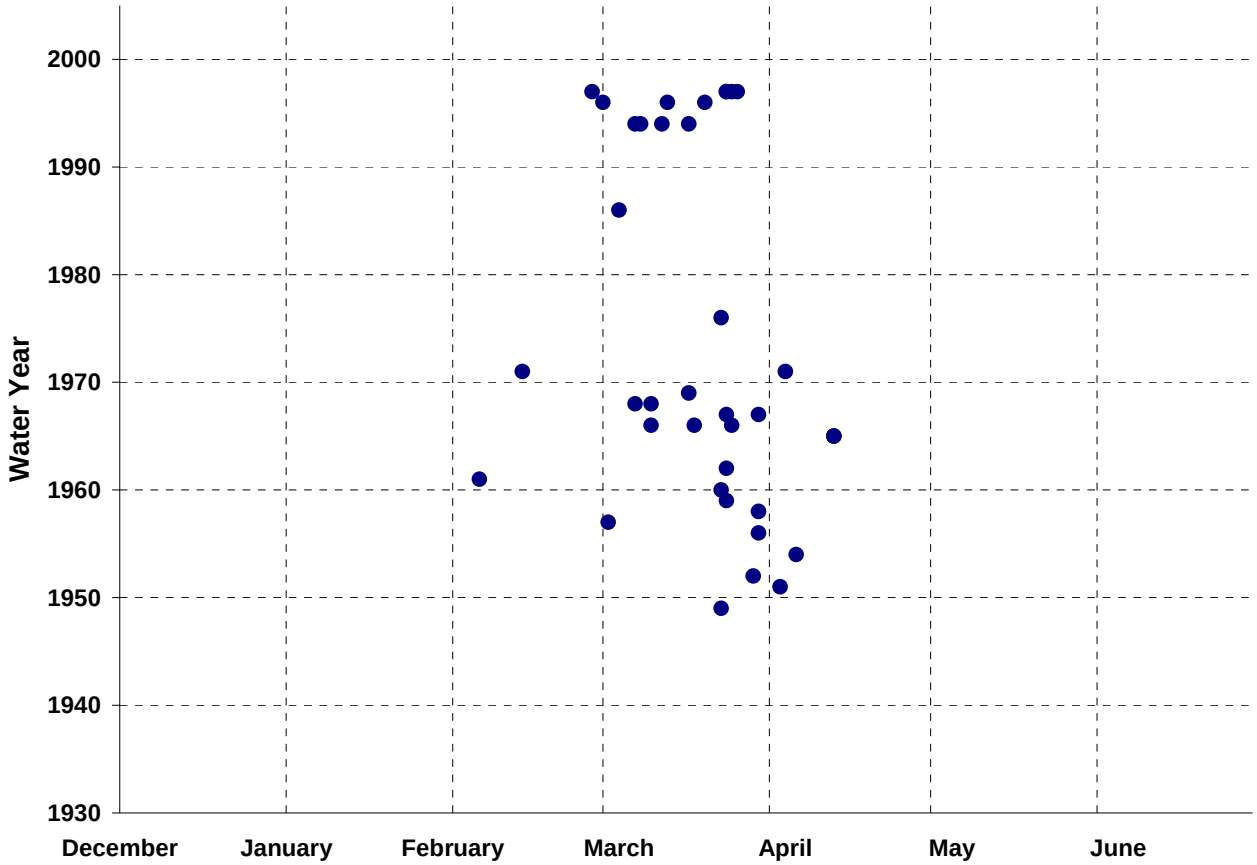

Figure 37. All ice jam data for the Milk River. Freeze up jams are open circles, breakup jams are solid.

Overview

The Milk River has several dams and flows can be impacted by irrigation diversions. Flows in the Milk River tend to decline slightly throughout the winter until the spring rise begins in late February or early March. Only the gages downstream of Juneberg tend to display a consistent spring rise,

typically peaking in late March and early April. Upstream of Juneberg the spring rise tends to be not as pronounced, with a gradual increase in flow that can continue into June. The Milk River rates as only a moderately flashy river on the RBW index. However, reviewing the record of daily average flows along the Milk River suggests that the river displays considerable year to year variation in flow. All the jams on the recorded on the Milk River were classified as breakup jams although 27% remain as unknown type due to gaps in the discharge records. The winters along the Milk River are relatively harsh; with average annual maximums AFDD of over 1800 AFDD (F) recorded (Table 6B).

Table 6b. Ice jam data for the Milk River.

Gage	Breakup Jams				
	Average Day-of-Year	Average AFDD (F)	Average Time To Peak (Days)	Average Discharge (CFS)	Average Base flow (CFS)
Eastern Crossing	3/21	2219	2.0	2019	228
Harve	3/2	2050	1.8	2482	82
Harlem	3/18	2274	2.7	1933	332
Dodson	3/22	2373	0.5	3450	108
Juneberg	3/1	2284	4.0	5425	87
Tampico	3/19	2165	7.5	7500	363
Nashua	3/24	2499	6.1	5332	113

A general overview of ice jams on the Milk River is presented next. The dates when all ice jams occurred on the Milk River is shown in Figure 38. Breakup jams occur largely in March, with the histogram peak occurring in the last week of the month. Breakup jams can occur as early as the second week of February and as late as mid April. The histogram of AFDD associated with breakup jams peaks around 2500 AFDD (F) (Figure 39). This is much larger than the average annual maximum AFDD, indicating that jams tend to occur at the end of winters that are colder than normal, as determined by the number of AFDD. The histogram of discharges associated with breakup jams peaks between 2000 and 3000 CFS (Figure 40). The range of discharges for breakup jams extends from 1000 CFS to over 11,000 CFS. In summary, jams on the Milk River tend to occur at the end of the winter season after colder than normal winters, and at relatively large discharges.

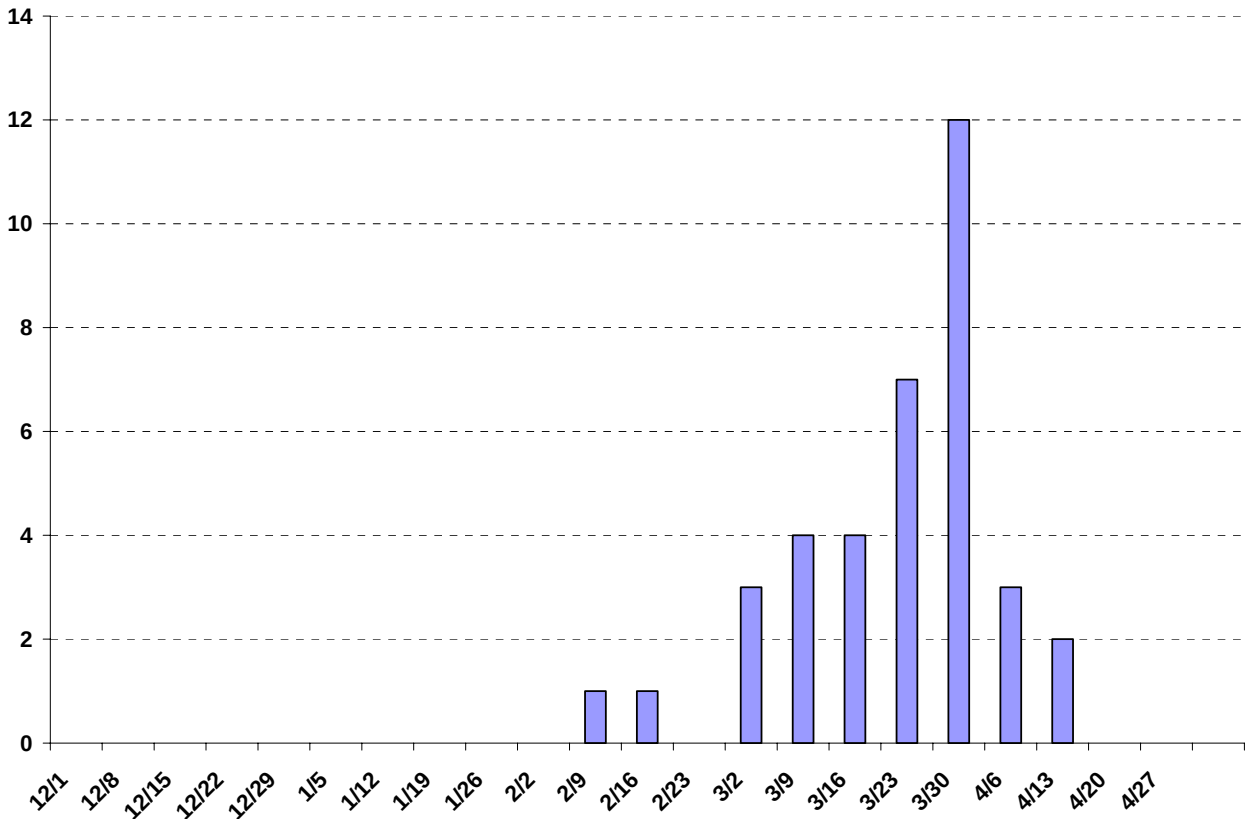

Figure 38. Histogram of ice events on the Milk River watershed by day of year.

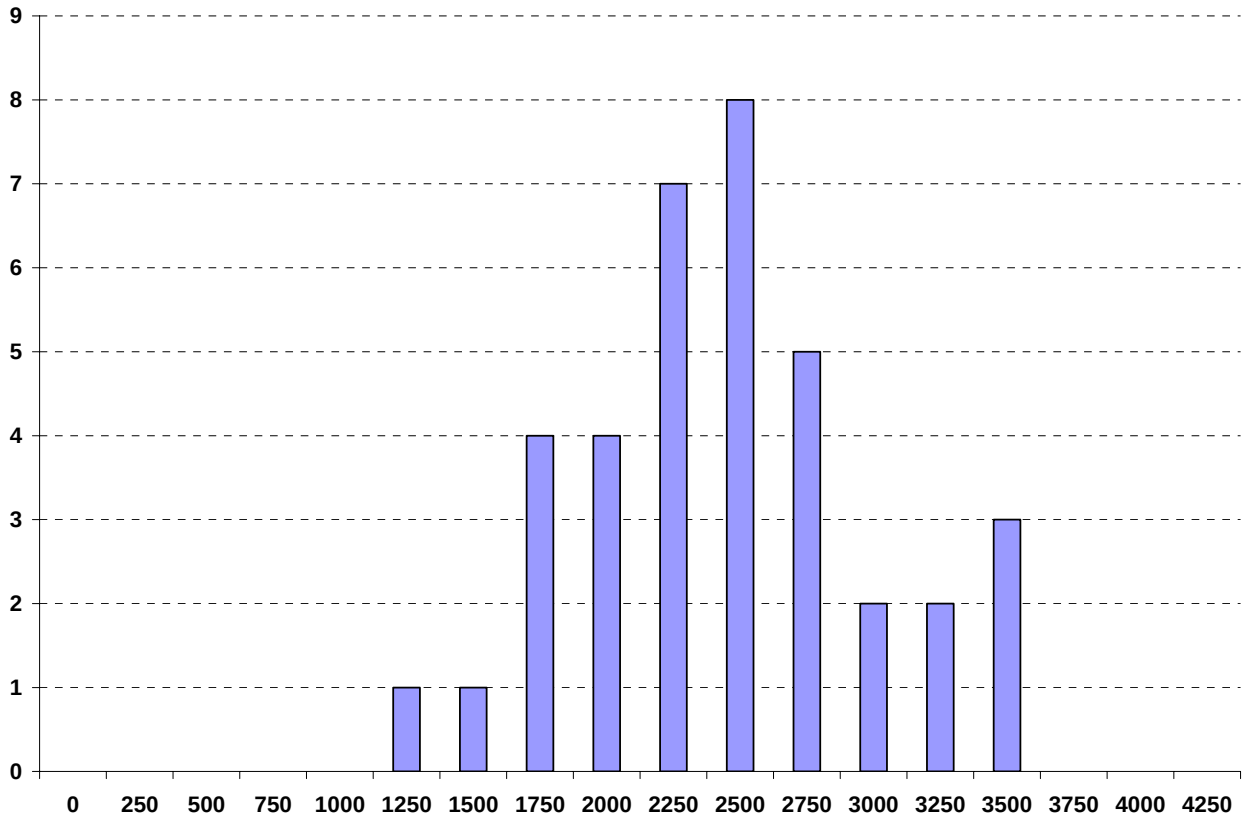

Figure 39. Histogram of ice events on the Milk River by AFDD.

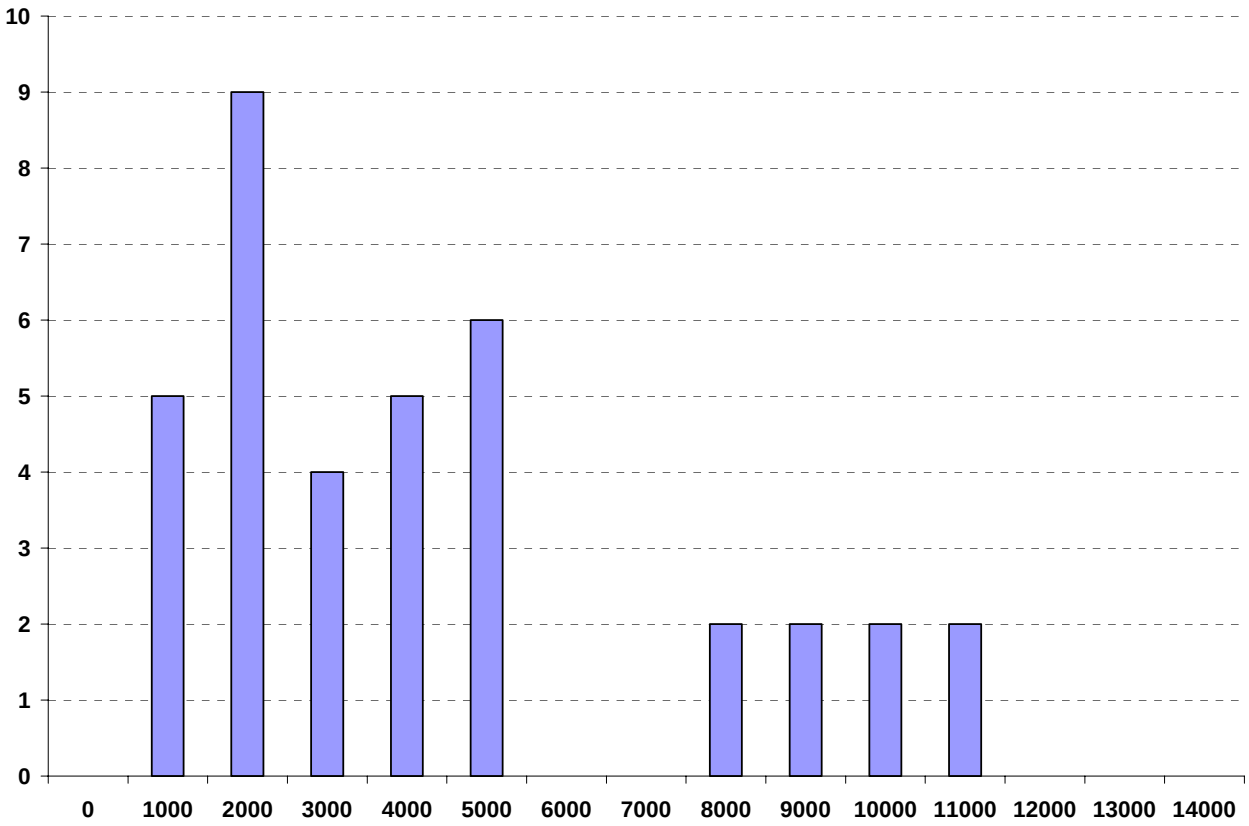

Figure 40. Histogram of ice events on the Milk River watershed by discharge.

Breakup jams on the Milk River

As with the Yukon and Kuskokwim Rivers, all jams recorded in the IJDB for the Milk River were classified as breakup jams. Overall, breakup ice jam formation on the Milk River can be considered to be partially progressive (Figure 41). There is no trend in breakup ice jam formation upstream of about Saco where the average dates of breakup range between 3 March and 23 March. Downstream of Saco the breakup dates are somewhat progressive, starting at Saco on about 2 March and progressing downstream to Nashua on 24 March. In every case, the discharge was increasing prior to the formation of a breakup ice jam at the gage associated with the jam (Figure 42). It can be seen that the increase in flow over the previous ten days (*DelQ10*, red line) formed nearly all of the discharge at the time of the jam and the increase over the previous two days (*DelQ2*, black line) formed a relatively small portion of the discharge at the time of the jam. This suggests the relatively rapid rise in flow in the period immediately before the formation of the jams. The average discharge associated with breakup jams can also be compared to the long-

term annual average discharge (pink triangles). Breakup ice jam formation all along the Milk River occurs at an average discharge much greater than the long-term annual average discharge. This result is consistent with the relative time of year when breakup jams occur coinciding with the spring rise. The average seasonal AFDD associated with breakup ice jams (Figure 43) tend to be significantly greater than the average annual maximum AFDD.

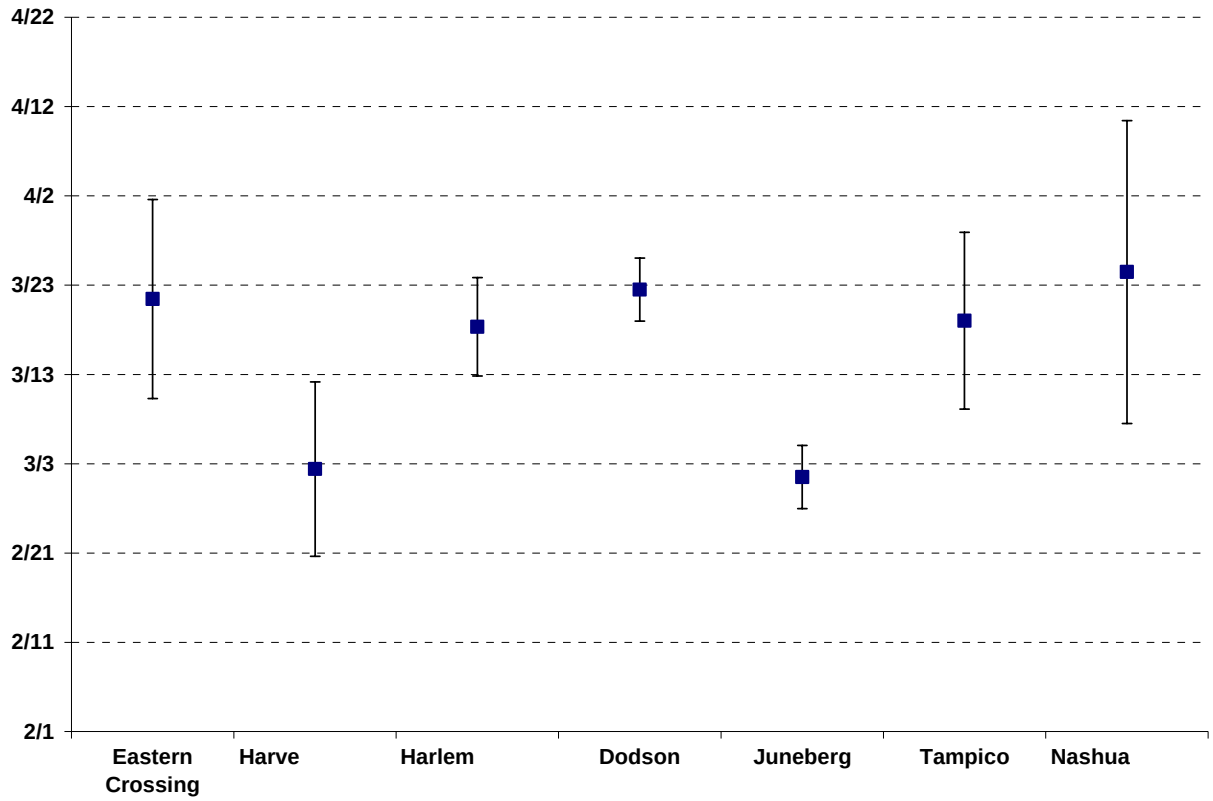

Figure 41. Dates of ice events along the Milk River.

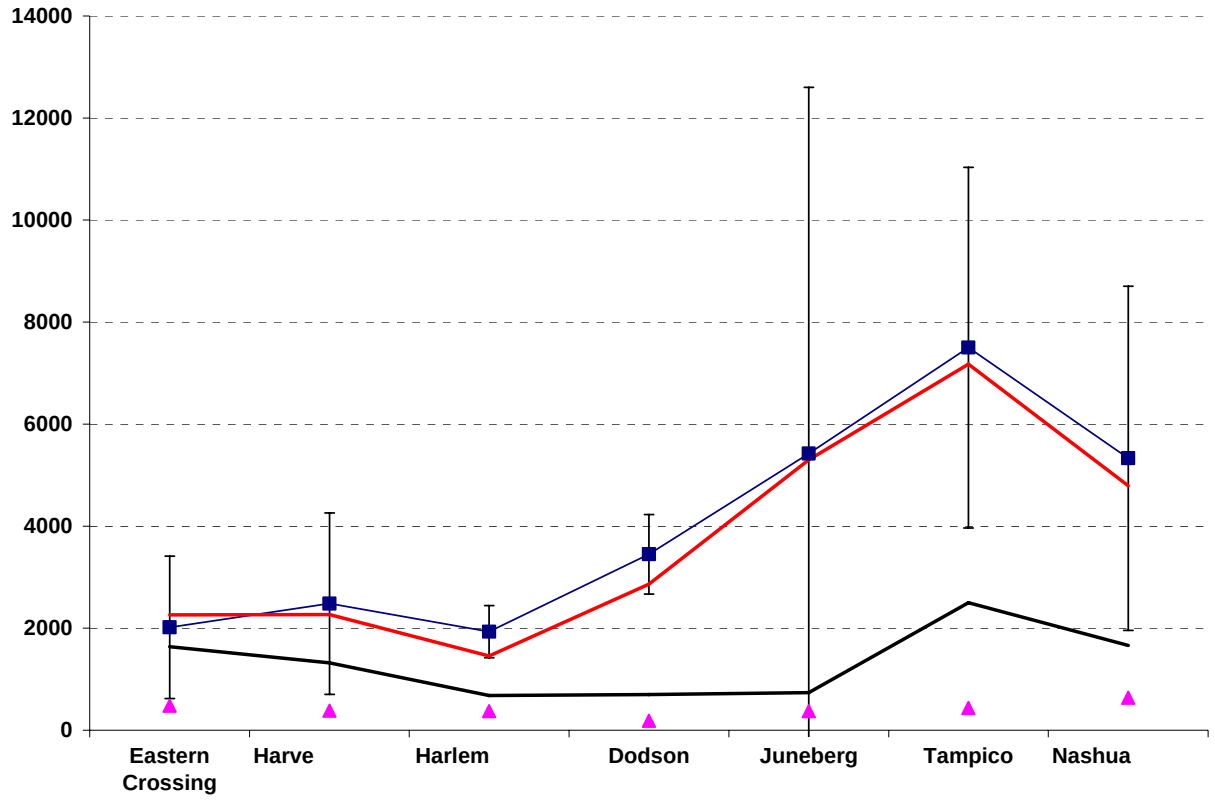

Figure 42. Discharges associated with ice events along the Milk River. Shown are the average discharge and standard deviation associated with the events, the average DelQ10 (red line), DelQ2 (black line), and annual average discharge each location (pink triangle).

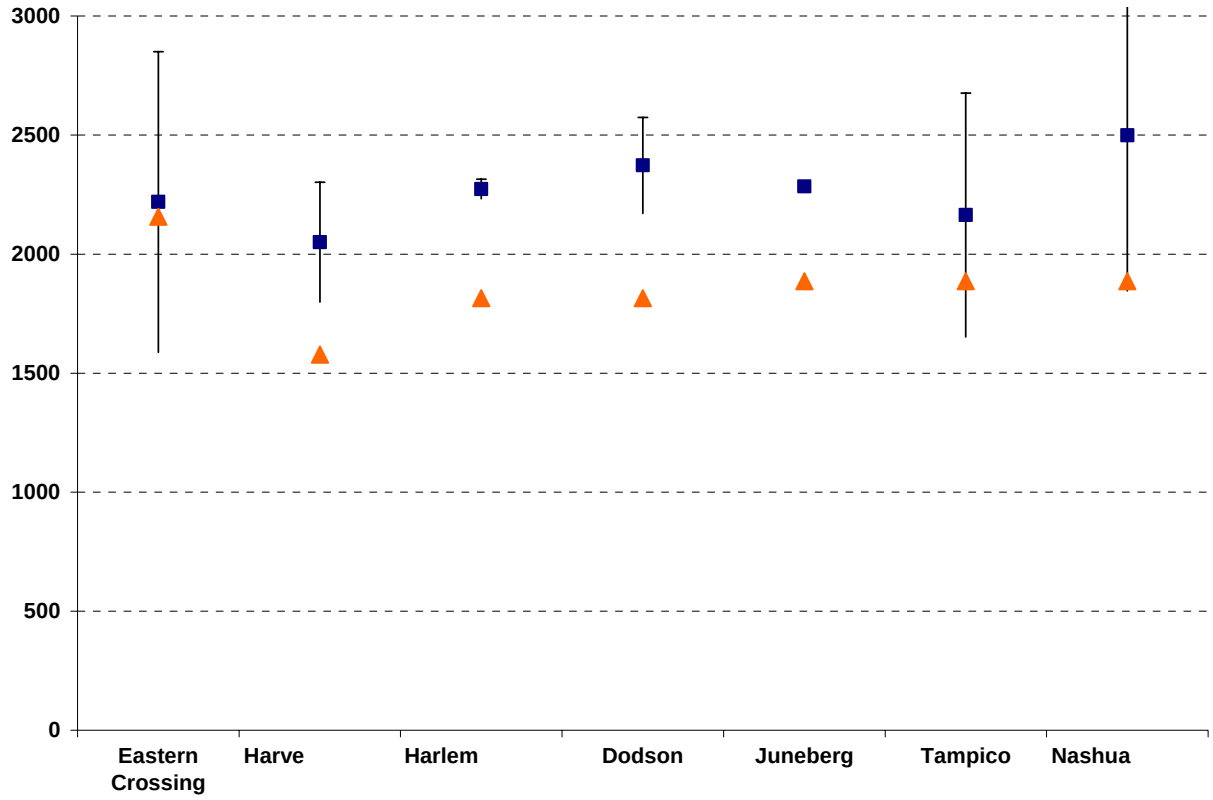

Figure 43. AFDD's associated with ice events along the Milk River. Shown are the average discharge and standard deviation associated with the events, and the average annual maximum AFDD at selected locations (Orange triangles).

Kankakee River

Introduction

The Kankakee River is a tributary of the Illinois River, approximately 90 mi (144 km) long, in northwestern Indiana and northeastern Illinois (Figure 44). The Kankakee rises in northwestern Indiana, approximately 5 mi (8 km) southwest of South Bend. It joins the Des Plaines River from the south to form the Illinois, approximately 50 mi (80 km) southwest of Chicago.

At the time of this study, there were 38 entries in the IJDB for the Kankakee River (Table 7A). The dates of the jams recorded in the IJDB range from the mid 1920's to 2005 (Figure 45). Both freezeup and breakup jams were recorded more or less continuously during this period. The day-of-year recorded in the IJDB ranges from mid December through early

March, with most of the jams occurring in February. The Kankakee also has only one discharge gage located in the reach where ice jams occur. It has several nearby NWS meteorological stations (Figure 44).

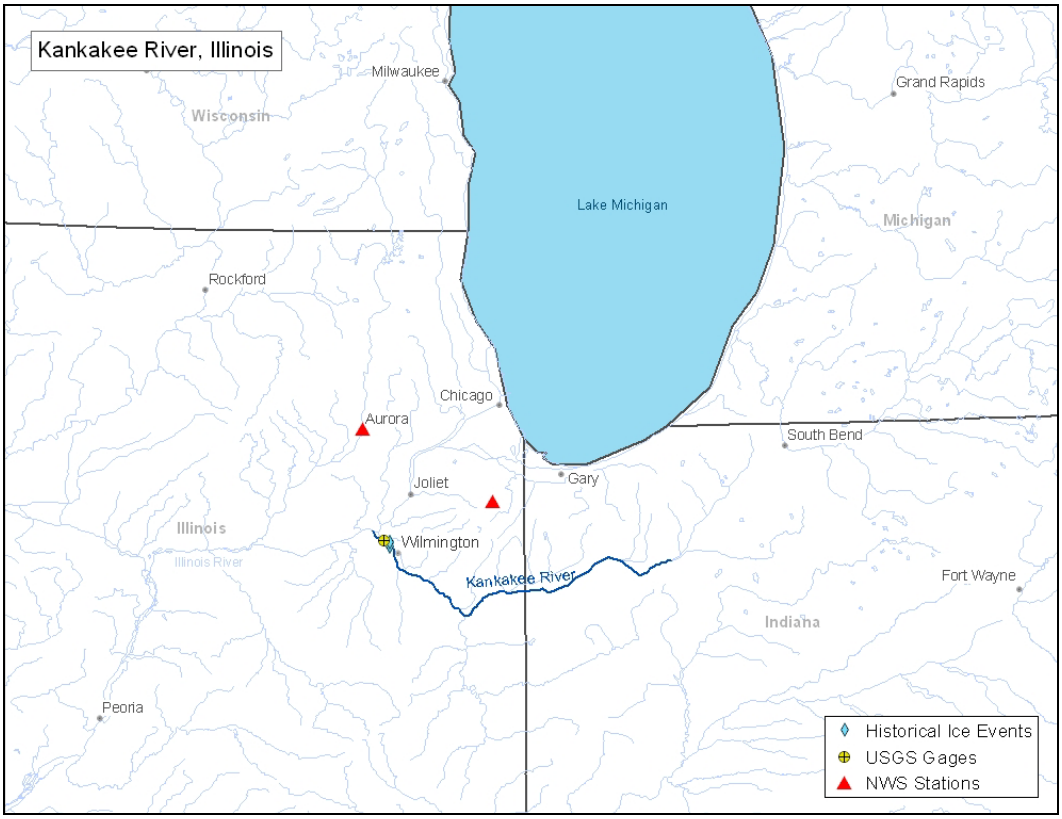

Figure 44. Kankakee River.

Table 7a. Ice jam, hydrologic and meteorologic information for the Kankakee River.

Gage	Freezeup Events	Breakup Events	Unknown	DA (sq.mi)	Average Flow (cfs)	Average Max AFDD's (F)	RBW Index
Wilmington	10	29	0	5150	4457	880	.095

Overview

Flow in the Kankakee River is somewhat affected by the presence of four dams along its length in Illinois. It is somewhat unusual in that flow in the Kankakee River does not decline during the winter but rather tends in increase throughout the autumn and winter months, generally reaching a peak in late March early April. The river is only moderately flashy on the RBW index. The winters are moderate with average annual maximum AFDD's of approximately 880 AFDD (F). Ice jams on the Kankakee tend to

largely breakup jams (75%) but freezeup jams can occur as well (25%) (Table 7B).

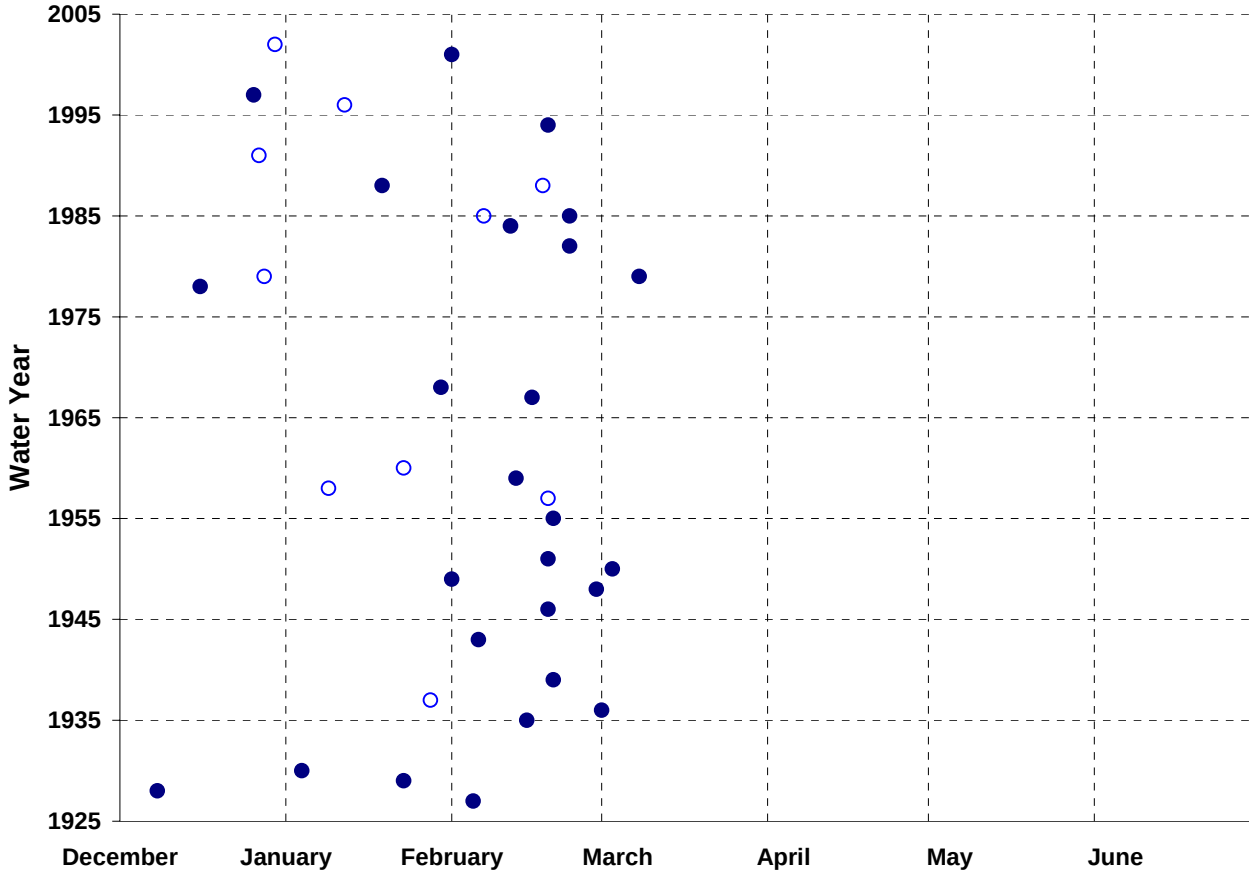

Figure 45. All ice jam data for the Kankakee River. Freeze up jams are open circles, breakup jams are solid.

Table 7b. Ice jam data for the Kankakee River

	Breakup Jams					Freezeup Jams					
Gage	Average Day-of-Year	Average AFDD (F)	Average Time To Peak (Days)	Average Discharge (CFS)	Average Base flow (CFS)	Average Day-of-Year	Average AFDD (F)	Average Discharge (CFS)	DelA2 (F)	DelA5 (F)	DelA10 (F)
Wilmington, IL	2/6	756	4.2	15616	1837	1/20	443	4082	23	70	126

The dates when all ice jams occurred on the Kankakee River is shown using a histogram that combines both the freezeup jams and breakup jams (Figure 46). The histogram of freezeup jams peaks in late December and early January, although freezeup jams have been recorded as late as the end of February. The histogram of breakup jams peaks in late February. Breakup jams can also occur throughout the winter season, starting in mid

December through mid March. The histogram of AFDD associated with freezeup jams peaks much early than the histogram associated with breakup jams as probably is expected (Figure 47). The histogram of

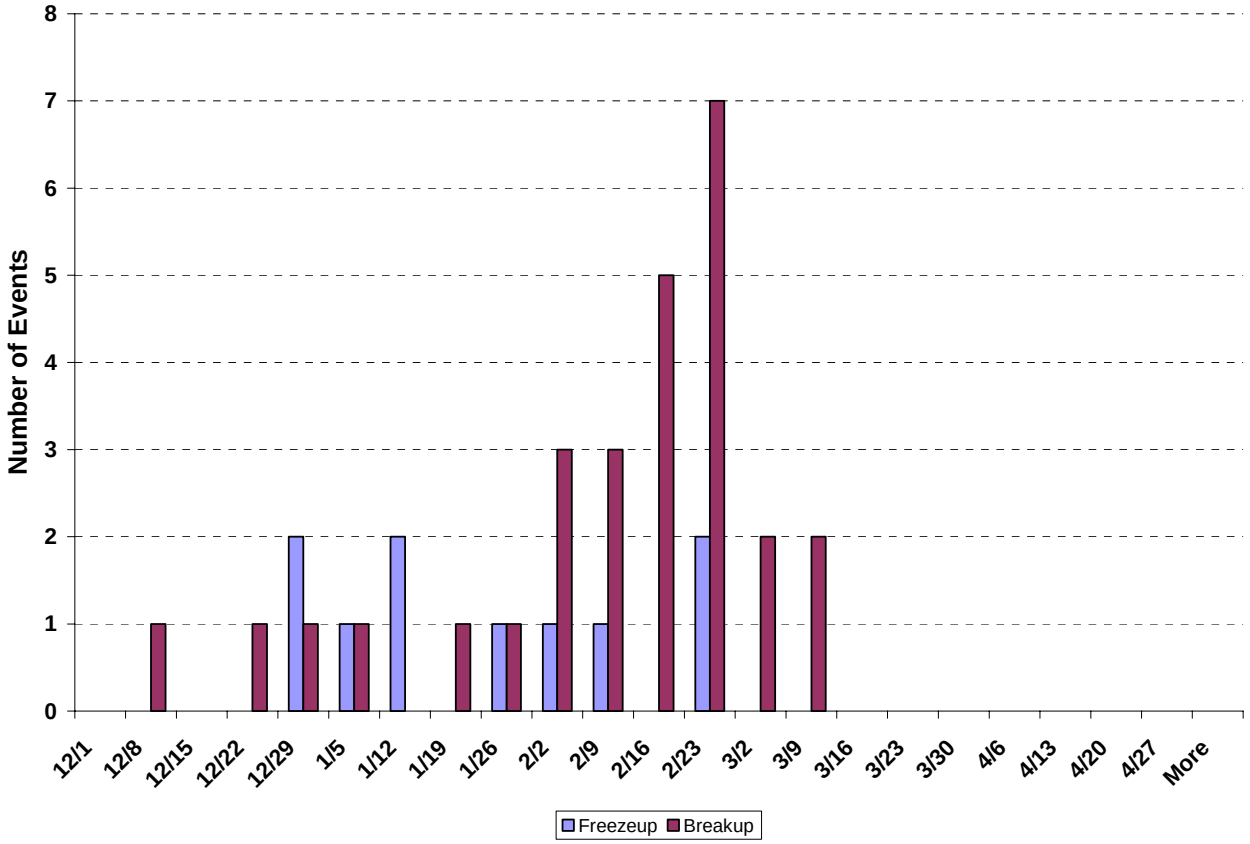

Figure 46. Histogram of ice events on the Kankakee River Watershed by day of year.

freezeup jams peaks between 250-500 AFDD (F) and the histogram of breakup jams peak between 750-1000 AFDD (F). The histogram of discharges associated with freezeup jams peaks between 2500-5000 CFS (Figure 48). The histogram of discharges associated with breakup jams peaks between 3000-4000 CFS. The range of discharges for breakup jams is much larger than that of freezeup jams, extending from 5000 CFS to 30,000 CFS, while the range for freezeup jams is much smaller, extending from 2500 CFS to about 12,500 CFS. In summary, freezeup jams tend to occur earlier in the winter season, at fewer seasonal AFDD, and at lower discharges than breakup jams. However, there is considerable overlap of the ranges for all three of these parameters between freezeup and breakup jams.

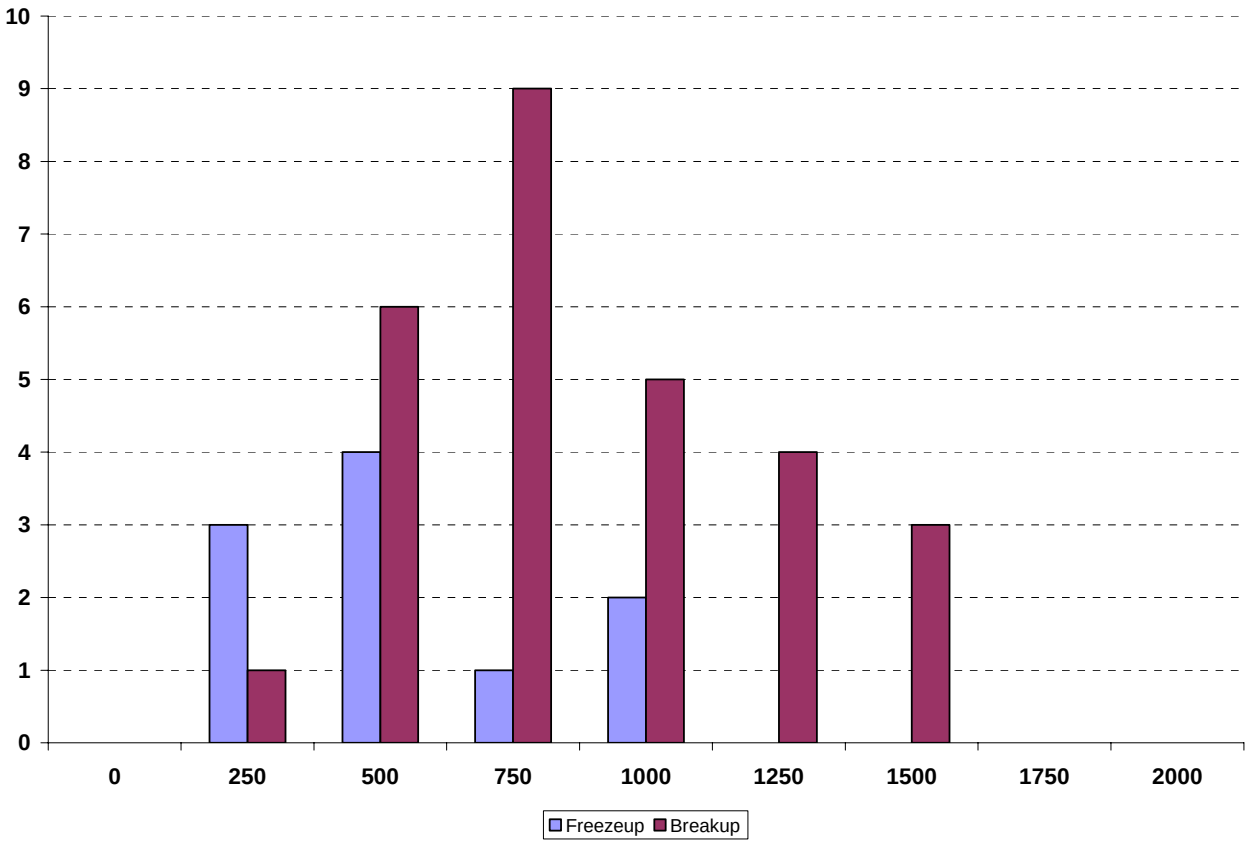

Figure 47. Histogram of ice events on the Kankakee River by AFDD.

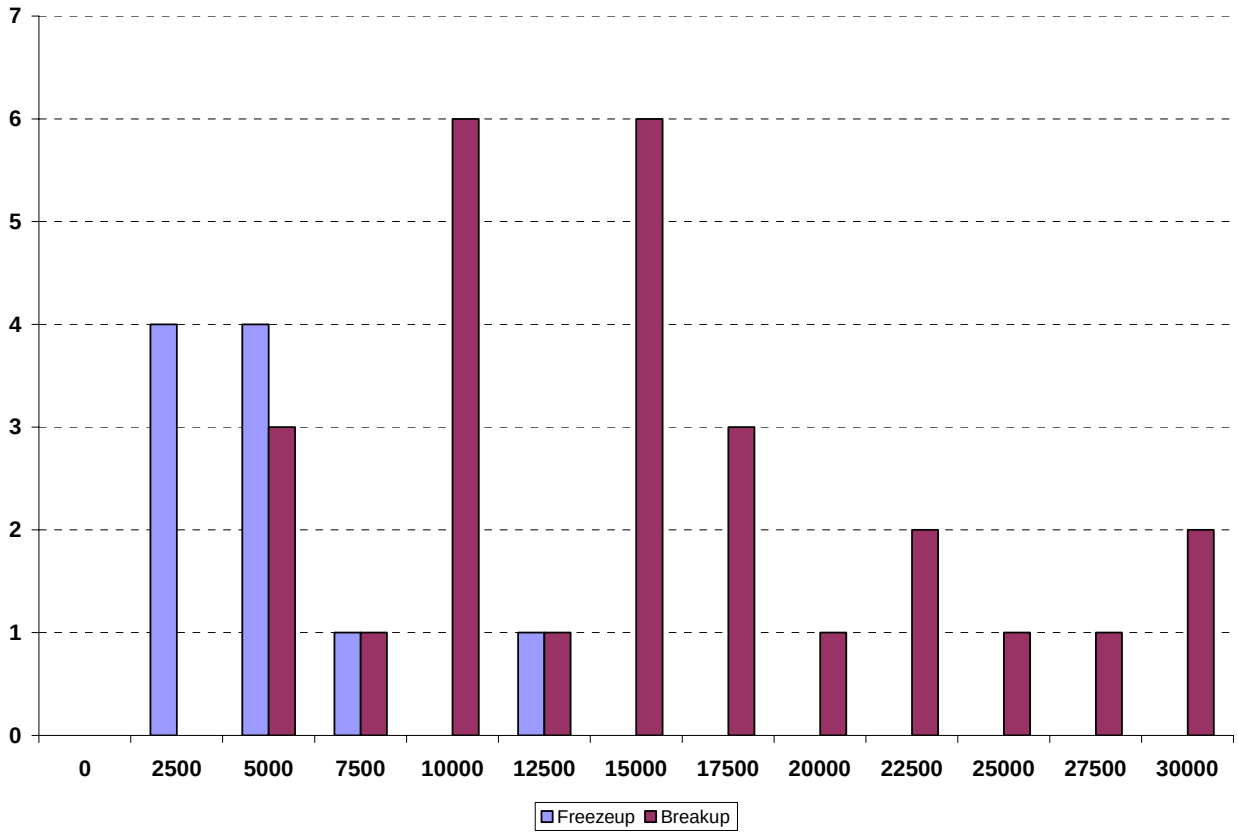

Figure 48. Histogram of ice events on the Kankakee River Watershed by discharge.

Ice jams on the Kankakee River at Wilmington

The Kankakee River at Wilmington was selected for a detailed review of the conditions under which freezeup and breakup ice jams occur because there was sufficient data for analysis at this site, and the differences between the mean discharge of each group of breakup jams was nearly statistically significant as determined by a F Test. The statistics of the discharge associated with each ice jam are shown in Figure 49. The discharge has been combined into five separate groups; all freezeup jams are combined into one group and there are four groups of breakup jams. The ranges of the breakup jams are 0-600 AFDD (F), 600-800 AFDD (F), 800-1000 AFDD (F), and 1000 and greater AFDD (F). The ranges of AFDD are somewhat arbitrary, and were selected to provide a more-or-less equal number of breakup jams for each group. The general trend is for median discharge to increase with increasing AFDD. The median discharge of all the breakup ice jam groups is larger than the discharge associated with freezeup group. The AFDD recorded immediately prior to the jam formation is shown in Figure 50. The AFDD recorded in the prior

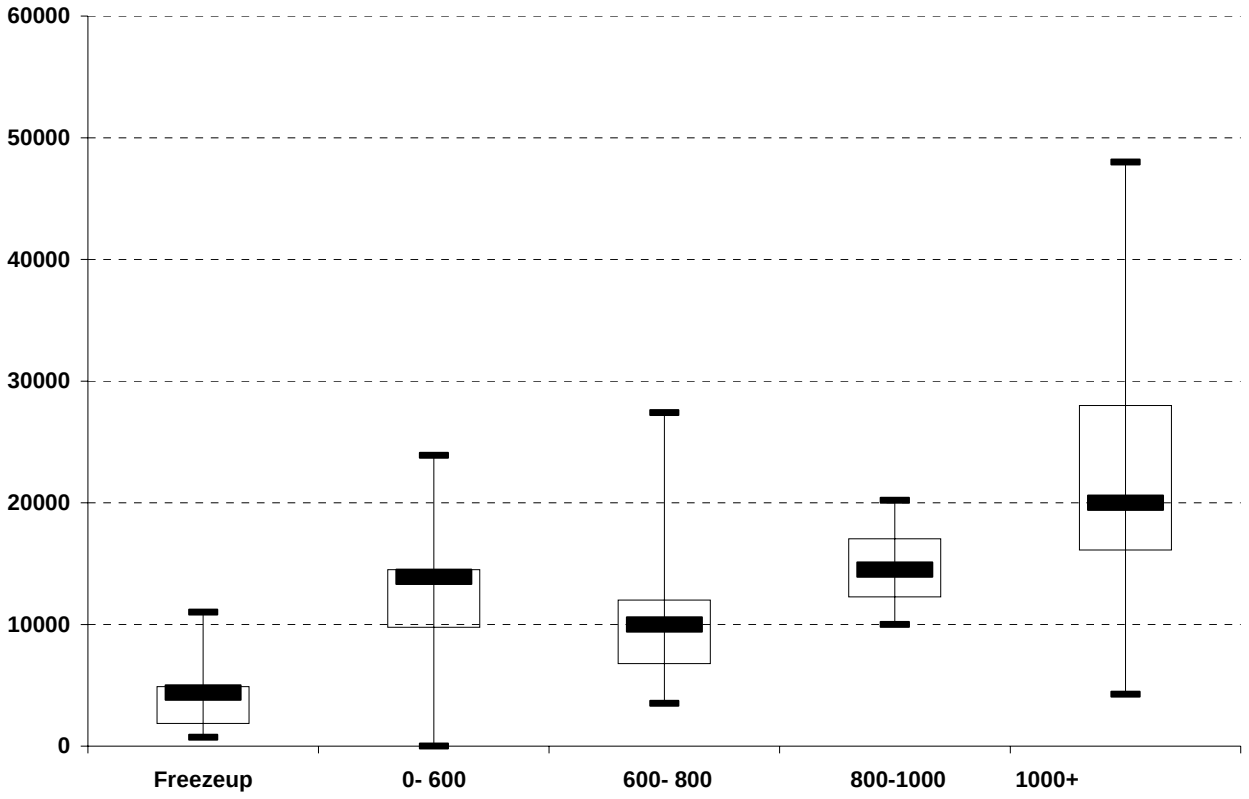

Figure 49. Discharge recorded during ice events as a function of AFDD for the Kankakee River. Shown are the flows for freezeup events, and for breakup events in four separate AFDD bins.

ten days (*delA10*), the prior five days (*delA5*), and the prior two days (*delA2*) are shown for each group. There are differences between the freezeup group and the breakup groups for the prior ten days, five days and two days, however, the differences between the freezeup jams and the breakup jams associated with the smallest category of AFDD (0-600 AFDD (F)) do not display the pronounced differences that has been seen at other locations. The median AFDD for the three largest breakup ranges tends to be at or very near zero for the prior 5 days and two days. This suggests that these breakup jams tend to occur during relatively warm periods, when the air temperature is above freezing, at least for the five days preceding the formation of the jam. The AFDD recorded for the freezeup jams over ten, five and two days periods prior to the formation of the freezeup jams tend to relatively large. This suggests that freezeup jams tend to occur after relatively cold periods, when the air temperature is below zero. The change in discharge recorded immediately prior to the jam formation is shown in Figure 51. The change in discharge recorded in the prior ten days (*delQ10*), the prior five days (*delQ5*), and the prior two days (*delQ2*) are shown for each group. The median change in discharge for the

freezeup jams is always less than zero. The change over the prior 10 days and five days are relatively equal in magnitude; and the change over the previous two days is also significant. This suggests that the rise in discharge occurred over the two to five days prior to the ice jam formation.

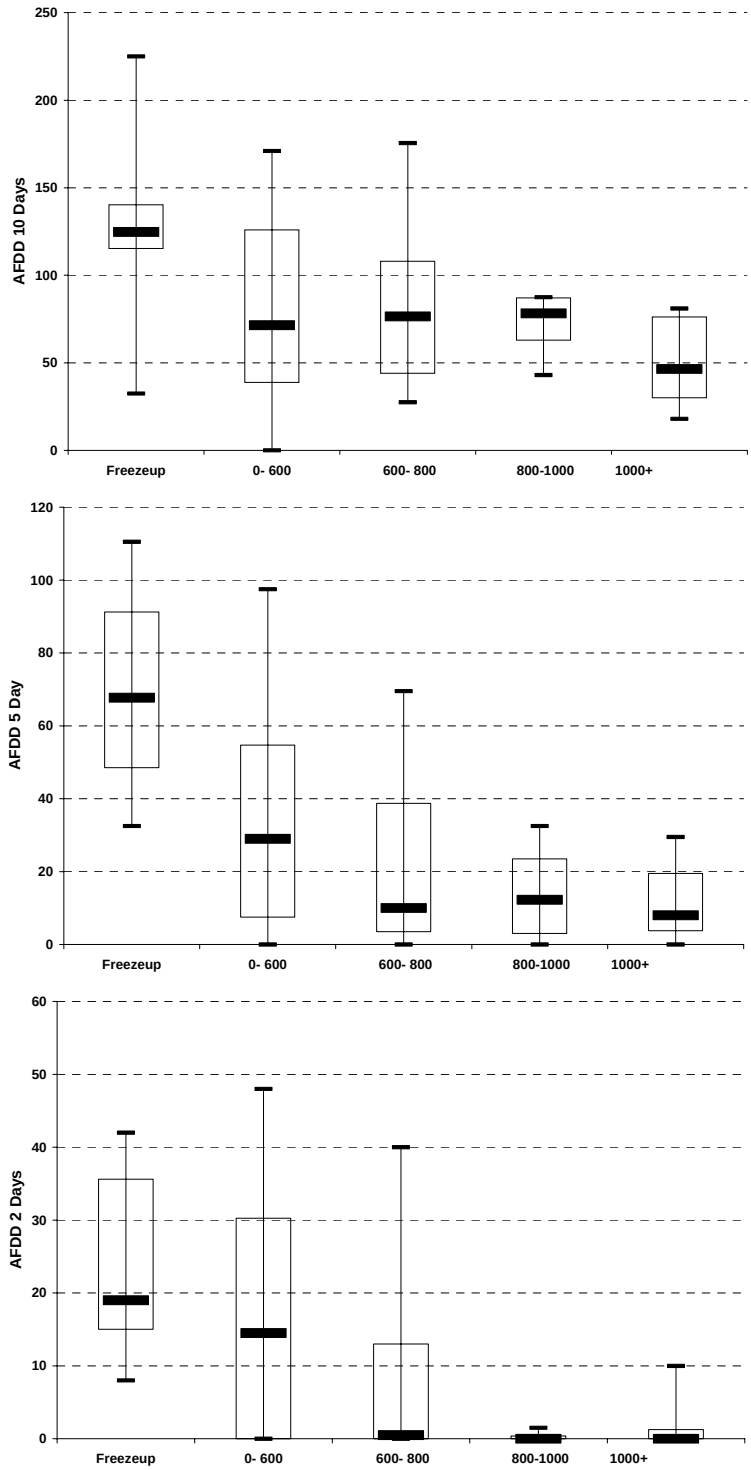

Figure 50. DelA10, DelA5, and DelA2 for ice events on the Kankakee River. Shown are the DelA10, DelA5, and DelA2 for freezeup events, and for breakup events in four separate AFDD bins.

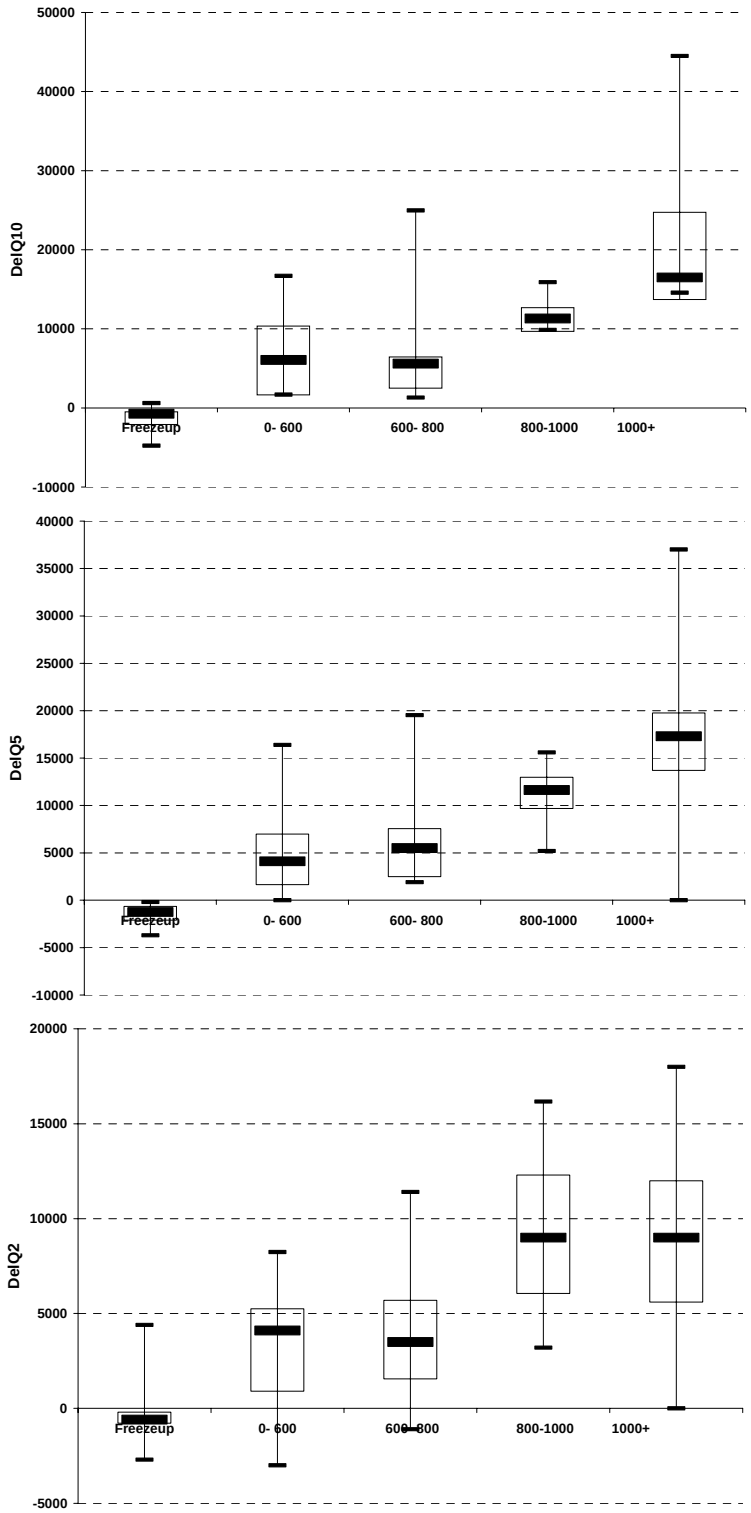

Figure 51. DelQ10, DelQ5, and DelQ2 for ice events on the Kankakee River. Shown are the DelA10, DelA5, and DelA2 for freezeup events, and for breakup events in five separate AFDD bins.

Mohawk River

Introduction

The Mohawk River is a major waterway in upstate New York (Figure 52) flowing from west to east across upstate New York approximately 143miles (230 km) entering the Hudson River near Albany. The cities of Schenectady, Amsterdam, Utica, and Rome are built on its banks.

At the time of this study, there were 18 entries in the IJDB for the Mohawk River (Table 8A). The dates of the jams recorded in the IJDB range from the mid 1930's to the early 2000's (Figure 53). The data falls into two rough groups, with the first group ranging from the early 1930's to 1960. Then there is a gap until the mid 1990's, with no ice jams recorded during the period from the early 1970's to the mid 1990's. The day-of-year recorded in the IJDB occurs largely in March, with a few jams occurring in February and early April.

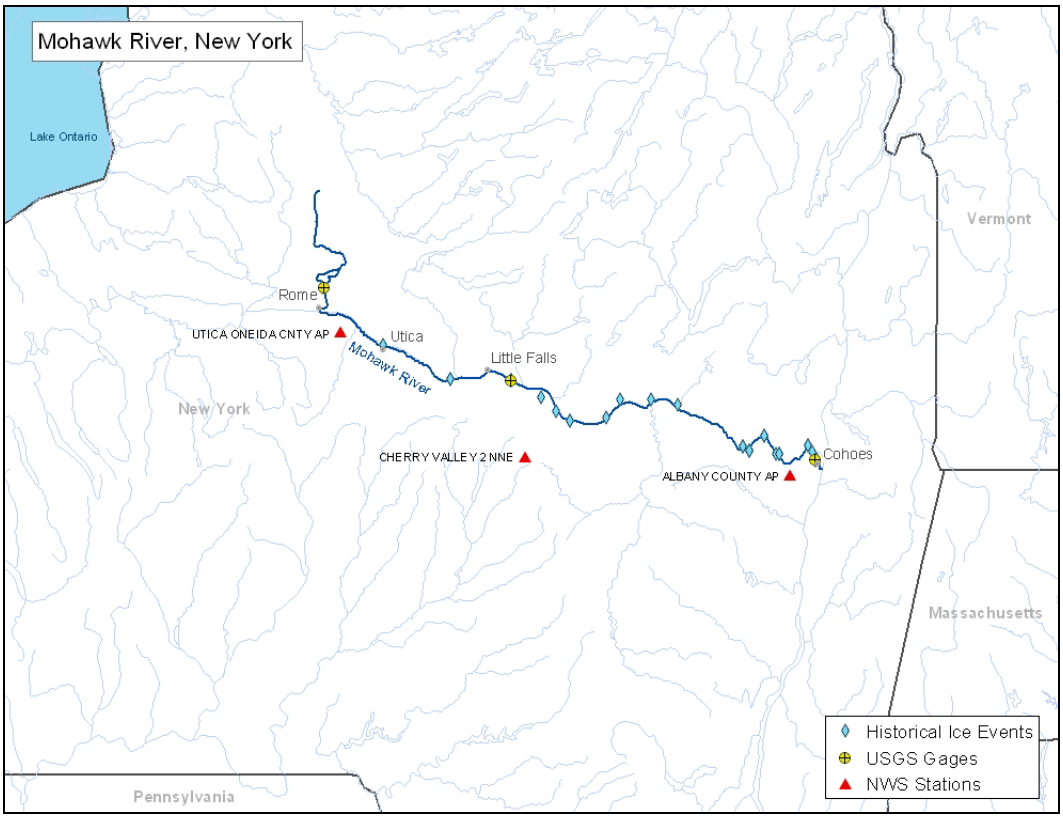

Figure 52. Mohawk River.

Table 8a. Ice jam, hydrologic and meteorologic information for the Mohawk River.

Gage	Freezeup Events	Breakup Events	Unknown	DA (sq.mi)	Average Flow (cfs)	Average Max AFDD's (F)	RBW Index
Delta Dam	0	2	1	152	368	869	0.077
Little Falls	1	8	4	1342	2829	1219	0.176
Cohoes	2	8	9	3450	5697	762	0.251

Overview

There are several dams located along the course of the Mohawk River. The Erie Canal (a part of the New York State Canal System, called the New York State Barge Canal for much of the 20th century) also parallels the course of much of the river. The river becomes flashier in the downstream direction as rated by the RBW index, and can be considered to be especially flashy at its downstream end. Flows in the Mohawk River tend to increase throughout autumn until late November through early December and then slightly decline or remain steady throughout the winter until the spring rise begins in late February. Winters along the Mohawk are moderate with average annual maximum AFDD's of approximately 800-1200 AFDD (F) (Table 8B).

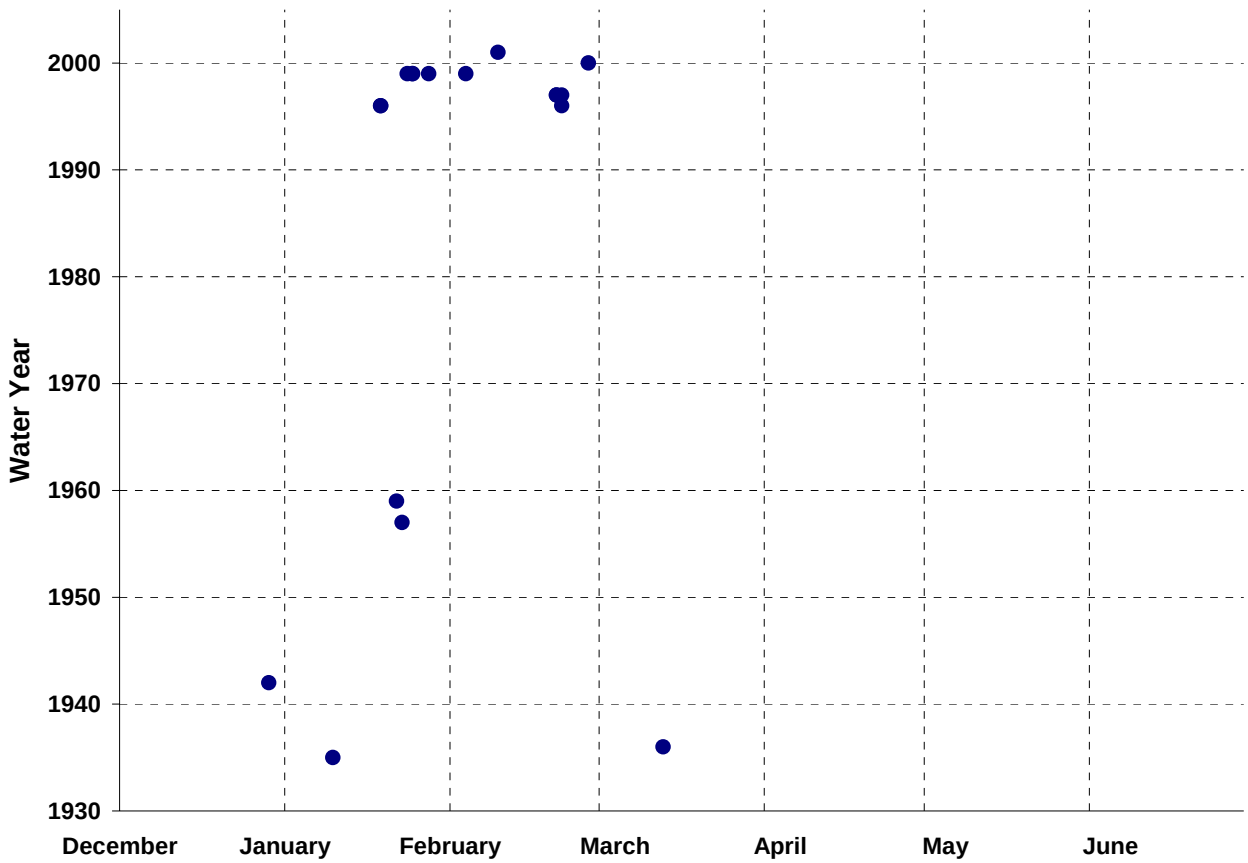

Figure 53. All ice jam data for the Mohawk River. All events are breakup jams.

Table 8b. Ice Jam Data for the Mohawk River

Gage	Breakup Jams				
	Average Day-of-Year	Average AFDD (F)	Average Time To Peak (Days)	Average Discharge (CFS)	Average Base flow (CFS)
Delta Dam	1/10	455	3.5	1030	368
Little Falls	2/13	744	3.3	25988	2829
Cohoes	1/28	651	2.6	9425	5697

The histogram of dates of breakup jams on the Mohawk River is shown in Figure 54. Breakup jams have occurred from late December to late March. The histogram has two peaks, similar to the histogram of the Connecticut River. The histogram of the Mohawk River has its first peak in late January and second in late February. The histogram of AFDD associated with breakup jams also has two peaks; the first at 500 AFDD (F) and the second at 800 AFDD (F) (Figure 55). The histogram of discharges associated with breakup jams peaks between 10000 and 15,000 CFS

(Figure 56). The range of discharges for breakup jams extends from 1000 CFS to over 55,000 CFS.

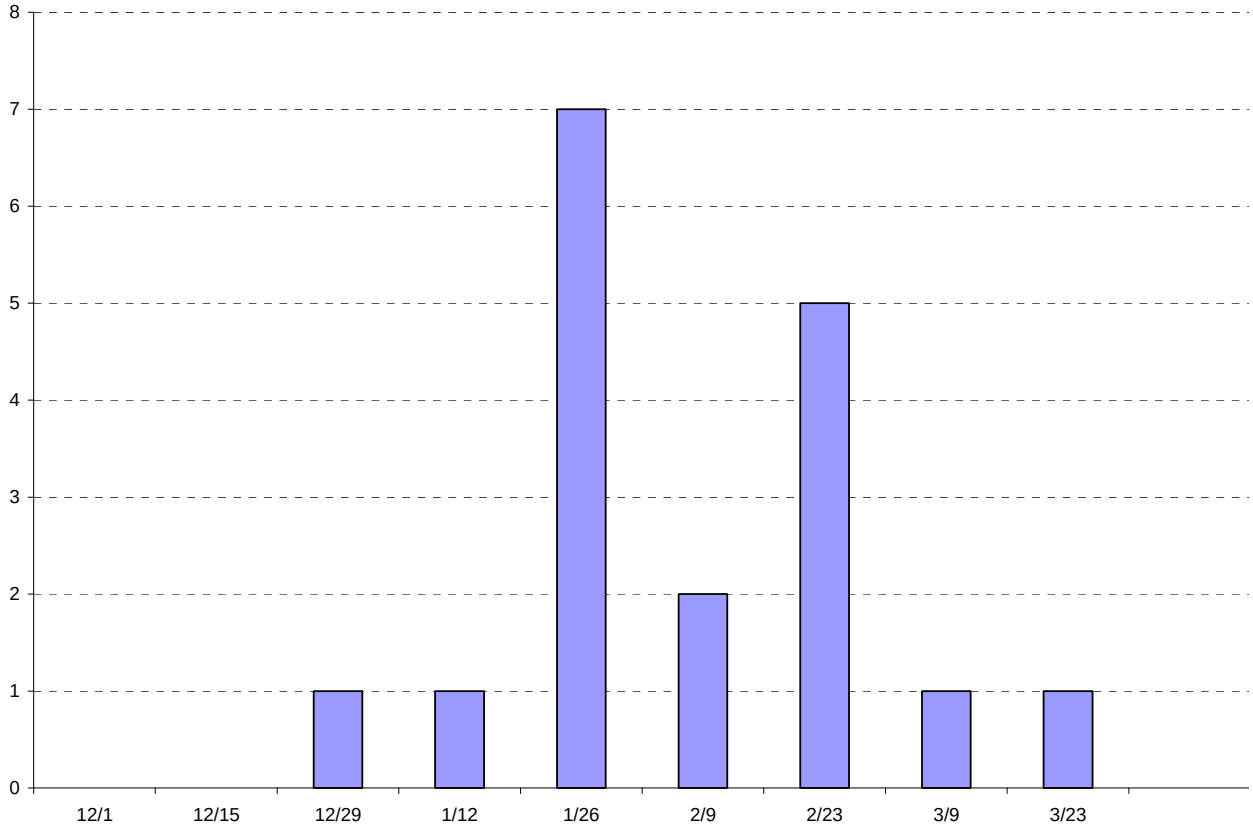

Figure 54. Histogram of ice events on the Mohawk River watershed by day of year.

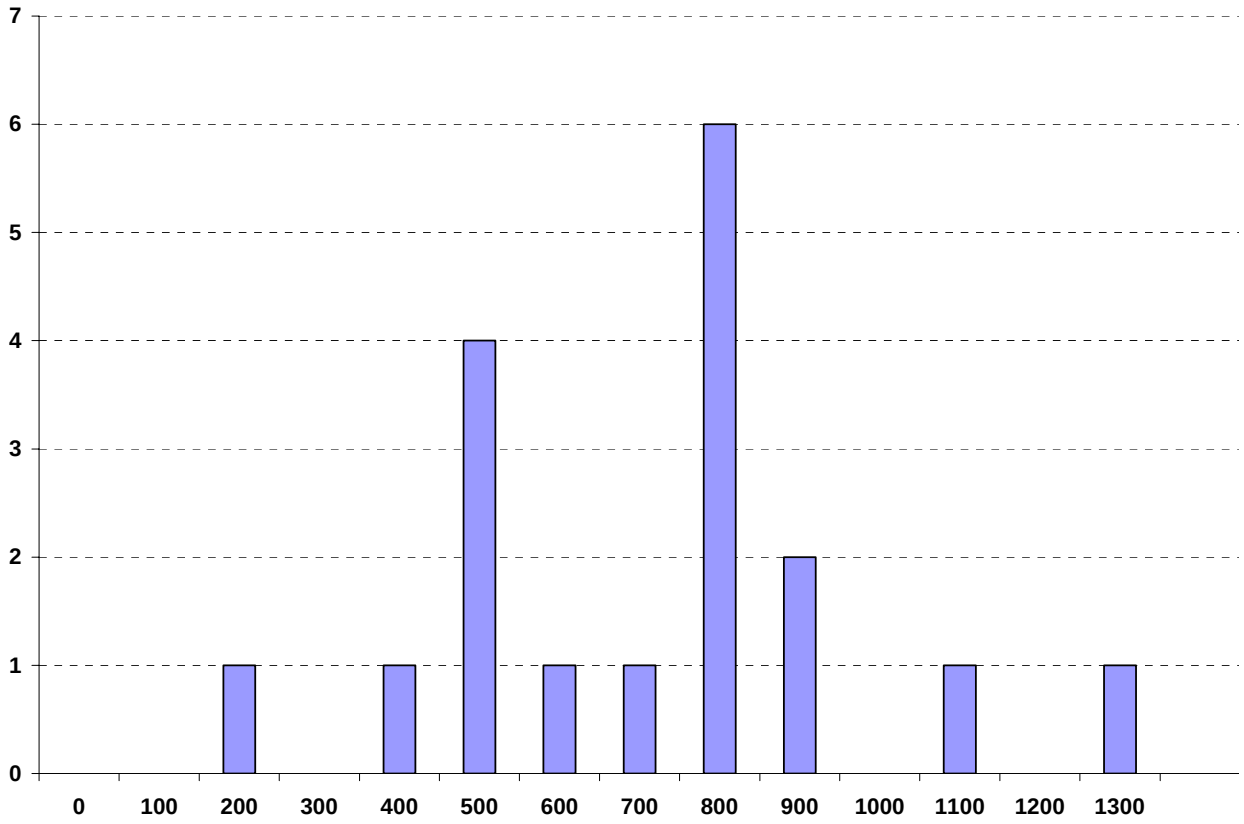

Figure 55. Histogram of ice events on the Mohawk River watershed by AFDD.

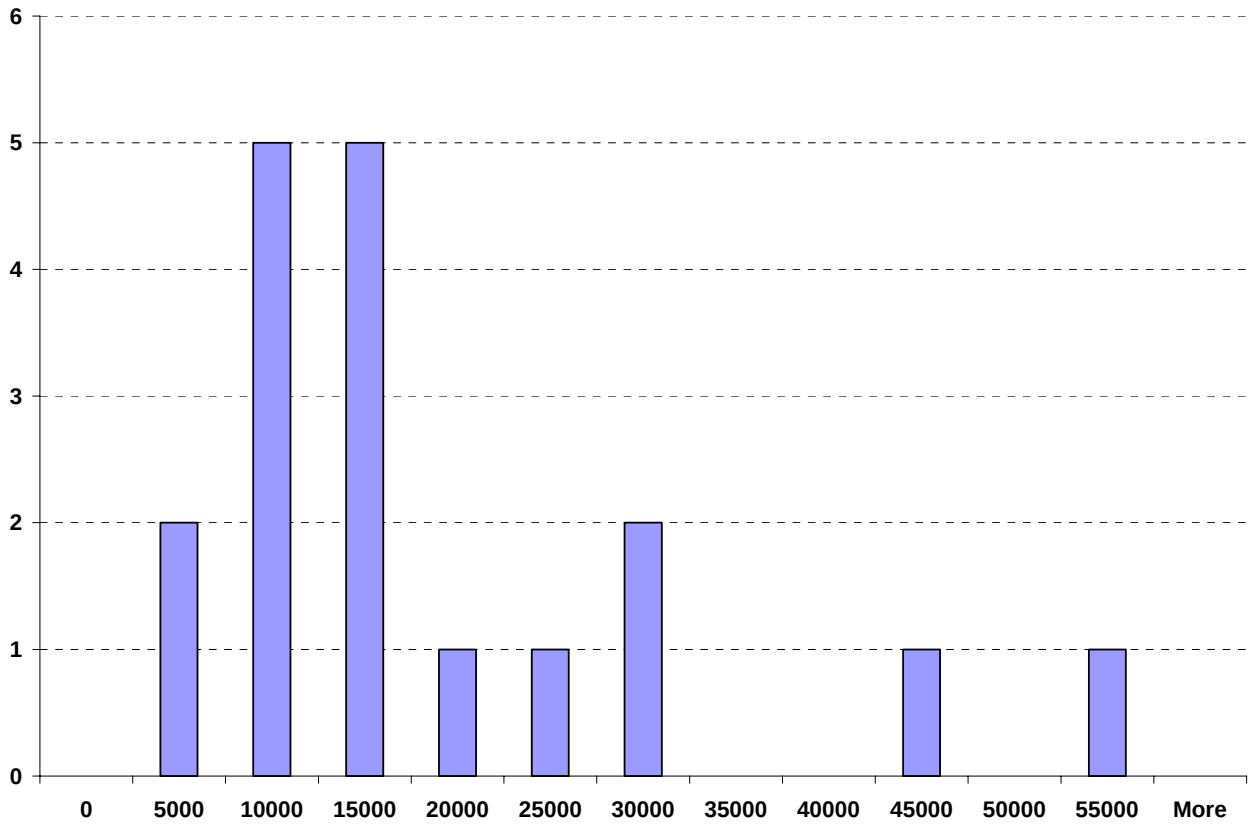

Figure 56. Histogram of ice events on the Mohawk River by discharge.

Breakup jams on the Mohawk River

As with the Yukon, Kuskokwim and Milk Rivers, all jams recorded in the IJDB for the Mohawk River were classified as breakup jams. Overall, breakup ice jam formation on the Mohawk River cannot be considered to be progressive (Figure 57). There is no overall trend in breakup ice jam formation. The average date of breakup jam occurrence in the upstream portion near Delta Dam and the downstream portion near Cohoes tends to occur in earlier in the winter than in the mid portion at Little Falls. In every case, the discharge was increasing prior to the formation of a breakup ice jam at the gage associated with the jam (Figure 58). It can be seen that the increase in flow over the previous ten days (*DelQ10*, red line) and the previous two days (*DelQ2*, black line) both formed significant portion of the discharge at the time of the jam. This suggests a relatively rapid rise in flow in the period immediately before the formation of the jams. The average discharge associated with breakup jams can also be compared to the long-term annual average discharge (pink triangles). Breakup ice jam formation in the upstream and downstream portions of

the Mohawk River occurs at an average discharge approximately equal to the long-term annual average discharge. In the middle portion, the average discharge is significantly greater than the long-term annual average. This result is consistent with the later occurrence of breakup jams in the middle portion of the river. The average seasonal AFDD associated with breakup ice jams (Figure 59) is almost always less than the average annual maximum AFDD.

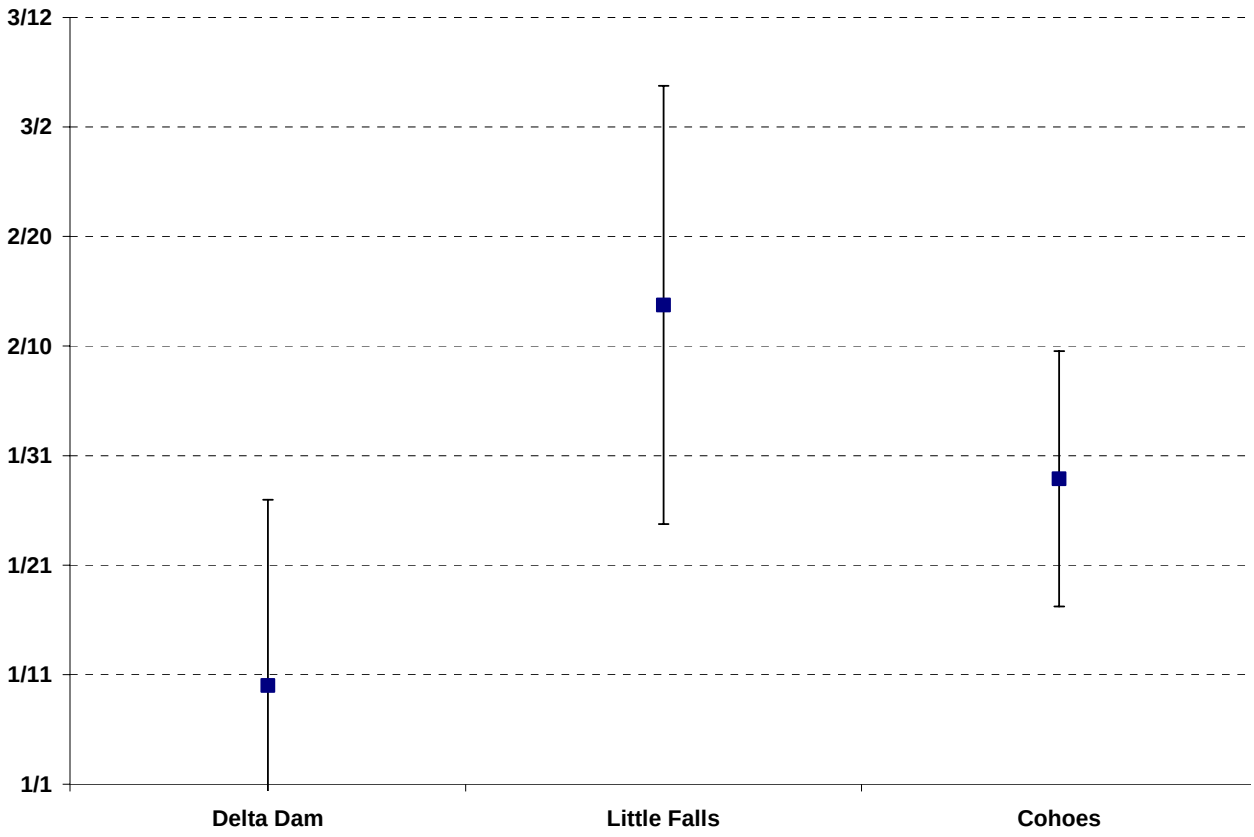

Figure 57. Dates of ice events along the Mohawk River.

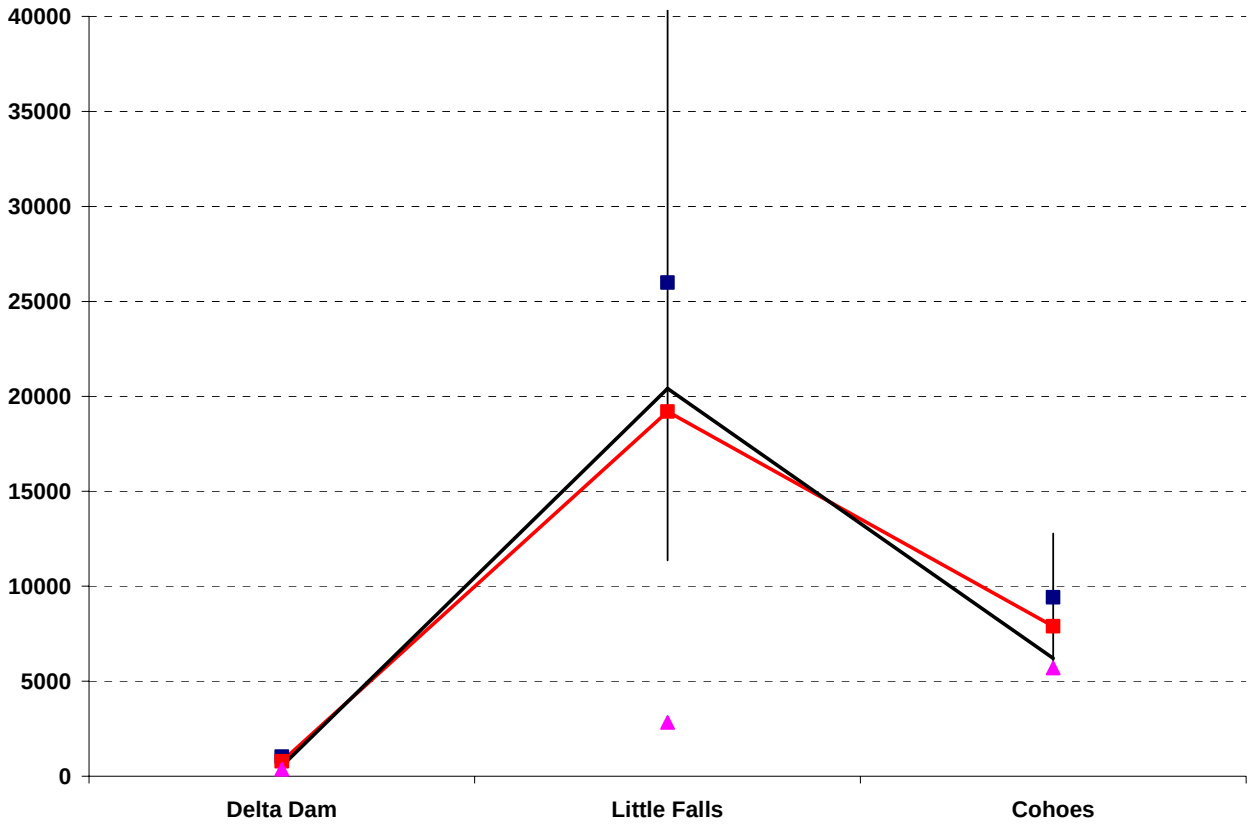

Figure 58. Discharges associated with ice events along the Mohawk River. Shown are the average discharge and standard deviation associated with the events, the average DelQ10 (red line), DelQ2 (black line), and annual average discharge each location (pink triangle).

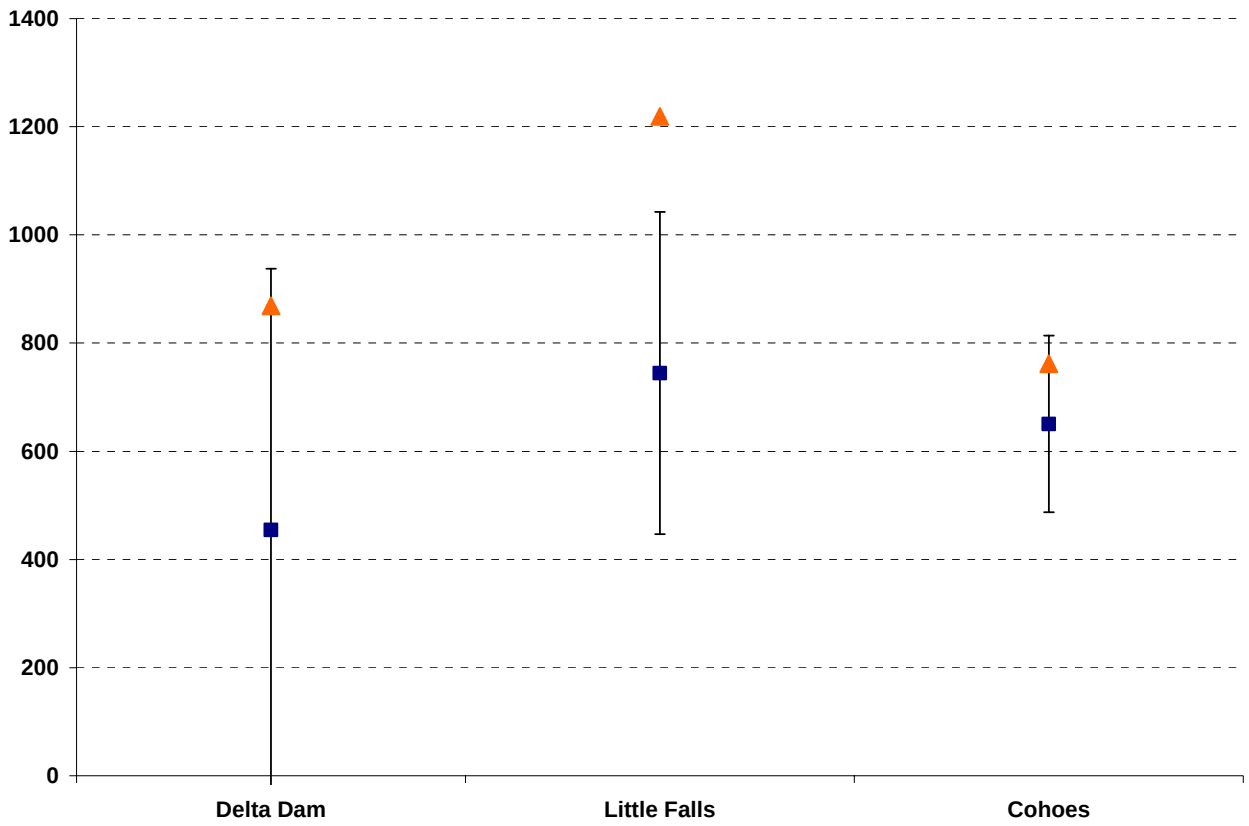

Figure 59. AFDD's associated with ice events along the Mohawk River. Shown are the average discharge and standard deviation associated with the events, and the average annual maximum AFDD at selected locations (Orange triangles).

Salmon River

Introduction

The Salmon River is located in Idaho in. The Salmon flows for 425 miles (684 km) through central Idaho, draining 14,000 square miles and drops more than 7,000 vertical feet between its headwaters above the Sawtooth Valley to its confluence with the Snake River at 910 feet.

At the time of this study, there were 26 entries in the IJDB for the Salmon River (Table 9A). The dates of the jams recorded in the IJDB range from the early 1920's to the late 1990's (Figure 60). The day-of-year recorded in the IJDB occurs from late December through very early March. The Salmon River has two discharge gages located along its length, with the vast majority of jams associated Salmon gage site. There are two NWS meteorological gages in the area (Figure 60).

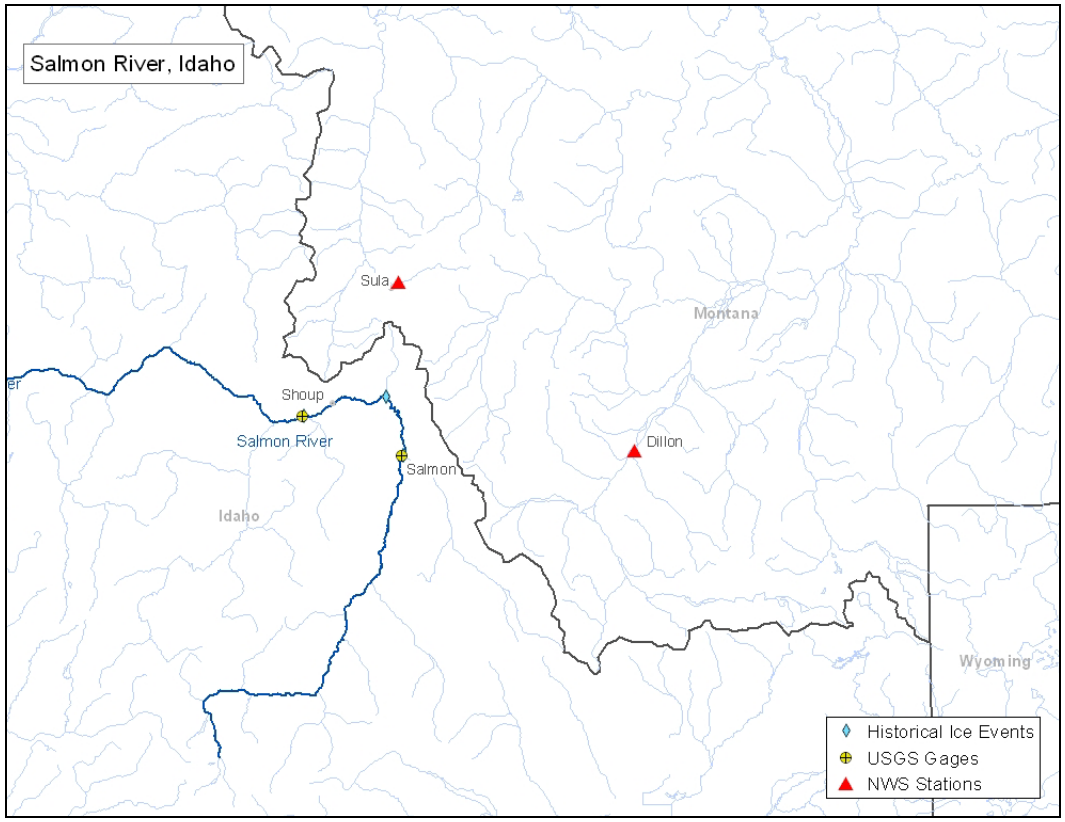

Figure 60. Salmon River in Idaho.

Table 9a. Ice jam, hydrologic and meteorologic information for the Salmon River.

Gage	Freezeup Events	Breakup Events	Unknown	DA (sq.mi)	Average Flow (cfs)	Average Max AFDD's (F)	RBW Index
Salmon	14	9	1	3760	1935	1086	0.043
Shoup	0	2	0	6270	3009	1086	0.043

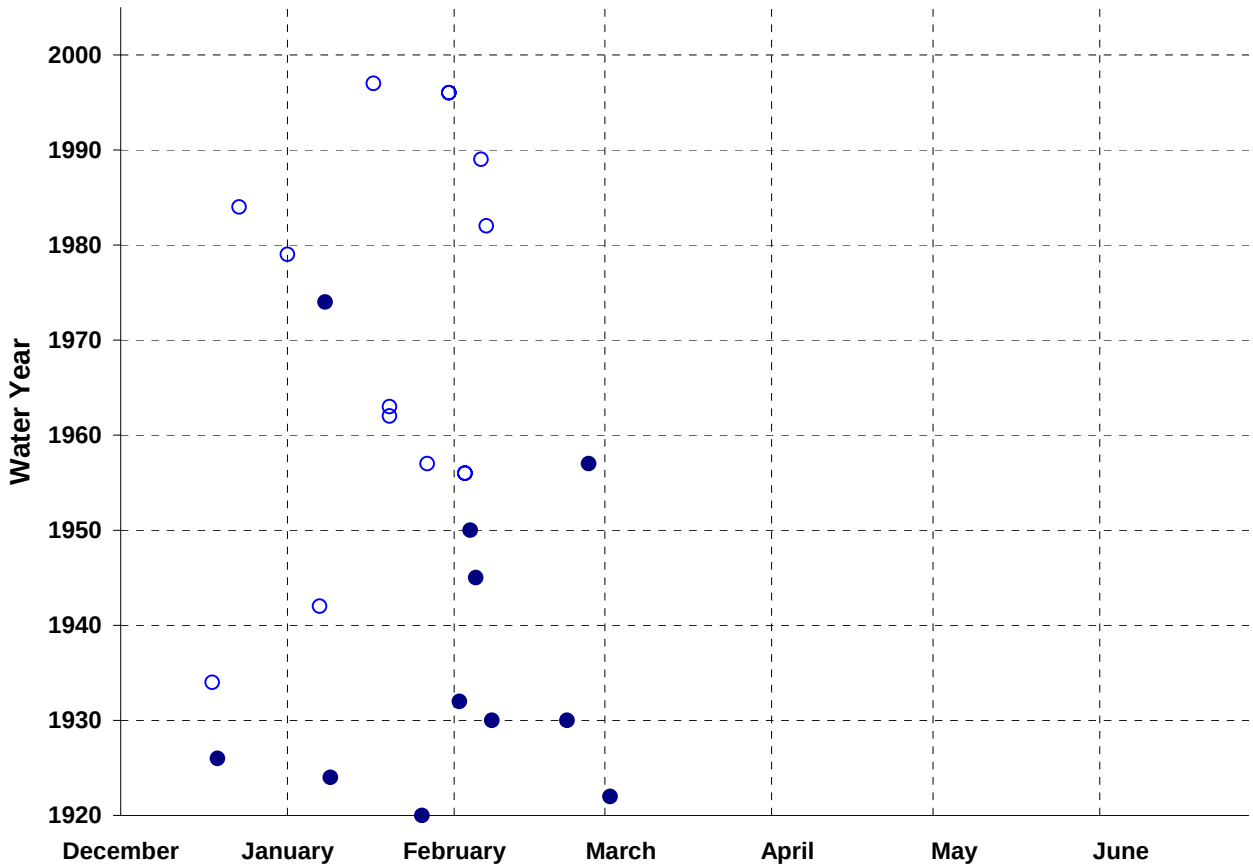

Figure 61. All ice jam data for the Salmon River. Freeze up jams are open circles, breakup jams are solid.

Overview

There are no dams on the Salmon River. Some tributaries of the Salmon are subject to irrigation withdrawals. Flows in the Salmon River tend to be constant or decline slightly during the winter months. The spring rise typically begins in April and peaks during May or June. The spring peak is usually the maximum discharge that occurs in any years. The Salmon rates as "unflashy" on the RBW index. Winters in Idaho in the area of the Salmon River tend to be moderate with average recorded annual maximum AFDD's of approximately 1000 AFDD (F) (Table 9B). Ice jams on the Salmon are almost equally split between freezeup jams and breakup jams with slightly more freezeup jams recorded (54%). Only freezeup jams have been recorded since the mid 1970's.

Table 9b. Ice jam data for the Salmon River.

Gage	Breakup Jams					Freezeup Jams					
	Average Day-of-Year	Average AFDD (F)	Average Time To Peak (Days)	Average Discharge (CFS)	Average Base flow (CFS)	Average Day-of-Year	Average AFDD (F)	Average Discharge (CFS)	DelA2 (F)	DelA5 (F)	DelA10 (F)
Salmon	1/28	795	0.1	992	876	1/19	788	860	69	166	255
Shoup	2/15	1043	2.0	2050	1435						

A general overview of ice jams on the Salmon River is shown using three histograms that combine both the freezeup jams and the breakup jams. The day-of-year when jams occurred is shown first (Figure 62). The histogram of freezeup jams increases from late December and reaches a peak in early February. No freezeup jams were recorded later in the winter. The histogram of breakup jams also peaks in early February but breakup jams were recorded through mid March. The recorded AFDD's when all ice jams occurred is displayed next (Figure 63). The histogram of AFDD associated with freezeup jams is peaks around 1000 AFDD (F). The histogram associated with breakup jams peaks between 1000 and 1250 AFDD (F). The histogram of discharges associated with freezeup jams peaks sharply around 1000 CFS and only one event occurred at a discharge larger than this (Figure 58). The histogram of discharges associate with breakup peaks around 1000-1250 CFS and only two events occurred at higher discharges. The Salmon River is interesting in that all the events tend to near or slightly below the recorded average discharges.

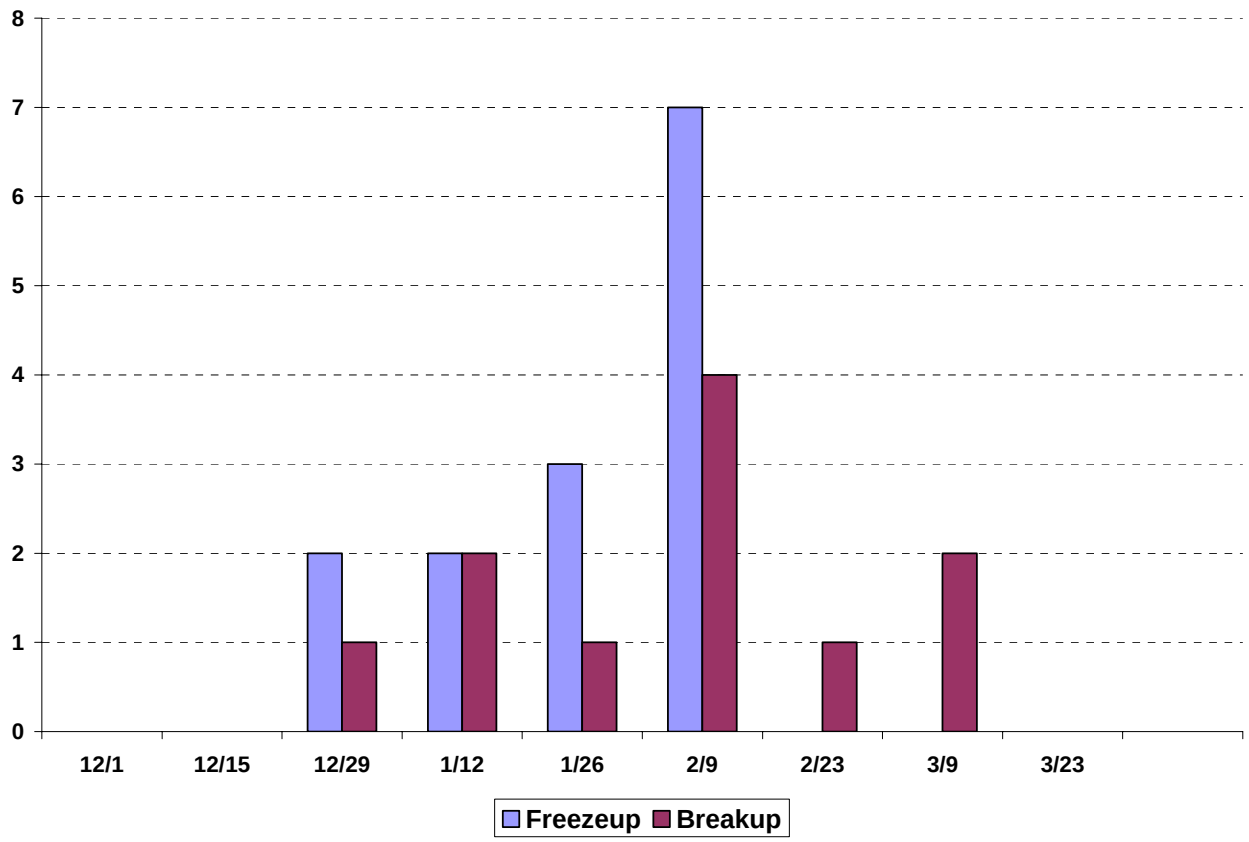

Figure 62. Histogram of ice events on the Salmon River watershed by day of year.

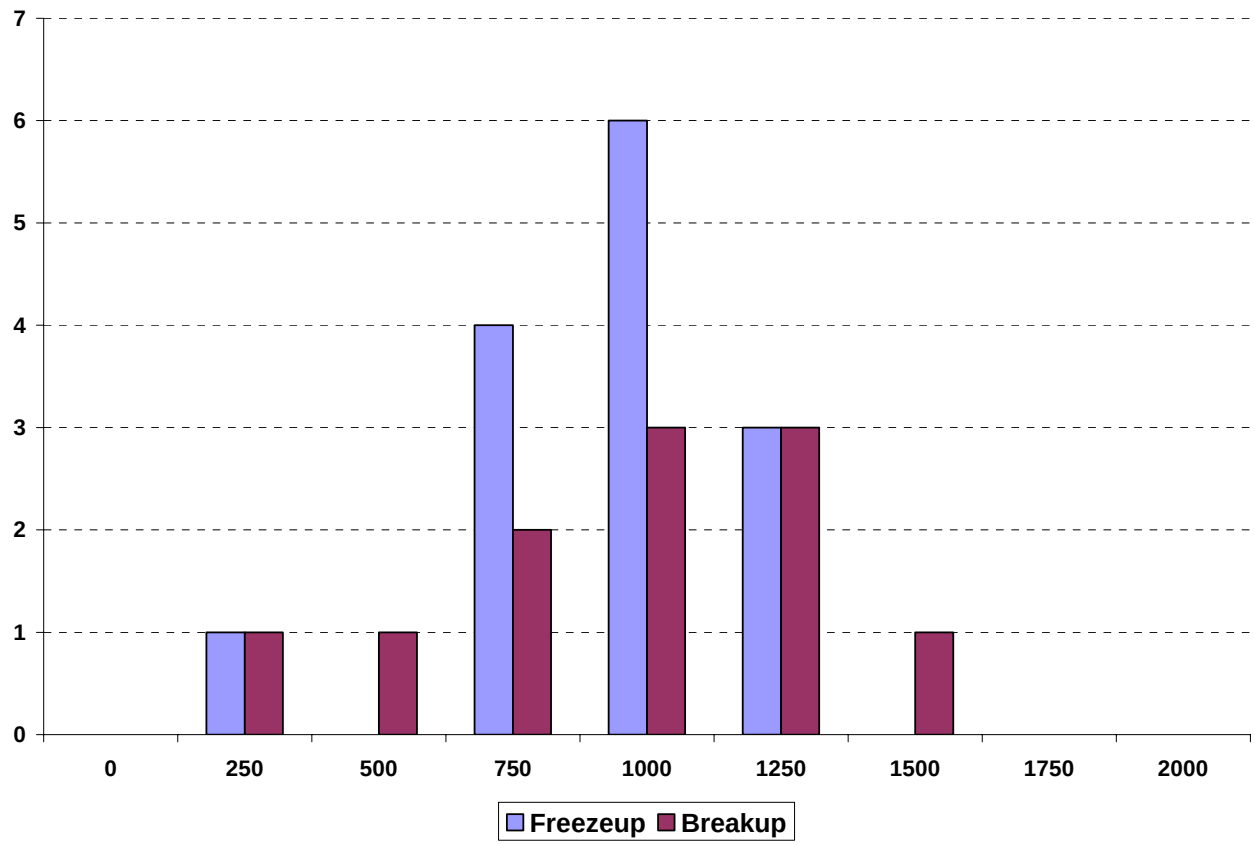

Figure 63. Histogram of ice events on the Salmon River by AFDD.

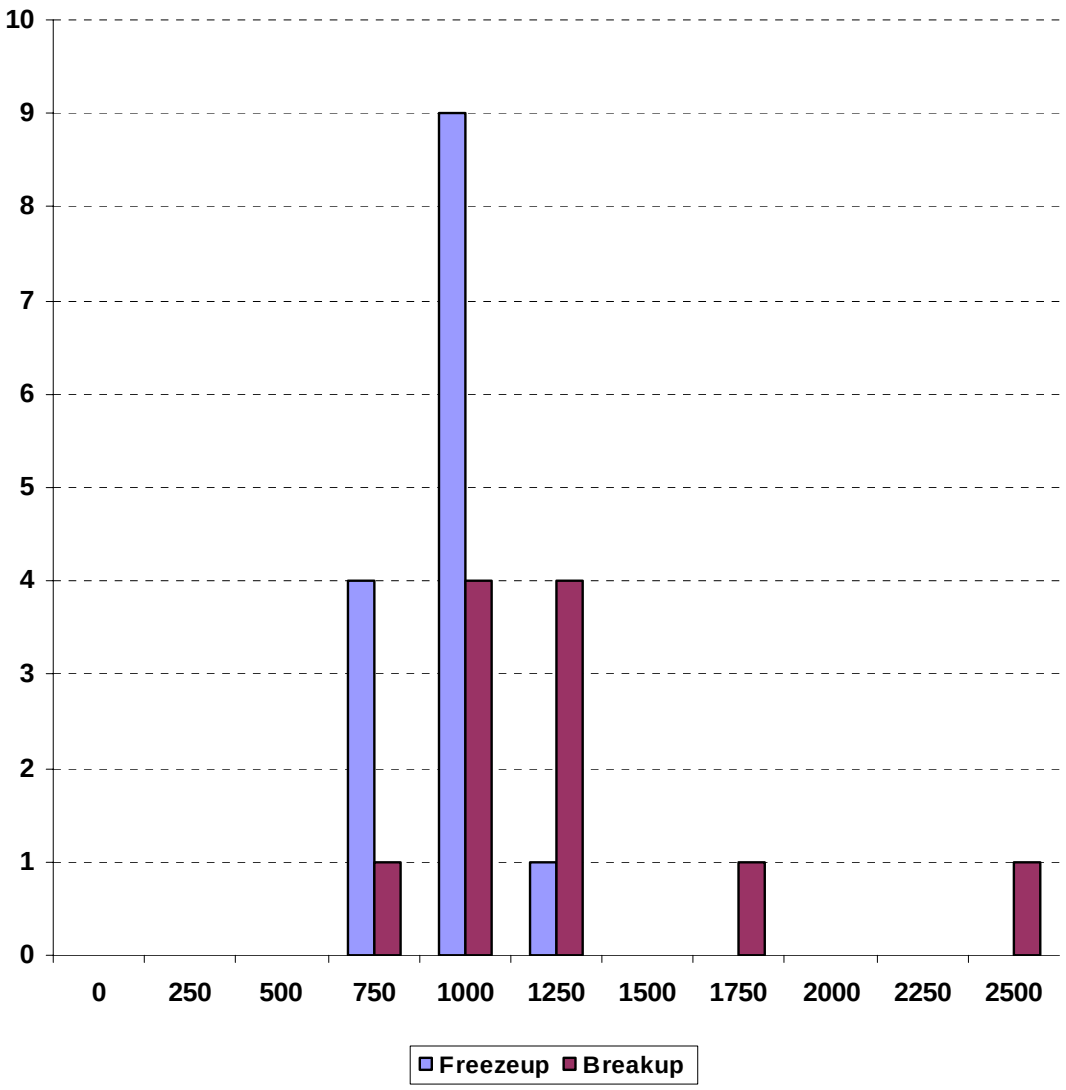

Figure 64. Histogram of ice events on the Salmon River by discharge.

7 Summary

This report analyzed the ice jam entries in the Ice Jam Database (IJDB) for eight selected rivers in the United States. These rivers were the Platte, Yukon, Kuskokwim, Connecticut, Milk, Kankakee, Mohawk, and Salmon Rivers. Three additional rivers were also considered for this study but were not included due to a lack of data (Weiser River), continuously changing conditions due to aggradation and delta formation (Missouri River at Williston, SD), or because of highly site-specific conditions involving the interaction of freezeup jams with breakup jams (Oil Creek at Oil City, PA). First, the IJDB was interrogated to provide information on all ice events in the selected rivers and locations. This information included the date, location (latitude and longitude), type, etc. The jam locations then formed a GIS coverage that was combined with other GIS coverages including the locations of the NWS meteorological stations, USGS gaging stations, river layouts, and state boundaries. Each ice jam retrieved from the IJDB was then associated with the closest NWS meteorological station and the closest downstream USGS gaging station for which there were consistent records. Information from these stations was used to determine the following parameters: daily average river discharge on the day of the jam and the change in discharge over the previous 2, 5, and 10 days; the accumulated freezing degree-days (AFDD) on the day of the ice jam and the change over the previous 2, 5, and 10 days; and the time number of days the flow increased prior to the jam. Next every jam was classified as either a breakup jam or a freezeup jam. Freezeup jams were screened by selecting those jams for which the river discharge had been consistently dropping over the prior five days. All jams that were not classified as freezeup were classified as breakup. In almost every case it was found that this classification system produced consistent and reasonable results. The number of freezeup and breakup ice jams for each river system is summarized in Table 10.

The parameters determined for all the jams were presented in the form of tables and histograms of the day-of-year, the discharge, and the AFDD at which all the breakup and freezeup jams for each river system occurred. Histograms were developed for each river except for the Yukon and Kuskokwim Rivers. For these rivers it was felt that the overview of the ice

jam data along the river provided comparable and better information. An overview of the day-of-year, the discharge, and the AFDD at which ice jams occurred were also presented for each river that had at least two breakup ice jams entries in the IJDB for three or more sites along the river. These included the Platte, Yukon, Kuskokwim, Connecticut, Milk, and Mohawk Rivers. Finally, at select locations where ample ice jam data existed, detailed reviews of the conditions under which freezeup and breakup ice jams occur were conducted. These reviews separated the data for freezeup and breakup ice jams and the breakup ice jams were then divided in separate groups, with each group representing a range of AFDD.

Table 10. Number of freezeup and breakup ice jams for each river system.

River	Jams*	Ice jam type		Timing	Primary flow direction	Prog.	RBW Index	Avg. Annual Max. AFDD (F)
		Breakup	Freezeup					
Platte	154	64%	12%	Dec-Mar	W to E	Semi	0.066 -0.107	914 - 977
Yukon	178	100%	0%	May	E to W	Yes	0.016 -0.017	4275 -6524
Kuskokwim	158	100%	0%	Apr-Jun	NE to SW	No	0.019 -0.023	3676 - 5301
Connecticut	83	76%	18%	Dec-Apr	N to S	No	0.159 -0.256	1151 - 1872
Milk	38	100%	0%	Feb-Apr	NW to SE	Semi	0.056-0.111	1578-2157
Kankakee	39	75%	25%	Dec-Mar	E to W	-	0.095	880
Mohawk	21	86%	14%	Dec-Mar	NW to SE	No	0.077 -0.251	762 - 1219
Salmon	26	46%	54%	Dec-Feb	S to N	-	0.043	1086

* Number of jams identified as to type

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APPENDIX B. Ice Jam Data

Platte River

River:		Platte River		
Reach:		Entire reach		
USGS Gages:			Gage Number	POR:
SOUTH PLATTE RIVER AT ROSCOE NEBR				
PLATTE RIVER NEAR OVERTON, NEBR. (TOTFLO)				
PLATTE R MID CH,COTTONWOOD RANCH, NR ELM CREEK, NE				
PLATTE RIVER NEAR KEARNEY, NEBR.				
PLATTE RIVER NEAR GRAND ISLAND, NEBR.				
PLATTE RIVER NEAR DUNCAN, NEBR.				
PLATTE RIVER AT NORTH BEND, NEBR.				
PLATTE RIVER NR LESHARA, NE				
PLATTE R NR ASHLAND, NE				
WAHOO CR AT ASHLAND, NE				
JOHNSON CR NR MEMPHIS, NE				
PLATTE R AT LOUISVILLE NE				
Met Stations:	State	Gage No.	Start Year	Source
ASHLAND 2	NE	250375	1949	Coop
AURORA	NE	250445	1965	Coop
BLAIR	NE	250930	1949	Coop
BRIDGEPORT	NE	251145	1899	Coop
CENTRAL CITY	NE	251560	1932	Coop
CLARKSON	NE	251660	1949	Coop
COLUMBUS 3 NE	NE	251825	1949	Coop
DAVID CITY	NE	252205	1900	Coop
GENOA 2 W	NE	253185	1949	Coop
GOTHENBURG	NE	253365	1898	Coop
GRAND ISLAND ARPT	NE	253395	1901	Coop
GRAND ISLAND ARPT	NE	725520	1949	GSOD
HASTINGS 4 N	NE	253660	1949	Coop
KEARNEY 4 NE	NE	254335	1932	Coop
KINGSLEY DAM	NE	254455	1949	Coop
MADRID	NE	255090	1902	Coop
MINDEN	NE	255565	1949	Coop
NORTH PLATTE BRD FLD	NE	725620	1949	GSOD

NORTH PLATTE EXP FRM	NE	256075	1962	Coop
OGALLALA	NE	256200	1949	Coop
OSCEOLA	NE	256375	1956	Coop
OSHKOSH	NE	256385	1915	Coop
RAVENNA	NE	257040	1949	Coop
SAINT PAUL 4 N	NE	257515	1949	Coop
WAHOO	NE	258905	1964	Coop

Ice Jam Database Entries for Platte River

River	City	State	Jam Date	Water Year	Jam Type	Damages
North Platte River	Northgate	CO	9-Apr-62	1962	?	?
South Platte River	Waterton	CO	13-Dec-61	1961	?	?
North Platte River	Northgate	CO	5-Apr-61	1961	?	?
North Platte River	Northgate	CO	28-Mar-60	1960	?	?
North Platte River	Northgate	CO	7-Apr-59	1959	?	?
North Platte River	Northgate	CO	17-Apr-58	1958	?	?
North Platte River	Northgate	CO	3-Apr-56	1956	?	?
North Platte River	Northgate	CO	16-Apr-55	1955	?	?
North Platte River	Northgate	CO	17-Apr-52	1952	?	?
North Platte River	Northgate	CO	17-Apr-48	1948	?	?
North Platte River	Northgate	CO	2-Apr-46	1946	?	?
North Platte River	Walden	CO	22-Apr-45	1945	?	?
North Platte River	Northgate	CO	21-Apr-45	1945	?	?
North Platte River	Northgate	CO	2-Apr-43	1943	?	?
North Platte River	Northgate	CO	10-Apr-42	1942	?	?
North Platte River	Northgate	CO	2-Apr-40	1940	?	?
North Platte River	Northgate	CO	16-Apr-38	1938	?	?
Platte River	Royalton	MN	23-Mar-35	1935	?	?
Platte River	Royalton	MN	7-Apr-34	1934	?	?
Platte River	Royalton	MN	1-Apr-33	1933	?	?
Platte River	Agency	MO	11-Feb-96	1996	Break-up	River fluctuations
Platte River	Agency	MO	6-Feb-62	1962	?	?
Platte River	Agency	MO	26-Feb-49	1949	?	?
Platte River	Agency	MO	19-Feb-49	1949	?	?
Platte River	Agency	MO	13-Feb-37	1937	?	?
Platte River	Gretna	NE	27-Feb-04	2004	Released	?
North Platte River	North Platte	NE	4-Feb-04	2004	Released	?
North Platte River	Lewellen	NE	19-Dec-03	2004	Released	?
Platte	Grand Island	NE	1-Jan-03	2003	Freeze-up	?
Platte River	Fremont	NE	21-Feb-03	2003	Break-up	?

Platte River	Fremont/Big Island	NE	21-Feb-03	2003	Freeze-up	?
North Platte River	Lewellen	NE	26-Dec-02	2003	Freeze-up	agricultural land flooding
Platte River	Grand Island	NE	27-Dec-01	2002	Freeze-up	minor flooding onto road
Platte River	Valley	NE	14-Mar-01	2001	Break-up	overland flooding
Platte River	State Lakes Area	NE	15-Mar-01	2001	?	?
Platte River	Highway 64	NE	14-Mar-01	2001	Break-up	Flooded farm land; Sokol Camp flooded; evacuation precautions.
Platte River	Fremont	NE	14-Mar-01	2001	Break-up	minor flooding into local cabins
Platte River	Ashland	NE	14-Mar-01	2001	Break-up	minor flooding
North Platte River	Lewellen	NE	17-Dec-00	2001	Freeze-up	?
Platte River	Leshara	NE	3-Feb-00	2000	?	?
Platte River	Ashland	NE	5-Feb-00	2000	?	?
South Platte River	North Platte	NE	11-Jan-98	1998	Break-up	Flooded the golf course
Platte River	Woodcliff	NE	16-Mar-98	1998	Break-up	Lowland flooding
Platte River	Wood River	NE	20-Jan-98	1998	Break-up	Road flooding
Platte River	Leshara	NE	??Mar1998	1998	Break-up	Lowland flooding
Platte River	Fremont	NE	16-Mar-98	1998	Break-up	Lowland flooding
Platte River	Fremont	NE	21-Jan-98	1998	Break-up	Lowland flooding
Platte River	Ashland	NE	16-Mar-98	1998	Break-up	Road and lowland flooding
Platte River	Schuyler	NE	20-Feb-97	1997	?	Flooding in low-lands near Thomas Lakes' cabins
Platte River	Fremont/Big Island	NE	21-Feb-97	1997	?	Localized flooding
Platte River	Grand Island	NE	10-Mar-96	1996	Break-up	Lowland flooding
Platte River	Fremont/Big Island	NE	14-Jan-96	1996	Break-up	Flooding, evacuations, road closure
Platte River	Ashland	NE	14-Jan-96	1996	Break-up	?
Platte River	Schuyler	NE	6-Feb-95	1995	Break-up	Lowland flooding
Platte River	North Bend	NE	5-Feb-95	1995	Break-up	Road and cabin flooding
Platte River	Kearney	NE	12-Dec-94	1995	Freeze-up	Lowland flooding
Platte	Beacon View	NE	20-Feb-94	1994	Break-up	flooding
Platte River	Wood River	NE	16-Jan-94	1994	?	Lowland flooding
Platte River	Schuyler	NE	5-Mar-94	1994	Break-up	Lowland flooding
Platte River	Leshara	NE	5-Mar-94	1994	Break-up	?
Platte River	Grand Island	NE	10-Jan-94	1994	?	?
Platte River	Gibbon	NE	16-Jan-94	1994	?	?

Platte River	Columbus	NE	29-Nov-93	1994	Freeze-up	Lowland flooding
Platte River	Clarks	NE	4-Jan-94	1994	?	Local overflow, no cabins affected
Platte River	North Bend	NE	8-Mar-93	1993	?	?
Platte River	Ashland	NE	9-Mar-93	1993	Break-up	Road, agr., residential flooding, levee break
Platte River	North Bend	NE	22-Jan-92	1992	?	?
South Platte River	Roscoe	NE	25-Feb-89	1989	?	?
Platte River	Overton	NE	11-Feb-89	1989	?	?
Platte River	North Bend	NE	12-Mar-89	1989	?	?
Platte River	Kearney	NE	8-Mar-89	1989	?	?
Platte River	Grand Island	NE	11-Mar-89	1989	?	?
Platte River	Freemont/ Big Island	NE	??Feb1989	1989	?	?
Platte River	Duncan	NE	12-Mar-89	1989	?	?
Platte River	North Bend	NE	24-Feb-88	1988	?	?
Platte River	Louisville	NE	28-Feb-88	1988	?	?
Platte River	Grand Island	NE	22-Feb-88	1988	?	?
Platte River	Duncan	NE	26-Feb-88	1988	?	?
North Platte River	Lisco	NE	31-Dec-88	1988	?	?
North Platte River	Lewellen	NE	26-Dec-88	1988	?	?
Platte River	North Bend	NE	26-Feb-86	1986	?	?
Platte River	Leshara	NE	28-Feb-86	1986	?	?
Platte River	Highway 64	NE	27-Feb-86	1986	Break-up	None
Platte River	Grand Island	NE	2-Jan-86	1986	?	?
South Platte River	Roscoe	NE	16-Dec-84	1985	?	?
Platte	Shelton	NE	2-Jan-85	1985	Freeze-up	one evacuation, road flooded
Platte	Fremont	NE	8-Jan-85	1985	Freeze-up	flooded several cabins, park, Ridge Road
Platte River	Odessa	NE	30-Dec-85	1985	?	?
Platte River	North Bend	NE	28-Feb-85	1985	?	?
Platte River	Highway 92 Bridge	NE	26-Feb-85	1985	?	?
Platte River	Grand Island	NE	6-Feb-85	1985	?	?
Platte River	Fremont	NE	1-Mar-85	1985	Break-up	?
Platte River	Freemont/ Big Island	NE	7-Jan-85	1985	?	?
Platte River	Duncan	NE	22-Jan-85	1985	?	?
Platte River	Venice	NE	13-Feb-84	1984	?	?
Platte River	Highway 64	NE	12-Feb-84	1984	Break-up	Lowland flooding

Platte River	Freemont/ Big Island	NE	14-Feb-84	1984	?	?
Platte River	North Bend	NE	18-Feb-83	1983	?	?
Platte River	Odessa	NE	1-Jan-82	1982	?	?
Platte River	North Bend	NE	22-Feb-82	1982	?	?
Platte River	Louisville	NE	22-Feb-82	1982	?	?
Platte River	Leshara	NE	??Feb1982	1982	?	?
Platte River	Highway 64	NE	22-Feb-82	1982	Break-up	None
Platte River	Grand Island	NE	21-Feb-82	1982	?	?
Platte River	Freemont/ Big Island	NE	22-Feb-82	1982	?	?
Platte River	Duncan	NE	6-Mar-82	1982	?	?
Platte River	Odessa	NE	10-Feb-81	1981	?	?
Platte River	Grand Island	NE	10-Feb-81	1981	?	?
Platte River	Duncan	NE	19-Feb-81	1981	?	?
Platte River	North Bend	NE	18-Jan-80	1980	?	?
Platte River	North Bend	NE	??Feb1980	1980	?	?
Platte River	Leshara	NE	27-Feb-80	1980	?	?
Platte River	Gibbon	NE	4-Mar-80	1980	Break-up	Lowland and road flooding
Platte River	Odessa	NE	4-Mar-79	1979	?	?
Platte River	North Bend	NE	14-Mar-79	1979	?	?
Platte River	Leshara	NE	16-Mar-79	1979	?	?
Platte River	Highway 92 Bridge	NE	14-Mar-79	1979	Break-up	?
Platte River	Grand Island	NE	8-Mar-79	1979	?	?
Platte River	Freemont/ Big Island	NE	11-Mar-79	1979	?	?
Platte River	Duncan	NE	10-Mar-79	1979	?	?
Platte River	Yutan	NE	21-Mar-78	1978	Break-up	Lowland flooding
Platte River	North Bend	NE	19-Mar-78	1978	?	?
Platte River	Grand Island	NE	17-Mar-78	1978	?	?
Platte River	Freemont/ Big Island	NE	??Mar1978	1978	?	?
Platte River	Ashland	NE	8-Mar-78	1978	Break-up	18M USD total: 4000 evac; 60,000 acres flooded
Platte River	Odessa	NE	20-Dec-77	1977	?	?
Platte River	North Bend	NE	23-Feb-77	1977	?	?
Platte River	Grand Island	NE	25-Jan-77	1977	?	?
Platte River	Duncan	NE	10-Feb-77	1977	?	?
Platte River	Odessa	NE	3-Jan-76	1976	?	?

Platte River	Odessa	NE	6-Dec-76	1976	?	?
Platte River	North Bend	NE	13-Feb-76	1976	?	?
Platte River	Grand Island	NE	12-Feb-76	1976	?	?
Platte River	Duncan	NE	5-Jan-76	1976	?	?
Platte River	Odessa	NE	11-Jan-75	1975	?	?
Platte River	North Bend	NE	17-Feb-74	1974	?	?
Platte River	Grand Island	NE	9-Jan-74	1974	?	?
Platte River	Grand Island	NE	9-Dec-74	1974	?	?
Platte River	Duncan	NE	19-Jan-74	1974	?	?
Platte River	Odessa	NE	28-Dec-73	1973	?	?
Platte River	South Bend	NE	27-Feb-72	1972	?	?
Platte River	Odessa	NE	13-Jan-72	1972	?	?
Platte River	North Bend	NE	29-Feb-72	1972	?	?
Platte River	Grand Island	NE	21-Feb-72	1972	?	?
Platte River	Duncan	NE	14-Feb-72	1972	?	?
Platte River	Venice	NE	23-Feb-71	1971	Break-up	Lowland flooding
Platte River	South Bend	NE	19-Feb-71	1971	?	?
Platte River	Odessa	NE	1-Feb-71	1971	?	?
Platte River	North Bend	NE	20-Feb-71	1971	?	?
Platte River	Grand Island	NE	28-Feb-71	1971	?	?
Platte River	Duncan	NE	20-Feb-71	1971	?	?
Platte River	Ashland	NE	21-Feb-71	1971	Break-up	Greater than 3M (see also Elkhorn River)
Platte River	South Bend	NE	30-Jan-70	1970	?	?
Platte River	Odessa	NE	2-Feb-70	1970	?	?
Platte River	North Bend	NE	24-Feb-70	1970	?	?
Platte River	Grand Island	NE	19-Feb-70	1970	?	?
Platte River	Duncan	NE	30-Jan-70	1970	?	?
Platte River	Grand Island	NE	20-Mar-69	1969	?	?
Platte River	Duncan	NE	22-Mar-69	1969	?	?
Platte River	Odessa	NE	20-Jan-68	1968	?	?
Platte River	Grand Island	NE	20-Feb-68	1968	?	?
Platte River	Odessa	NE	22-Jan-66	1966	?	?
Platte River	Grand Island	NE	6-Mar-66	1966	?	?
Platte River	Duncan	NE	10-Feb-66	1966	?	?
Platte River	Ashland	NE	10-Feb-66	1966	Break-up	About 200K USD
Platte River	Grand Island	NE	2-Mar-65	1965	?	?
Platte River	Odessa	NE	15-Jan-64	1964	?	?
Platte River	Grand Island	NE	3-Feb-64	1964	?	?
Platte River	Duncan	NE	25-Feb-64	1964	?	?

Platte River	Odessa	NE	26-Dec-62	1963	?	?
Platte River	Grand Island	NE	10-Feb-63	1963	?	?
Platte River	Duncan	NE	13-Feb-63	1963	?	?
South Platte River	Paxton	NE	30-Jan-62	1962	?	?
South Platte River	North Platte	NE	27-Jan-62	1962	?	?
Platte River	South Bend	NE	28-Mar-62	1962	?	?
Platte River	North Bend	NE	23-Mar-62	1962	?	?
Platte River	North Bend	NE	24-Dec-62	1962	?	?
Platte River	Grand Island	NE	12-Feb-62	1962	?	?
Platte River	Duncan	NE	24-Mar-62	1962	?	?
North Platte River	Lisco	NE	28-Jan-62	1962	?	?
Platte River	South Bend	NE	18-Feb-61	1961	?	?
Platte River	Overton	NE	31-Jan-61	1961	?	?
Platte River	Overton	NE	28-Dec-61	1961	?	?
Platte River	Odessa	NE	19-Feb-61	1961	?	?
Platte River	North Bend	NE	16-Feb-61	1961	?	?
Platte River	Grand Island	NE	3-Feb-61	1961	?	?
North Platte River	Lisco	NE	25-Jan-61	1961	?	?
Platte River	Overton	NE	14-Jan-60	1960	?	?
Platte River	Odessa	NE	14-Feb-60	1960	?	?
Platte River	North Bend	NE	29-Mar-60	1960	?	?
Platte River	Grand Island	NE	27-Mar-60	1960	?	?
Platte River	Fremont	NE	?????1960	1960	Break-up	areas flooded
North Platte River	North Platte	NE	1-Jan-60	1960	?	?
South Platte River	North Platte	NE	10-Jan-59	1959	?	?
Platte River	Overton	NE	26-Jan-59	1959	?	?
Platte River	North Bend	NE	12-Mar-59	1959	?	?
Platte River	Grand Island	NE	2-Mar-59	1959	?	?
Platte River	Duncan	NE	3-Mar-59	1959	?	?
North Platte River	Lisco	NE	14-Nov-59	1959	?	?
Platte River	Overton	NE	10-Mar-58	1958	?	?
Platte River	Odessa	NE	11-Feb-58	1958	?	?
Platte River	North Bend	NE	26-Feb-58	1958	?	?
Platte River	Grand Island	NE	25-Feb-58	1958	?	?
Platte River	Duncan	NE	26-Feb-58	1958	?	?
North Platte River	Lisco	NE	4-Jan-58	1958	?	?
North Platte River	Lisco	NE	14-Dec-58	1958	?	?
Platte River	Overton	NE	24-Jan-57	1957	?	?
Platte River	Overton	NE	14-Feb-56	1956	?	?

Platte River	Odessa	NE	6-Jan-56	1956	?	?
Platte River	Duncan	NE	16-Feb-56	1956	?	?
South Platte River	North Platte	NE	3-Feb-55	1955	?	?
Platte River	Overton	NE	13-Jan-55	1955	?	?
Platte River	Odessa	NE	6-Jan-55	1955	?	?
Platte River	North Bend	NE	9-Mar-55	1955	?	?
Platte River	Grand Island	NE	10-Mar-55	1955	?	?
Platte River	Duncan	NE	10-Mar-55	1955	?	?
North Platte River	Lisco	NE	30-Nov-55	1955	?	?
South Platte River	North Platte	NE	26-Jan-54	1954	?	?
Platte River	Overton	NE	28-Jan-54	1954	?	?
Platte River	Odessa	NE	4-Feb-54	1954	?	?
Platte River	Grand Island	NE	6-Feb-54	1954	?	?
Platte River	Duncan	NE	8-Feb-54	1954	?	?
North Platte River	Lisco	NE	5-Mar-54	1954	?	?
South Platte River	North Platte	NE	23-Feb-53	1953	?	?
Platte River	Odessa	NE	15-Jan-53	1953	?	?
Platte River	North Bend	NE	8-Feb-53	1953	?	?
Platte River	Grand Island	NE	27-Jan-53	1953	?	?
Platte River	Duncan	NE	29-Jan-53	1953	?	?
North Platte River	Lisco	NE	20-Jan-53	1953	?	?
Platte River	Overton	NE	30-Jan-52	1952	?	?
Platte River	Overton	NE	27-Dec-52	1952	?	?
Platte River	Odessa	NE	5-Mar-52	1952	?	?
Platte River	North Bend	NE	13-Feb-52	1952	?	?
Platte River	Grand Island	NE	7-Feb-52	1952	?	?
Platte River	Duncan	NE	26-Mar-52	1952	?	?
North Platte River	North Platte	NE	23-Mar-52	1952	?	?
North Platte River	Lisco	NE	27-Jan-52	1952	?	?
Platte River	Overton	NE	13-Feb-51	1951	?	?
Platte River	Odessa	NE	3-Jan-51	1951	?	?
Platte River	North Bend	NE	24-Feb-51	1951	?	?
Platte River	Duncan	NE	24-Feb-51	1951	?	?
Platte River	North Bend	NE	7-Mar-50	1950	?	?
Platte River	Grand Island	NE	19-Feb-50	1950	?	?
Platte River	Grand Island	NE	15-Dec-50	1950	?	?
Platte River	Fremont/ Big Island	NE	6-Mar-50	1950	?	?
Platte River	Duncan	NE	7-Mar-50	1950	?	?
North Platte River	Lisco	NE	9-Dec-50	1950	?	?

Platte River	Grand Island	NE	4-Mar-49	1949	?	?
Platte River	Fremont/ Big Island	NE	6-Mar-49	1949	?	?
Platte River	Duncan	NE	16-Mar-49	1949	?	?
Platte River	Grand Island	NE	18-Mar-48	1948	?	?
Platte River	Duncan	NE	19-Mar-48	1948	?	?
Platte River	Ashland	NE	26-Jan-47	1947	?	?
South Platte River	North Platte	NE	31-Jan-46	1946	?	?
Platte River	Grand Island	NE	6-Jan-46	1946	?	?
Platte River	Grand Island	NE	25-Dec-44	1944	?	?
North Platte River	Sutherland	NE	27-Dec-44	1944	?	?
North Platte River	North Platte	NE	1-Dec-44	1944	?	?
South Platte River	North Platte	NE	19-Mar-43	1943	?	?
South Platte	North Platte	NE	28-Dec-41	1942	?	?
South Platte	North Platte	NE	17-Jan-41	1941	?	?
South Platte	North Platte	NE	24-Feb-41	1941	?	?
South Platte River	North Platte	NE	4-Jan-41	1941	?	?
South Platte River	North Platte	NE	24-Feb-41	1941	?	?
South Platte River	North Platte	NE	11-Nov-40	1941	?	?
South Platte River	North Platte	NE	13-Dec-40	1941	?	?
Platte River	Duncan	NE	7-Feb-41	1941	?	?
North Platte River	North Platte	NE	17-Jan-41	1941	?	?
North Platte River	North Platte	NE	4-Jan-41	1941	?	?
North Platte River	North Platte	NE	21-Feb-41	1941	?	?
North Platte River	North Platte	NE	11-Nov-40	1941	?	?
North Platte River	North Platte	NE	12-Dec-40	1941	?	?
South Platte River	North Platte	NE	13-Mar-40	1940	?	?
South Platte River	North Platte	NE	1-Jan-40	1940	?	?
Platte River	Odessa	NE	8-Feb-40	1940	?	?
Platte River	Odessa	NE	29-Dec-40	1940	?	?
Platte River	Grand Island	NE	4-Mar-40	1940	?	?
Platte River	Duncan	NE	5-Mar-40	1940	?	?
North Platte River	Sutherland	NE	11-Feb-40	1940	?	?
North Platte River	Oshkosh	NE	7-Feb-40	1940	?	?
North Platte River	North Platte	NE	13-Mar-40	1940	?	?
North Platte River	North Platte	NE	1-Jan-40	1940	?	?
Platte River	Overton	NE	8-Feb-39	1939	?	?
Platte River	Duncan	NE	11-Mar-39	1939	?	?
North Platte River	Sutherland	NE	11-Feb-39	1939	?	?
North Platte River	Lisco	NE	24-Nov-38	1938	?	?

North Platte River	Bridgeport	NE	29-Dec-38	1938	?	?
Platte River	Fremont	NE	3-Jan-07	1907	?	homes flooded
Platte River	Fremont	NE	14-Feb-07	1907	Break-up	homes flooded, farm animals drowned
Platte River	Fremont	NE	26-Feb-05	1905	?	bridge destroyed, streets and homes flooded
Platter Kill	Gilboa	NY	6-Jan-79	1979	?	?
Platter Kill	Gilboa	NY	26-Jan-78	1978	?	?
Platter Kill	Gilboa	NY	22-Feb-78	1978	?	?
Platte Kill	Dunraven	NY	19-Feb-61	1961	?	?
Platte Kill	Dunraven	NY	22-Jan-57	1957	?	?
Platte Kill	Dunraven	NY	8-Mar-50	1950	?	?
Platte Kill	Dunraven	NY	16-Mar-48	1948	?	?
Platte Kill	Dunraven	NY	14-Mar-47	1947	?	?
Platte Kill	Dunraven	NY	22-Feb-45	1945	?	?
Platte Kill	Dunraven	NY	13-Mar-44	1944	?	?
Laplatte River	Shelburne Falls	VT	27-Feb-00	2000	Break-up	Unknown
Laplatte River	Shelburne Falls	VT	24-Jan-99	1999	?	?
Laplatte River	Shelburne Falls	VT	29-Mar-97	1997	?	?
LaPlatte River	Shelburne	VT	8-Mar-95	1995	?	?
Laplatte River	Shelburne Falls	VT	20-Feb-94	1994	?	?
LaPlatte River	Shelburne	VT	10-Feb-94	1994	?	?
Laplatte River	Shelburne	VT	6-Feb-91	1991	?	?
Platte River	Rockville	WI	18-Feb-61	1961	?	?
Platte River	Rockville	WI	23-Feb-58	1958	?	?
North Platte River	Casper	WY	9-Feb-97	1997	?	Blacks Forks/I-80 underpass flooded

Yukon River

River:	Yukon River			
Reach:	Alaska			
USGS Gages:	Gage Number		POR:	
YUKON R AT EAGLE AK	15356000			
NATION R NR NATION AK	15388030			
YUKON R NR STEVENS VILLAGE AK	15453500			
ANVIK R NR ANVIK AK	15565400			
YUKON R AT PILOT STATION AK	15565447			
Met Stations:	State	Gage No.	Start Year	Source
ANNETTE ISLAND AP	AK	500352	1952	Coop
AUKE BAY	AK	500464	1964	Coop
BARROW W POST-W ROGE	AK	500546	1951	Coop
BETTLES FIELD	AK	500761	1952	Coop
BIG DELTA ALLEN AAF	AK	500770	1944	Coop
COLLEGE OBSERVATORY	AK	502107	1952	Coop
EAGLE	AK	502607	1951	Coop
FAIRBANKS INTL AP	AK	702610	1949	GSOD
JUNEAU AP	AK	703810	1949	GSOD
KING SALMON AP	AK	703260	1950	GSOD
KOTZEBUE RALPH WEIN	AK	505076	1951	Coop
KOTZEBUE RALPH WEIN	AK	701330	1950	GSOD
NOME MUNICIPAL AP	AK	702000	1950	GSOD
SITKA JAPONSKI AP	AK	703710	1949	GSOD
ST PAUL ISLAND AP	AK	703080	1950	GSOD
YAKUTAT STATE AP	AK	703610	1949	GSOD

Ice Jam Database Entries for Yukon River in Alaska

City	Jam Date	Water Year	Jam Type	Damages
Galena	9-May-03	2003	Break-up	?
Eagle	29-Apr-03	2003	Break-up	?
Stevens Village	18-May-02	2002	Break-up	?
Kaltag	18-May-02	2002	Break-up	?
Nulato	24-May-01	2001	Break-up	major flooding in low areas and on the airport road.
Koyukuk	24-May-01	2001	Break-up	1/3 homes flooded, 34 evacuated
Halfway Island	27-May-01	2001	Break-up	minor flooding
Eagle	17-May-01	2001	Break-up	minor flooding
Circle	19-May-01	2001	Break-up	none

Saint Marys	10-May-95	1995	Break-up	?
Russian Mission	12-May-95	1995	Break-up	Lowland flooding
Ruby	3-May-95	1995	Break-up	?
Pilot Station	10-May-95	1995	Break-up	Lowland flooding
Marshall	10-May-95	1995	Break-up	Lowland flooding
Emmonak	16-May-95	1995	Break-up	5 or 6 homes and road flooded
Eagle	29-Apr-95	1995	Break-up	?
Circle	2-May-95	1995	Break-up	Roads, campground, and home flooding
Alakanuk	16-May-95	1995	Break-up	Roads and low areas flooded
Tanana	7-May-94	1994	Break-up	Lowland flooding
Ruby	9-May-94	1994	Break-up	Lowland flooding
Mountain Village	14-May-94	1994	Break-up	?
Galena	12-May-94	1994	Break-up	366K USD ADES total: roads flooded and erosion
Fort Yukon	2-May-94	1994	Break-up	?
Emmonak	16-May-94	1994	Break-up	?
Circle	4-May-94	1994	Break-up	Airport and campground flooded
Woodchopper Creek	5-May-93	1993	Break-up	?
Sheldon Point	23-May-93	1993	Break-up	?
Saint Marys	14-May-93	1993	Break-up	Fish buildings damaged
Pitkas Point	13-May-93	1993	Break-up	Fish buildings damaged
Pilot Station	13-May-93	1993	Break-up	Fish buildings damaged
Nulato	10-May-93	1993	Break-up	Roads and structures flooded
Mountain Village	14-May-92	1993	Break-up	Lowland flooding
Koyukuk	10-May-93	1993	Break-up	Runway and structures flooded
Fort Yukon	7-May-93	1993	Break-up	?
Emmonak	20-May-93	1993	Break-up	Homes and roads flooded
Alakanuk	20-May-93	1993	Break-up	5 buildings and roads flooded
Russian Mission	31-May-92	1992	Break-up	Lower sewage lagoon flooded
Nation	15-May-92	1992	Break-up	Cabin flooding
Marshall	27-May-92	1992	Break-up	?
Kaltag	3-Jun-92	1992	Break-up	None
Galena	25-May-92	1992	Break-up	434,791 USD ADES total homes damaged
Emmonak	4-Jun-92	1992	Break-up	Roads damaged, homes flooded
Eagle	13-May-92	1992	Break-up	8,553 USD ADES total-275K USD in Eagle + Eagle Village
Eagle Village	13-May-92	1992	Break-up	170,898 USD ADES total-275K USD in Eagle and Eagle Vill.
Bishop Rock	25-May-92	1992	Break-up	?
Alakanuk	4-Jun-92	1992	Break-up	Roads damaged

Tanana	7-May-91	1991	Break-up	Fish camps damaged
Sheldon Point	21-May-91	1991	Break-up	Minor town flooding
Russian Mission	15-May-91	1991	Break-up	Minor flooding
Ruby	9-May-91	1991	Break-up	None
Pilot Station	17-May-91	1991	Break-up	Homes and runway flooded
Nulato	9-May-91	1991	Break-up	?
Mountain Village	16-May-91	1991	Break-up	None
Marshall	12-May-91	1991	Break-up	Lowland flooding
Koyukuk	9-May-91	1991	Break-up	?
Holy Cross	12-May-91	1991	Break-up	20,265 USD ADES total4 or 5 homes and runway affected
Grayling	12-May-91	1991	Break-up	75,762 USD ADES total, 23 buildings and runway
Grayling	10-May-91	1991	Break-up	Road and runway flooded
Galena	26-May-91	1991	Break-up	?
Galena	11-May-91	1991	Break-up	None
Fort Yukon	9-May-91	1991	Break-up	Roads flooded
Emmonak	21-May-91	1991	Break-up	398,246 USD ADES total,10 homes, sewer, tanks, pipes
Circle	4-May-91	1991	Break-up	Lowland flooding
Anvik	12-May-91	1991	Break-up	104,745 USD ADES total, power+phone out, 18 houses
Anvik	10-May-91	1991	Break-up	None
Alakanuk	21-May-91	1991	Break-up	133,900 USD ADES total,10 homes, warehouse, tanks, etc.
Saint Marys	14-May-90	1990	Break-up	?
Ruby	7-May-90	1990	Break-up	?
River mile 570	8-May-90	1990	Break-up	?
Nulato	10-May-90	1990	Break-up	?
Nation	1-May-90	1990	Break-up	?
Koyukuk	8-May-90	1990	Break-up	?
Emmonak	21-May-90	1990	Break-up	?
Circle	3-May-90	1990	Break-up	?
Beaver	7-May-90	1990	Break-up	?
Alakanuk	21-May-90	1990	Break-up	Airport, streets and houses flooded
Tanana	4-May-89	1989	Break-up	Road and cabins flooded
Stevens Village	5-May-89	1989	Break-up	None
Saint Marys	24-May-89	1989	Break-up	Flooding of riverfront area
Russian Mission	16-May-89	1989	Break-up	Lowland flooding
Ruby	10-May-89	1989	Break-up	Road and cabin flooding
Rampart	6-May-89	1989	Break-up	?

Pilot Station	17-May-89	1989	Break-up	Flooding of homes and structures
Nulato	13-May-89	1989	Break-up	51,500 USD 17 homes damaged, city barge dock, fuel de
Mountain Village	17-May-89	1989	Break-up	Homes flooded and docks under water
Marshall	17-May-89	1989	Break-up	Minor flooding
Koyukuk	13-May-89	1989	Break-up	Homes, town hall and school- major flooding
Kokrines	11-May-89	1989	Break-up	Lowland flooding
Kaltag	13-May-89	1989	Break-up	?
Holy Cross	17-May-89	1989	Break-up	None
Grayling	15-May-89	1989	Break-up	None
Galena	8-May-89	1989	Break-up	Lowland flooding
Fort Yukon	2-May-89	1989	Break-up	194,812 USD ADES total
Emmonak	27-May-89	1989	Break-up	None
Circle	3-May-89	1989	Break-up	196,657 USD ADES total, also estimated damage at 69K USD
Beaver	5-May-89	1989	Break-up	?
Anvik	17-May-89	1989	Break-up	None
Alakanuk	27-May-89	1989	Break-up	None
Saint Marys	16-May-88	1988	Break-up	Minor flooding
Ruby	5-May-88	1988	Break-up	?
Pilot Station	16-May-88	1988	Break-up	Minor flooding
Mountain Village	16-May-88	1988	Break-up	?
Marshall	16-May-88	1988	Break-up	?
Holy Cross	11-May-88	1988	Break-up	?
Galena	8-May-88	1988	Break-up	?
Fort Yukon	5-May-88	1988	Break-up	?
Fish Island	8-May-88	1988	Break-up	?
Emmonak	16-May-88	1988	Break-up	Roads and low spots flooded, power out
Circle	5-May-88	1988	Break-up	Roads and homes affected by water
Anvik	11-May-88	1988	Break-up	?
Alakanuk	17-May-88	1988	Break-up	?
Twentytwo Mile Village	13-May-87	1987	Break-up	?
Tanana	13-May-87	1987	Break-up	?
Stevens Village	15-May-87	1987	Break-up	?
Rivermile 94	23-May-87	1987	Break-up	?
Kotlik	26-May-87	1987	Break-up	?
Holy Cross	21-May-87	1987	Break-up	?
Grayling	24-May-87	1987	Break-up	?
Galena	18-May-87	1987	Break-up	?

Emmonak	26-May-87	1987	Break-up	?
Circle	13-May-87	1987	Break-up	Campground, houses, parking area flooded
Anvik	25-May-87	1987	Break-up	?
Alakanuk	26-May-87	1987	Break-up	?
Stevens Village	18-May-86	1986	Break-up	?
Russian Mission	24-May-86	1986	Break-up	?
Galena	20-May-86	1986	Break-up	?
Fish Village	29-May-86	1986	Break-up	?
Emmonak	31-May-86	1986	Break-up	?
Circle	15-May-86	1986	Break-up	?
Alakanuk	24-May-86	1986	Break-up	?
Twentytwo Mile Village	19-May-85	1985	Break-up	?
Tanana	21-May-85	1985	Break-up	?
Stevens Village	21-May-85	1985	Break-up	?
Saint Marys	2-Jun-85	1985	Break-up	House, post office and roads flooded
Russian Mission	30-May-85	1985	Break-up	?
Rampart	22-May-85	1985	Break-up	?
Pilot Station	29-May-85	1985	Break-up	?
Mountain Village	3-Jun-85	1985	Break-up	?
Marshall	29-May-85	1985	Break-up	?
Holy Cross	26-May-85	1985	Break-up	?
Grayling	29-May-85	1985	Break-up	?
Galena	23-May-85	1985	Break-up	?
Fort Yukon	19-May-85	1985	Break-up	?
Emmonak	3-Jun-85	1985	Break-up	72,832 USD ADES total
Circle	17-May-85	1985	Break-up	?
Bishop Rock	23-May-85	1985	Break-up	?
Anvik	26-May-85	1985	Break-up	17,878 USD ADES total
Alakanuk	3-Jun-85	1985	Break-up	?
Stevens Village	16-May-84	1984	Break-up	?
Holy Cross	21-May-84	1984	Break-up	?
Galena	19-May-84	1984	Break-up	Road washed out
Emmonak	25-May-84	1984	Break-up	22,884 USD ADES total, houses, power plant
Circle	11-May-84	1984	Break-up	?
Charley Village	10-May-84	1984	Break-up	?
Anvik	19-May-84	1984	Break-up	?
Alakanuk	25-May-84	1984	Break-up	277,544 USD ADES total
Stevens Village	12-May-83	1983	Break-up	?

Ruby	9-May-83	1983	Break-up	?
Rampart	10-May-83	1983	Break-up	?
Nulato	10-May-83	1983	Break-up	?
Mountain Village	14-May-83	1983	Break-up	?
Galena	10-May-83	1983	Break-up	?
Eagle	1-May-83	1983	Break-up	?
Circle	6-May-83	1983	Break-up	Campground , homes and town flooded
Alakanuk	20-May-83	1983	Break-up	?
Stevens Village	18-May-82	1982	Break-up	?
Russian Mission	23-May-82	1982	Break-up	Lowland flooding
Ruby	17-May-82	1982	Break-up	?
River mile 15	30-May-82	1982	Break-up	?
Rampart	20-May-82	1982	Break-up	?
Pilot Station	27-May-82	1982	Break-up	?
Nulato	20-May-82	1982	Break-up	?
Kotlik	28-May-82	1982	Break-up	?
Holy Cross	22-May-82	1982	Break-up	?
Grayling	22-May-82	1982	Break-up	?
Galena	17-May-82	1982	Break-up	?
Fort Yukon	16-May-82	1982	Break-up	1.2 to 1.7 million USD estimated, 811,323 USD ADES total
Emmonak	28-May-82	1982	Break-up	?
Charley River	15-May-82	1982	Break-up	?
Bishop Rock	19-May-82	1982	Break-up	?
Anvik	23-May-82	1982	Break-up	?
Alakanuk	28-May-82	1982	Break-up	?
Tanana	9-May-81	1981	Break-up	?
Tanana	9-May-81	1981	Break-up	?
Emmonak	19-May-81	1981	Break-up	?
Eagle	7-May-81	1981	Break-up	?
Bishop Rock	13-May-81	1981	Break-up	?
Alakanuk	19-May-81	1981	Break-up	?
Galena	10-May-80	1980	Break-up	?
Emmonak	17-May-80	1980	Break-up	?
Stevens Village	6-May-79	1979	Break-up	?
Fort Yukon	4-May-79	1979	Break-up	Road, low areas
Eagle	3-May-79	1979	Break-up	Serious flooding
Russian Mission	10-May-78	1978	Break-up	?
Galena	11-May-78	1978	Break-up	?
Fort Yukon	16-May-78	1978	Break-up	?

Fort Yukon	11-May-78	1978	Break-up	?
Circle	12-May-78	1978	Break-up	?
Mountain Village	27-May-77	1977	Break-up	?
Kwiguk	31-May-77	1977	Break-up	?
Koyukuk	16-May-77	1977	Break-up	?
Galena	16-May-77	1977	Break-up	75-pct of old village" flooded"
Stevens Village	9-May-76	1976	Break-up	?
Saint Marys	26-May-76	1976	Break-up	?
Russian Mission	16-May-76	1976	Break-up	?
Pilot Station	21-May-76	1976	Break-up	?
Nulato	15-May-76	1976	Break-up	Portion of airport flooded
Mountain Village	26-May-76	1976	Break-up	?
Marshall	20-May-76	1976	Break-up	?
Koyukuk	15-May-76	1976	Break-up	?
Kokrines	14-May-76	1976	Break-up	?
Kaltag	16-May-76	1976	Break-up	?
Holy Cross	16-May-76	1976	Break-up	?
Grayling	17-May-76	1976	Break-up	?
Circle	6-May-76	1976	Break-up	?
Bullfrog Island	15-May-76	1976	Break-up	?
Anvik	20-May-76	1976	Break-up	?
Pilot Station	24-May-75	1975	Break-up	22 houses flooded
Nulato	13-May-75	1975	Break-up	?
Koyukuk	13-May-75	1975	Break-up	?
Holy Cross	18-May-75	1975	Break-up	Major flooding
Grayling	18-May-75	1975	Break-up	Homes flooded
Fort Yukon	11-May-75	1975	Break-up	Flooded streets
Fish Island	14-May-75	1975	Break-up	?
Emmonak	29-May-75	1975	Break-up	Runway and many homes flooded
Anvik	18-May-75	1975	Break-up	?
Alakanuk	29-May-75	1975	Break-up	49 houses and 5 fishing boats damaged
Woodchopper	13-May-72	1972	Break-up	?
Russian Mission	27-May-72	1972	Break-up	No buildings flooded
Russian Mission	19-May-72	1972	Break-up	Town flooded
Holy Cross	22-May-72	1972	Break-up	Minor flooding
Galena	19-May-72	1972	Break-up	?
Fort Yukon	19-May-72	1972	Break-up	?
Emmonak	30-May-72	1972	Break-up	35 to 40 houses flooded
Anvik	23-May-72	1972	Break-up	Major flooding

Alakanuk	30-May-72	1972	Break-up	90-pct of 70 homes had up to 3 ft water
Sheldon Point	4-Jun-71	1971	?	Village flooded and evacuated
Saint Marys	??May1971	1971	Break-up	Lowland flooding minor damage to homes
Russian Mission	28-May-71	1971	Break-up	Minor damages
Pilot Station	??May1971	1971	Break-up	Minor damage
Mountain Village	1-Jun-71	1971	Break-up	?
Koyukuk	??May1971	1971	Break-up	Village evacuated
Holy Cross	??May1971	1971	Break-up	Major damages
Grayling	??May1971	1971	Break-up	None
Galena	19-May-71	1971	Break-up	2 million USD estimated, 80-pct of town destroyed
Emmonak	4-Jun-71	1971	?	Village flooded and evacuated
Beaver	18-May-71	1971	?	?
Anvik	??May1971	1971	Break-up	Minor home flooding
Alakanuk	4-Jun-71	1971	?	Village flooded and evacuated
Pilot Station	31-May-66	1966	Break-up	?
Nulato	??May1966	1966	Break-up	Flooding
Koyukuk	??May1966	1966	Break-up	Flooding
Sheldon Point	?????1964	1964	Break-up	?
Alakanuk	11-Jun-64	1964	Break-up	?
Kaltag	20-May-63	1963	?	?
Galena	??May1963	1963	Break-up	?
Rampart	16-May-63	1963	?	?
Kwiguk	26-May-63	1963	Break-up	?
Fort Yukon	??May1963	1963	Break-up	?
Eagle	??May1962	1962	?	Unknown
Fort Yukon	?????1961	1961	Unknown	?
Ruby	8-Aug-59	1959	Break-up	?
Eagle	9-May-59	1959	Break-up	?
Fort Yukon	?????1957	1957	Break-up	?
Fort Yukon	16-May-48	1948	Break-up	?
Fort Yukon	20-May-45	1945	flooding	?
Fort Yukon	15-May-37	1937	Break-up	Unknown
Fort Yukon	10-May-36	1936	Break-up	flooding

Kuskokwim River

River:			Kuskokwim River	
Reach:			Alaska	
USGS Gages:			Gage Number	POR:
KUSKOKWIM R AT LISKYS CROSSING NR STONY RIVER AK			15303900	
KUSKOKWIM R AT CROOKED CREEK AK			15304000	
KUSKOKWIM R AT ANIAK AK			15304060	
Met Stations:	State	Gage No.	Start Year	Source
BETHEL AIRPORT	AK	500754	1951	Coop
MC GRATH AP	AK	702310	1950	GSOD

Ice Jam Database Entries for Kuskokwim River in Alaska

City	Jam Date	Water Year	Jam Type	Damages
Red Devil	30-Apr-04	2004	Released	?
Aniak	2-May-04	2004	Released	?
Mcgrath	4-May-03	2003	Break-up	?
Mcgrath	10-May-02	2002	Break-up	?
Aniak	12-May-02	2002	Break-up	road flooding, dike overtopped in 4 places
Aniak	24-Apr-98	1998	Break-up	Unknown
McGrath	9-May-96	1996	Break-up	?
Aniak	??May1996	1996	Break-up	?
Aniak	7-May-96	1996	Break-up	Water in village
Upper Kalskag	3-May-95	1995	Break-up	Road flooding
Tuluksak	4-May-95	1995	Break-up	Fish camps flooded
Sleetmute	28-Apr-95	1995	Break-up	None
Red Devil	27-Apr-95	1995	Break-up	None
Oscarville	7-May-95	1995	Break-up	Roads, boardwalks and sewage lagoon flooded
Napaskiak	7-May-95	1995	Break-up	Roads flooded, boardwalk and home damage
Napakiak	7-May-95	1995	Break-up	?
Lower Kalskag	3-May-95	1995	Break-up	Road flooding
Kwethluk	5-May-95	1995	Break-up	Airport and homes flooded
Crooked Creek	28-Apr-95	1995	Break-up	Road flooding
Bethel	5-May-95	1995	Break-up	Extensive flooding, homes damaged
Aniak	29-Apr-95	1995	Break-up	Road, dike and home damage
Akiak	5-May-95	1995	Break-up	Roads, runway flooded
Akiachak	6-May-95	1995	Break-up	Low lying areas and road flooded
Upper Kalskag	6-May-94	1994	Break-up	Road flooding
Tuluksak	7-May-94	1994	Break-up	Airport and road flooding

Oscarville	8-May-94	1994	Break-up	?
McGrath	1-May-94	1994	Break-up	Road flooding
Lower Kalskag	6-May-94	1994	Break-up	Road flooding
Kwethluk	10-May-94	1994	Break-up	Road flooding
Crooked Creek	30-Apr-94	1994	Break-up	?
Bethel	7-May-94	1994	Break-up	?
Aniak	2-May-94	1994	Break-up	Road flooding
Akiak	9-May-94	1994	Break-up	Lowland flooding
Sleetmute	26-Apr-93	1993	Break-up	None
Red Devil	26-Apr-93	1993	Break-up	None
Napaskiak	3-May-93	1993	Break-up	Road flooding
Napakiak	4-May-93	1993	Break-up	?
McGrath	1-May-93	1993	Break-up	Roads and structures flooded
Lower Kalskag	29-Apr-93	1993	Break-up	Road and fish camp flooding
Bethel	29-Apr-93	1993	Break-up	?
Aniak	29-Apr-93	1993	Break-up	None
Akiak	2-May-93	1993	Break-up	Roads flooded
Chauthbaluk	21-May-92	1992	Break-up	?
Aniak	21-May-92	1992	Break-up	?
Stony River	2-May-91	1991	Break-up	Lowland flooding
Sleetmute	3-May-91	1991	Break-up	None
Red Devil	3-May-91	1991	Break-up	192,933 USD ADES Total -homes flooded
Oscarville	9-May-91	1991	Break-up	90-pct covered in water
Napaskiak	9-May-91	1991	Break-up	90-pct covered in water
Napakiak	9-May-91	1991	Break-up	?
McGrath	6-May-91	1991	Break-up	368,169 USD ADES total- 50-pct of homes flooded + roads
Lower Kalskag	5-May-91	1991	Break-up	?
Kwethluk	9-May-91	1991	Break-up	90-pct covered in water
Crooked Creek	3-May-91	1991	Break-up	Roads and airport flooded
Bethel	9-May-91	1991	Break-up	Minor flooding
Aniak	4-May-91	1991	Break-up	215,358 USD ADES total- flooded 13 homes, 1 casualty
Akiak	May1991	1991	Break-up	?
Tuluksak	4-May-90	1990	Break-up	?
Napaskiak	6-May-90	1990	Break-up	?
McGrath	1-May-90	1990	Break-up	39,409 USD ADES total
Bethel	5-May-90	1990	Break-up	Water over bank
Bethel	2-May-90	1990	Break-up	?
Aniak	29-Apr-90	1990	Break-up	?

Akiak	6-May-90	1990	Break-up	?
Tuluksak	11-May-89	1989	Break-up	None
Stewarts Bend	5-May-89	1989	Break-up	Extensive upstream flooding
Sleetmute	2-May-89	1989	Break-up	?
Red Devil	2-May-89	1989	Break-up	?
Oscarville	12-May-89	1989	Break-up	55K USD 8 homes flooded, village boardwalk, etc..
Napaskiak	12-May-89	1989	Break-up	175,500 USD 45 homes flooded, roads washed out
Napakiak	12-May-89	1989	Break-up	?
McGrath	5-May-89	1989	Break-up	?
Kwethluk	10-May-89	1989	Break-up	Runway flooded
Kalskag	11-May-89	1989	Break-up	?
Crooked Creek	2-May-89	1989	Break-up	Minor flooding
Bethel	12-May-89	1989	Break-up	Minor flooding
Appel Mountain	5-May-89	1989	Break-up	?
Aniak	5-May-89	1989	Break-up	732,500 USD-affected ice dike, city dump, roads,
Tuluksak	9-May-88	1988	Break-up	?
Oscarville	15-May-88	1988	Break-up	Town flooding
Napaskiak	15-May-88	1988	Break-up	125,292 USD ADES total for Napakiak and Napaskiak
Napakiak	15-May-88	1988	Break-up	125,292 USD ADES total for Napakiak and Napaskiak
McGrath	4-May-88	1988	Break-up	?
Kwethluk	12-May-88	1988	Break-up	?
Georgetown	6-May-88	1988	Break-up	?
Crooked Creek	6-May-88	1988	Break-up	133,320 USD ADES total
Bethel	15-May-88	1988	Break-up	Town flooding
Aniak	6-May-88	1988	Break-up	?
Akiak	12-May-88	1988	Break-up	Village flooded minor
Akiachak	11-May-88	1988	Break-up	?
Sleetmute	7-May-87	1987	Break-up	51,602 USD ADES total for Sleetmute and Red Devil
Red Devil	7-May-87	1987	Break-up	51,602 USD ADES total for Red Devil and Sleetmute
McGrath	9-May-87	1987	Break-up	?
Kalskag	16-May-87	1987	Break-up	?
Chuathbaluk	9-May-87	1987	Break-up	Flooding upstream at Red Devil
Bethel	17-May-87	1987	Break-up	?
Aniak	9-May-87	1987	Break-up	993,861 USD ADES total, dike undermined

Akiak	17-May-87	1987	Break-up	?
Tuluksak	16-May-86	1986	Break-up	?
Red Devil	15-May-86	1986	Break-up	?
Nikolai	May1986	1986	Break-up	?
McGrath	12-May-86	1986	Break-up	?
Crooked Creek	15-May-86	1986	Break-up	?
Bethel	15-May-86	1986	Break-up	?
Aniak	13-May-86	1986	Break-up	?
Akiak	21-May-86	1986	Break-up	?
Stony River	20-May-85	1985	Break-up	?
Sleetmute	21-May-85	1985	Break-up	56,826 USD ADES total for Sleetmute, McGrath, Red Devil
Red Devil	21-May-85	1985	Break-up	56,826 USD ADES total for Sleetmute, McGrath, Red Devil
Oscarville	26-May-85	1985	Break-up	Some houses flooded
Napaskiak	26-May-85	1985	Break-up	Some houses flooded
Napakiak	26-May-85	1985	Break-up	?
McGrath	22-May-85	1985	Break-up	56,836 USD ADES total for McGrath, Sleetmute, Red Devil
Kwethluk	26-May-85	1985	Break-up	?
Kalskag	24-May-85	1985	Break-up	Airstrip and homes flooded
Bethel	26-May-85	1985	Break-up	?
Bethel	21-May-85	1985	Break-up	Some houses flooded
Aniak	22-May-85	1985	Break-up	?
Akiak	25-May-85	1985	Break-up	?
Tuluksak	18-May-84	1984	Break-up	Airport runway
Red Devil	15-May-84	1984	Break-up	A few houses
McGrath	16-May-84	1984	Break-up	Houses
Aniak	14-May-84	1984	Break-up	?
Red Devil	5-May-83	1983	Break-up	Runway and town flooded
Kalskag	12-May-83	1983	Break-up	School, homes and runway flooded
Georgetown	5-May-83	1983	Break-up	Town and runway flooded
Crooked Creek	5-May-83	1983	Break-up	Road flooding
Aniak	9-May-83	1983	Break-up	75,614 USD ADES total, home flooding up to 4 feet
Akiachak	14-May-83	1983	Break-up	?
Tuluksak	17-May-82	1982	Break-up	Minor flooding
Sleetmute	13-May-82	1982	Break-up	Half of town flooded
Red Devil	14-May-82	1982	Break-up	?
Napakiak	19-May-82	1982	Break-up	?
McGrath	13-May-82	1982	Break-up	?

Lower Kalskag	16-May-82	1982	Break-up	?
Kwethluk	16-May-82	1982	Break-up	?
Kalskag	16-May-82	1982	Break-up	?
Bethel	19-May-82	1982	Break-up	?
Aniak	16-May-82	1982	Break-up	?
Akiak	19-May-82	1982	Break-up	?
Akiachak	21-May-82	1982	Break-up	?
Akiachak	19-May-82	1982	Break-up	?
Bethel	12-May-81	1981	Break-up	Low area flooding
Little Russian Mission	2-May-80	1980	Break-up	?
Kwethluk	9-May-80	1980	Break-up	?
Bethel	6-May-80	1980	Break-up	Town flooded
Aniak	2-May-80	1980	Break-up	?
Akiachak	8-May-80	1980	Break-up	?
Napakiak	3-May-79	1979	Break-up	?
Napaimiut	28-Apr-79	1979	Break-up	?
McGrath	1-May-79	1979	Break-up	Road, sloughs
Aniak	28-Apr-79	1979	Break-up	?
Akiachak	3-May-79	1979	Break-up	?
Kalskag	7-May-78	1978	Break-up	?
Eek Island	28-May-77	1977	Break-up	?
Aniak	14-May-77	1977	Break-up	Water in dump area and on west end of runway
Akiak	19-May-77	1977	Break-up	Town and runway flooding
Akiachak	22-May-77	1977	Break-up	Village flooded, road washed out
Nikolai	3-May-76	1976	Break-up	?
Tuluksak	10-May-76	1976	Break-up	Village 100-pct flooded
Stony River	11-May-76	1976	Break-up	?
Sleetmute	11-May-76	1976	Break-up	?
Sleetmute	8-May-76	1976	Break-up	?
Red Devil	11-May-76	1976	Break-up	?
Red Devil	8-May-76	1976	Break-up	?
Oscarville	20-May-76	1976	Break-up	?
Napaskiak	20-May-76	1976	Break-up	Entire village flooded, 100 evacuated
Napakiak	20-May-76	1976	Break-up	?
McGrath	8-May-76	1976	Break-up	18K USD to roads, 12K USD to welcome center, city hall
Kwethluk	17-May-76	1976	Break-up	Airstrip flooded
Kalskag	13-May-76	1976	Break-up	?

Kalskag	9-May-76	1976	Break-up	?
Bethel	19-May-76	1976	Break-up	Flooding in Bethel
Aniak	8-May-76	1976	Break-up	?
Akiak	14-May-76	1976	Break-up	Flooded airstrip
Akiachak	17-May-76	1976	Break-up	Flooding at Akiak
Tuluksak	17-May-75	1975	Break-up	?
Sleetmute	14-May-75	1975	Break-up	10 to 12 houses flooded, no evacuations
River mile 375	13-May-75	1975	Break-up	?
River mile 304	13-May-75	1975	Break-up	?
Red Devil	14-May-75	1975	Break-up	?
Oscarville	20-May-75	1975	Break-up	Town 100-pct flooded
Napaskiak	20-May-75	1975	Break-up	38 houses flooded, 80 people evacuated
Napakiak	15-May-75	1975	Break-up	3 houses flooded, no evacuations
McGrath	12-May-75	1975	Break-up	?
Kwethluk	15-May-75	1975	Break-up	Village 100-pct flooded, 90-pct runway under water
Kalskag	17-May-75	1975	Break-up	Flooding
Devils Elbow	14-May-75	1975	Break-up	Lowland flooding
Devils Bar	15-May-75	1975	Break-up	Islands and flood plain area flooded
Bethel	15-May-75	1975	Break-up	Estimated 60 homes and buildings flooded, no evacs
Aniak	15-May-75	1975	Break-up	Town flooding
Akiak	18-May-75	1975	Break-up	Flooding
Akiachak	20-May-75	1975	Break-up	Flooding of homes
Paimute Portage	17-May-72	1972	Break-up	?
Oscarville	24-May-72	1972	Break-up	Town evacuated
Napaimiut	19-May-72	1972	Break-up	Homes flooded
McGrath	16-May-72	1972	Break-up	?
H&R Mine	18-May-72	1972	Break-up	Homes flooded
Bethel	25-May-72	1972	Break-up	Flooding in Bethel
Aniak	20-May-72	1972	Break-up	Town flooded
Akiachak	17-May-72	1972	Break-up	?
McGrath	13-Oct-70	1971	Freeze-up	?
Sleetmute	7-Jun-71	1971	Break-up	Flooded homes, evacuation
Red Devil	Jun1971	1971	Break-up	Major flooding
Oscarville	May1971	1971	Break-up	Minor home flooding
Napaskiak	May1971	1971	Break-up	Minor home flooding
Napakiak	May1971	1971	Break-up	Minor house flooding
Medfra	19-May-71	1971	Break-up	?
McGrath	20-May-71	1971	Break-up	?

Kwethluk	May1971	1971	Break-up	Major home flooding
Bethel	May1971	1971	Break-up	Lowland and minor home flooding
Bethel	27-May-71	1971	Break-up	?
Aniak	21-May-71	1971	Break-up	Major flooding and damage of homes, all evacuated
Akiak	26-May-71	1971	Break-up	2660 USD day school, minor home flooding
Akiachak	29-May-71	1971	Break-up	None
McGrath	4-May-70	1970	Break-up	?
Sleetmute	1966	1966	Break-up	?
Bethel	18-May-66	1966	Break-up	?
Aniak	16-May-66	1966	Break-up	Village and lower part of airstrip flooded
Bethel	20-May-65	1965	Break-up	?
Mcgrath	2-Jun-64	1964	?	Unknown
Kalskag	3-Jun-64	1964	Break-up	?
Bethel	4-Jun-64	1964	Break-up	?
Aniak	31-May-64	1964	Break-up	?
Bethel	21-May-63	1963	Break-up	Town flooding
Tuluksak	May1962	1962	Break-up	?
McGrath	13-Oct-61	1962	Freeze-up	?
Bethel	26-May-62	1962	Break-up	?
Bethel	12-Oct-61	1962	Freeze-up	?
Crooked Creek	10-May-59	1959	Break-up	?
Crooked Creek	1-May-53	1953	Break-up	?

Connecticut River

River:	Connecticut River			
Reach:	Vermont and New Hampshire			
USGS Gages:		Gage Number	POR:	
CONNECTICUT R BELOW INDIAN STREAM NR PITTSBURG, NH		01129200		
MOHAWK RIVER NEAR COLEBROOK NH		01129440		
CONNECTICUT RIVER AT NORTH STRATFORD, NH		01129500		
UPPER AMMONOOSUC RIVER NEAR GROVETON, NH		01130000		
CONNECTICUT RIVER NEAR DALTON, NH		01131500		
AMMONOOSUC RIVER AT BETHLEHEM JUNCTION, NH		01137500		
CONNECTICUT RIVER AT WELLS RIVER, VT		01138500		
WELLS RIVER AT WELLS RIVER, VT		01139000		
EAST ORANGE BRANCH AT EAST ORANGE, VT		01139800		
CONNECTICUT RIVER AT WEST LEBANON, NH		01144500		
MASCOMA RIVER AT MASCOMA, NH		01150500		
OTTAUQUECHEE RIVER AT NORTH HARTLAND, VT		01151500		
SUGAR RIVER AT WEST CLAREMONT, NH		01152500		
BLACK RIVER AT NORTH SPRINGFIELD, VT		01153000		
WILLIAMS RIVER NEAR ROCKINGHAM VT		01153550		
SAXTONS RIVER AT SAXTONS RIVER, VT		01154000		
CONNECTICUT RIVER AT NORTH WALPOLE, NH		01154500		
Met Stations:	State	Gage No.	Start Year	Source
BENTON 5 SW	NH	270681	1966	Coop
BERLIN	NH	270690	1927	Coop
COLEBROOK	NH	271647	1961	Coop
CONCORD MUNI AP	NH	726050	1949	GSOD
EPPING	NH	272800	1965	Coop
FIRST CONN LAKE	NH	272999	1949	Coop
GRAFTON	NH	273530	1956	Coop
LANCASTER	NH	274556	1957	Coop
MASSABESIC LAKE	NH	275211	1949	Coop
MOUNT WASHINGTON	NH	275639	1949	Coop
MOUNT WASHINGTON	NH	726130	1949	GSOD
PLYMOUTH	NH	276945	1956	Coop
CAVENDISH	VT	431243	1949	Coop
MONTPELIER AP	VT	726145	1950	GSOD
MOUNT MANSFIELD	VT	435416	1960	Coop
NEWPORT	VT	435542	1931	Coop

RUTLAND	VT	436995	1949	Coop
SAINT JOHNSBURY	VT	437054	1927	Coop

Ice Jam Database Entries for Connecticut River in Vermont & New Hampshire

City	State	Jam Date	Water Year	Jam Type	Damages
Charlestown	NH	19-Dec-03	2004	Released	?
Plainfield	NH	24-Mar-03	2003	Break-up	?
North Stratford	NH	19-Jan-01	2001	?	?
Cornish	NH	17-Dec-00	2001	Break-up	none
West Lebanon	NH	28-Feb-00	2000	Break-up	Unknown
North Stratford	NH	29-Feb-00	2000	Break-up	Unknown
North Stratford	NH	24-Jan-99	1999	?	?
West Lebanon	NH	8-Jan-98	1998	Break-up	?
North Stratford	NH	16-Jan-98	1998	Break-up	Lowland flooding
North Stratford	NH	23-Feb-97	1997	?	?
Stratford	NH	19-Jan-96	1996	Break-up	?
Orford	NH	19-Jan-96	1996	Break-up	?
Monroe	NH	19-Jan-96	1996	Break-up	?
Haverhill	NH	19-Jan-96	1996	Break-up	Road flooding
Charlestown	NH	19-Jan-96	1996	Break-up	Road flooding and evacuations
West Lebanon	NH	18-Mar-95	1995	?	?
North Stratford	NH	6-Feb-95	1995	?	?
Dalton	NH	17-Jan-95	1995	Break-up	Unknown
Stratford	NH	30-Mar-93	1993	?	?
North Stratford	NH	30-Mar-93	1993	?	?
Dalton	NH	6-Mar-92	1992	Break-up	Floods NH Route 135
Cornish Flat	NH	11-Mar-92	1992	Break-up	?
West Lebanon	NH	27-Jan-90	1990	?	?
North Stratford	NH	29-Mar-89	1989	?	?
North Stratford	NH	27-Mar-88	1988	?	?
North Stratford	NH	27-Jan-86	1986	Break-up	?
North Stratford	NH	25-Feb-85	1985	?	?
West Stewartstown	NH	9-Jan-81	1981	?	Home flooding
West Lebanon	NH	12-Feb-81	1981	?	?
North Stratford	NH	12-Feb-81	1981	?	?
West Lebanon	NH	7-Mar-79	1979	?	?
North Stratford	NH	6-Mar-79	1979	Break-up	3M USD to 4M USD
North Stratford	NH	6-Mar-79	1979	?	?
North Stratford	NH	6-Mar-79	1979	?	?
North Stratford	NH	14-Apr-78	1978	?	?

Stratford	NH	13-Dec-77	1977	Break-up	Flooded RR track, road, residences
North Stratford	NH	14-Mar-77	1977	?	?
Lebanon	NH	??Feb1976	1976	Break-up	Sewer pipeline damaged
North Stratford	NH	3-Feb-73	1973	?	?
West Stewartstown	NH	??Jan1971	1971	Freeze-up	Residential, road, agricultural flooding
North Stratford	NH	24-Dec-71	1971	?	?
Plainfield	NH	20-Mar-68	1968	Break-up	River road flooded
North Stratford	NH	24-Mar-68	1968	?	?
North Stratford	NH	5-Feb-67	1967	?	?
North Stratford	NH	30-Jan-65	1965	?	?
North Stratford	NH	5-Mar-64	1964	?	?
North Stratford	NH	8-Apr-62	1962	?	?
Plainfield	NH	29-Jan-59	1959	Break-up	None
North Stratford	NH	3-Apr-59	1959	?	?
North Stratford	NH	23-Jan-57	1957	?	?
North Stratford	NH	31-Jan-47	1947	?	?
Walpole	NH	18-Dec-45	1946	?	?
North Walpole	NH	10-Mar-46	1946	?	?
North Stratford	NH	9-Mar-46	1946	?	?
North Stratford	NH	19-Dec-43	1944	?	?
North Stratford	NH	27-Mar-43	1943	?	?
North Stratford	NH	12-Apr-40	1940	Break-up	?
Walpole	NH	29-Jan-39	1939	?	Unknown
Walpole	NH	4-Jan-39	1939	?	Unknown
North Stratford	NH	24-Mar-38	1938	?	?
North Stratford	NH	6-Dec-38	1938	?	?
North Stratford	NH	15-Feb-37	1937	?	?
North Stratford	NH	13-Mar-36	1936	?	?
North Stratford	NH	10-Jan-35	1935	?	?
Littleton	NH	10-Jan-35	1935	Break-up	Rte. 18 flooded
Dalton	NH	18-Jan-35	1935	?	?
Springfield	VT	19-Dec-03	2004	Released	?
Windsor	VT	10-Jan-01	2001	Freeze-up	?
Windsor	VT	17-Dec-00	2001	Break-up	none
White River Junction	VT	19-Jan-96	1996	Break-up	?
Guildhall	VT	19-Jan-96	1996	Break-up	?
Brattleboro	VT	19-Jan-96	1996	Break-up	?
Bradford	VT	19-Jan-96	1996	Break-up	?
Bellows Falls	VT	19-Jan-96	1996	Break-up	Flooding, road closures, evacs

Lunenburg	VT	17-Jan-95	1995	Break-up	Unknown
Windsor	VT	11-Mar-92	1992	Break-up	75-100K USD (see also Mill R. at Windsor; Cornish, NH)
Newbury	VT	26-Jan-86	1986	Break-up	?
Wells River	VT	12-Feb-81	1981	?	Home flooding
Canaan	VT	9-Jan-81	1981	?	6 families evacuated
Windsor	VT	??Mar1979	1979	Break-up	?
Hartford/White River Junction	VT	27-Jan-76	1976	Break-up	?
Windsor	VT	??Feb1973	1973	Break-up	Floods 6 homes, road
Hartford/White River Junction	VT	12-Feb-70	1970	Break-up	?
Windsor	VT	21-Mar-68	1968	Break-up	?
Windsor	VT	6-Mar-64	1964	Break-up	Public and Private Property 2.5 million USD
Ascutney	VT	6-Mar-64	1964	Break-up	Lowland flooding
Hartford/White River Junction	VT	??Feb1961	1961	?	?
North Hartland	VT	29-Jan-59	1959	Break-up	None
Hartford/White River Junction	VT	29-Jan-59	1959	Break-up	?
Hartford/White River Junction	VT	22-Jan-59	1959	?	?
Vernon	VT	24-Jan-57	1957	?	?
Windsor	VT	9-Mar-46	1946	Break-up	?
Vernon	VT	10-Mar-46	1946	?	?
South Newbury	VT	16-Mar-46	1946	?	?
Hartford/White River Junction	VT	11-Mar-46	1946	?	?
Hartford/White River Junction	VT	2-Jan-45	1945	?	?
Hartford/White River Junction	VT	25-Feb-43	1943	?	?
Vernon	VT	17-Mar-36	1936	?	Flooded roads and cellars
St. Johnsbury	VT	10-Jan-35	1935	Break-up	?
South Newbury	VT	11-Jan-35	1935	?	Plant damaged
Bellows Falls	VT	9-Jan-35	1935	?	Road flooding, lost electricity
Brattleboro	VT	28-Mar-20	1920	Break-up	?

Milk River

River:		Milk River		
Reach:		Montana		
USGS Gages:			Gage Number	POR:
Milk River at Eastern Crossing of Int Bndry			06135000	
Big Sandy Creek near Havre MT			06139500	
Milk River at Havre MT			06140500	
Clear Creek near Chinook MT			06142400	
Battle Creek near Chinook MT			06151500	
Milk River near Harlem MT			06154100	
Peoples Cr bl Kuhr Coulee nr Dodson MT			06154550	
Milk River near Dodson MT			06155030	
Milk River at Juneberg Bridge nr Saco MT			06164510	
Beaver Cr bl Guston Coulee nr Saco MT			06166000	
Milk River at Tampico MT			06172310	
Milk River at Nashua MT			06174500	
Met Stations:	State	Gage No.	Start Year	Source
CHINOOK	MT	241722	1949	Coop
GILDFORD	MT	243530	1960	Coop
GLASGOW INTL AP	MT	727680	1957	GSOD
HARLEM 4 W	MT	243929	1949	Coop
HAVRE CITY-COUNTY AP	MT	727770	1962	GSOD
OPHEIM 12 SSE	MT	246238	1949	Coop
SIMPSON 6 NW	MT	247620	1949	Coop

Ice Jam Database Entries for the Milk River in Montana

City	Jam Date	Water Year	Jam Type	Damages
Dodson	11-Mar-04	2004	Released	?
Saco	27-Feb-97	1997	?	?
Nashua	24-Mar-97	1997	?	?
Harlem	24-Mar-97	1997	?	Extensive backwater flooding of low-lands
Glasgow	26-Mar-97	1997	?	Lowland flooding
Dodson	25-Mar-97	1997	?	?
Tampico	15-Feb-96	1996	Break-up	Lowland flooding
Malta	19-Mar-96	1996	?	5 calves died, evacuations, flooding
Havre	29-Feb-96	1996	Break-up	?
Harlem	12-Mar-96	1996	Break-up	Lowland flooding
Glasgow	??Feb1996	1996	Break-up	Flooding
Nashua	17-Mar-94	1994	?	?

Havre	8-Mar-94	1994	?	Low lying flooding
Havre	7-Mar-94	1994	Break-up	Road flooding
Glasgow	12-Mar-94	1994	Break-up	?
Chinook	11-Mar-94	1994	?	4-5 families evacuated
Saco	4-Mar-86	1986	?	?
Glasgow	2-Mar-86	1986	?	Severe
Tampico	?????1979	1979	?	Flooding
Malta	22-Mar-79	1979	?	Lowland flooding
Tampico	?????1978	1978	?	Flooding
Saco	??Apr1978	1978	?	?
Glasgow	4-Apr-78	1978	?	major flooding, evacuation
Tampico	22-Mar-76	1976	?	?
Babb	13-Mar-72	1972	?	?
Babb	8-Apr-71	1971	Break-up	?
Browning	5-Apr-71	1971	Break-up	?
Western Crossing Of International Boundary	21-Feb-71	1971	?	?
Vandalia	22-Feb-71	1971	?	?
Nashua	4-Apr-71	1971	?	?
International Boundary, Eastern Crossing	16-Feb-71	1971	?	?
Havre	14-Feb-71	1971	?	?
International Boundary, western crossing	7-Apr-70	1970	?	?
Babb	2-Apr-69	1969	?	?
International Boundary (West)	1-Apr-69	1969	?	?
International Boundary (Eastern Crossing)	17-Mar-69	1969	Break-up	?
Browning	14-Apr-68	1968	?	?
Nashua	9-Mar-68	1968	?	?
International Boundary (Eastern Crossing)	6-Mar-68	1968	Break-up	?
Nashua	30-Mar-67	1967	?	?
International Boundary (Eastern Crossing)	24-Mar-67	1967	?	?
Babb	29-Mar-66	1966	?	?

Browning	28-Mar-66	1966	?	?
Nashua	25-Mar-66	1966	?	?
International Boundary (West)	10-Mar-66	1966	?	?
Harve	10-Mar-66	1966	?	?
Harlem	18-Mar-66	1966	?	?
Browning	6-Apr-65	1965	?	?
Nashua	13-Apr-65	1965	?	?
Nashua	13-Apr-65	1965	?	?
Malta	8-Apr-65	1965	?	?
International Boundary (West)	28-Feb-65	1965	?	?
International Boundary (west)	6-Feb-63	1963	?	?
Del Bonita	6-Feb-63	1963	?	?
Browning	26-Mar-62	1962	?	?
International Boundary	5-Apr-62	1962	?	?
International Boundary (east)	24-Mar-62	1962	?	?
Del Bonita	10-Mar-62	1962	?	?
Nashua	6-Feb-61	1961	?	?
International Boundary (west)	19-Mar-61	1961	?	?
International Boundary	20-Mar-60	1960	?	?
International Boundary (east)	22-Mar-60	1960	?	?
International Boundary	21-Mar-59	1959	?	?
Browning	1-Apr-59	1959	?	?
Nashua	24-Mar-59	1959	?	?
International Boundary (east)	30-Mar-58	1958	?	?
Browning	28-Mar-57	1957	?	?
International Boundary (east)	2-Mar-57	1957	?	?
Nashua	29-Mar-56	1956	?	?
International Boundary (east)	6-Apr-54	1954	?	?
International Boundary	27-Mar-52	1952	?	?
International Boundary, eastern	28-Mar-52	1952	?	?

crossing				
International Boundary (east)	28-Mar-52	1952	?	?
Glasgow	17-Apr-52	1952	?	Severe flooding, evacuations
Nashua	3-Apr-51	1951	?	?
Lohman	23-Mar-51	1951	?	?
International Boundary (west)	2-Apr-51	1951	?	?
Lohman	2-Apr-50	1950	?	?
Nashua	23-Mar-49	1949	?	?
International Boundary (west)	7-Apr-49	1949	?	?
International Boundary	16-Apr-48	1948	?	?
International Boundary	17-Mar-47	1947	?	?
Nashua	30-Mar-47	1947	?	?
Lohman	22-Mar-47	1947	?	?
International Boundary (west)	20-Mar-47	1947	?	?
International Boundary (east)	23-Mar-47	1947	?	?
Lohman	26-Feb-46	1946	?	?
International Boundary (west)	6-Mar-46	1946	?	?
Nashua	28-Mar-45	1945	?	?
Lohman	12-Mar-45	1945	?	?
International Boundary (east)	12-Mar-45	1945	?	?
Nashua	27-Mar-44	1944	?	?
Lohman	20-Mar-44	1944	?	?
International Boundary (west)	4-Apr-44	1944	?	?
International Boundary	24-Mar-43	1943	?	?
Lohman	26-Mar-43	1943	?	?
International Boundary (west)	3-Apr-43	1943	?	?
International Boundary (east)	30-Mar-43	1943	?	?
Browning	3-Apr-42	1942	?	?
Nashua	20-Mar-42	1942	?	?
International Boundary	2-Apr-42	1942	?	?

International Boundary (east)	10-Mar-42	1942	?	?
Nashua	31-Mar-41	1941	?	?
Lohman	8-Mar-41	1941	?	?
Lohman	4-Mar-40	1940	?	?
International Boundary (east)	5-Mar-40	1940	?	?
International Boundary (west)	25-Mar-39	1939	?	?
International Boundary (east)	19-Mar-39	1939	?	?
Glasgow	30-Mar-39	1939	?	Severe flooding, evacuations
International Boundary (west)	15-Mar-38	1938	?	?
Vandalia	26-Mar-35	1935	?	?
Lohman	16-Mar-35	1935	?	?
Vandalia	18-Feb-34	1934	?	?
Vandalia	1-Feb-31	1931	?	?
Vandalia	22-Feb-30	1930	?	?
Glasgow	??Mar1918	1918	Break-up	?
Malta	19-Mar-16	1916	?	?
Havre	12-Mar-16	1916	?	?
Malta	5-Mar-14	1914	?	?

Kankakee River

River:	Kankakee River			
Reach:	Wilmington, IL			
USGS Gages:		Gage Number	POR:	
KANKAKEE RIVER NEAR WILMINGTON, IL		05527500		
Met Stations:	State	Gage No.	Start Year	Source
AURORA	IL	110338	1902	Coop
CHICAGO MIDWAY AP	IL	111577	1949	Coop
CHICAGO MIDWAY AP	IL	725340	1943	GSOD
PARK FOREST	IL	116616	1953	Coop
WHEATON 3 SE	IL	119221	1951	Coop

Ice Jam Database Entries for the Kankakee River in Wilmington, IL

Jam Date	Water Year	Jam Type	Damages
31-Dec-01	2002	Unknown	?
1-Feb-01	2001	?	?
26-Dec-96	1997	?	?
12-Jan-96	1996	?	?
26-Dec-96	1996	?	?
19-Feb-94	1994	?	?
28-Dec-90	1990	?	?
19-Jan-88	1988	Break-up	Minor flooding; avoided major by thermosyphons
18-Feb-88	1988	?	?
7-Feb-85	1985	Break-up	?
23-Feb-85	1985	Break-up	Greater than 1M USD
??Feb1984	1984	Break-up	527K USD
23-Feb-82	1982	Break-up	8.25M USD including flooded WWTP, 50 evacuated
8-Mar-79	1979	?	?
29-Dec-78	1978	Freeze-up	?
17-Dec-77	1977	?	?
21-Jan-74	1974	?	?
30-Jan-68	1968	?	?
16-Feb-67	1967	?	?
23-Jan-60	1960	?	?
13-Feb-59	1959	?	?
9-Jan-58	1958	?	?
19-Feb-57	1957	Break-up	?
20-Feb-55	1955	?	?
31-Jan-52	1952	?	?

19-Feb-51	1951	?	?
3-Mar-50	1950	?	?
1-Feb-49	1949	?	?
28-Feb-48	1948	?	?
19-Feb-46	1946	?	?
6-Feb-43	1943	?	?
20-Feb-39	1939	?	?
28-Jan-37	1937	?	?
29-Feb-36	1936	?	?
15-Feb-35	1935	?	?
4-Jan-30	1930	?	?
23-Jan-29	1929	?	?
5-Feb-27	1927	?	?
9-Dec-27	1927	?	?
7-Feb-24	1924	?	?
14-Feb-18	1918	?	?
21-Jan-16	1916	?	?
1876	1876	?	?

Mohawk River

River:	Mohawk River			
Reach:	New York			
USGS Gages:		Gage Number	POR:	
HUDSON R ABOVE LOCK 1 NR WATERFORD NY		01335754		
HUDSON RIVER AT LOCK 1 NEAR WATERFORD NY		01335755		
MOHAWK RIVER BELOW DELTA DAM NEAR ROME NY		01336000		
WEST CANADA CREEK AT KAST BRIDGE NY		01346000		
MOHAWK RIVER NEAR LITTLE FALLS NY		01347000		
CANAJOHARIE CREEK NR CANAJOHARIE NY		01349150		
MOHAWK RIVER AT COHOES NY		01357500		
HUDSON RIVER AT GREEN ISLAND NY		01358000		
HUDSON RIVER AT ALBANY NY		01359139		
Met Stations:	State	Gage No.	Start Year	Source
ALBANY COUNTY AP	NY	300042	1939	Coop
BOONVILLE 2 SSW	NY	300785	1951	Coop
CHERRY VALLEY 2 NNE	NY	301436	1953	Coop
COOPERSTOWN	NY	301752	1931	Coop
GLENS FALLS AP	NY	725185	1950	GSOD
GLENS FALLS FARM	NY	303284	1957	Coop
GRAFTON	NY	303360	1952	Coop
HUDSON CORRECTIONAL	NY	304025	1960	Coop
NORWICH	NY	306085	1927	Coop
UTICA ONEIDA CNTY AP	NY	725197	1952	GSOD

Ice Jam Database Entries for Mohawk River in New York

City	Jam Date	Water Year	Jam Type	Damages
Vischer Ferry	7-Mar-04	2004	Released	?
Schenectady	6-Mar-04	2004	Released	?
Rexford	7-Mar-04	2004	Released	homes flooded
Niskayuna	7-Mar-04	2004	Released	?
Herkimer	3-Mar-04	2004	Released	?
Little Falls	22-Jan-04	2004	Released	?
Utica	8-Mar-04	2004	Break-up:	?
Vischer Ferry	20-Mar-03	2003	Break-up	?
Scotia	20-Mar-03	2003	Break-up	?
Schenectady	18-Mar-03	2003	Break-up	?
Rexford	21-Mar-03	2003	Break-up	?
Crescent Dam	22-Mar-03	2003	Break-up	?

Canajoharie	18-Mar-03	2003	Break-up	?
Amsterdam	18-Mar-03	2003	Break-up	?
Fort Plain	10-Feb-01	2001	?	?
Schenectady	27-Feb-00	2000	?	Unknown
Crescent	29-Feb-00	2000	?	?
Cohoes	29-Feb-00	2000	Break-up	?
St. Johnsville	24-Jan-99	1999	?	?
Schenectady	25-Jan-99	1999	?	?
Rexford	4-Feb-99	1999	Freeze-up	?
Randall	25-Jan-99	1999	?	Lowland flooding
Canajoharie	28-Jan-99	1999	Combination	?
Vischer Ferry	27-Feb-97	1997	?	?
Schenectady	27-Feb-97	1997	?	?
Little Falls	21-Feb-97	1997	?	?
Crescent	22-Feb-97	1997	?	?
Cohoes Falls	21-Feb-97	1997	?	?
Scotia	??Jan1996	1996	Break-up	?
Scotia	22-Feb-96	1996	Break-up	?
Mohawk	19-Jan-96	1996	Break-up	175K USD
Little Falls	??Jan1996	1996	Break-up	1.25M USD
Herkimer	19-Jan-96	1996	Break-up	2.8M USD -includes Mohawk, German Flats + road damage
German Flatts	19-Jan-96	1996	Break-up	800K USD
Rome	22-Jan-59	1959	?	?
Little Falls	23-Jan-57	1957	?	?
Rome	30-Dec-41	1941	?	?
Cohoes	12-Mar-36	1936	?	?
Cohoes	10-Jan-35	1935	?	?
Tribes Hill	31-Jan-28	1928	?	?
Vischer Ferry Dam	28-Mar-14	1914	?	?

Allegheny River/Oil Creek

River:	Allegheny River/Oil Creek			
Reach:	Oil City, PA			
USGS Gages:		Gage Number	POR:	
Allegheny River at West Hickory, PA		03016000		
Oil Creek at Rouseville, PA		03020500		
French Creek at Utica, PA		03024000		
Allegheny River at Franklin, PA		03025500		
Met Stations:	State	Gage No.	Start Year	Source
FRANKLIN	PA	363028	1927	Coop
TITUSVILLE WTR WORKS	PA	368888	1956	Coop

Ice Jam Database Entries for Oil City, PA

River	Jam Date	Water Year	Jam Type	Damages
Allegheny River	21-Jan-03	2003	Freeze-up	?
Allegheny River	9-Jan-01	2001	?	?
Oil Creek	23-Jan-97	1997	?	Minor flooding
Allegheny River	29-Jan-97	1997	Break-up	?
Oil Creek	16-Jan-96	1996	Break-up	Minor flooding
Oil Creek	27-Jan-94	1994	?	?
Allegheny River	27-Jan-94	1994	?	No flooding
Oil Creek	2-Feb-82	1982	Break-up	35 evacuations
Oil Creek/Allegheny River	1-Feb-82	1982	Break-up	6M USD
Oil Creek/Allegheny River	17-Feb-81	1981	Break-up	3.5M USD
Oil Creek/Allegheny River	27-Feb-79	1979	Break-up	800K USD
Oil Creek/Allegheny River	5-Mar-77	1977	Break-up	?
Oil Creek/Allegheny River	27-Jan-76	1976	Break-up	?
Oil Creek/Allegheny River	21-Feb-71	1971	Break-up	?
Oil Creek/Allegheny River	22-Jan-70	1970	Break-up	?
Oil Creek/Allegheny River	17-Jan-69	1969	Break-up	?
Oil Creek/Allegheny River	11-Feb-66	1966	Break-up	?
Oil Creek/Allegheny River	8-Feb-65	1965	Break-up	?
Oil Creek/Allegheny River	14-Mar-62	1962	Break-up	?
Oil Creek/Allegheny River	31-Mar-60	1960	Break-up	?
Oil Creek/Allegheny River	22-Jan-59	1959	Break-up	?
Oil Creek/Allegheny River	23-Jan-57	1957	Break-up	?
Oil Creek/Allegheny River	8-Mar-56	1956	Break-up	?
Oil Creek/Allegheny River	1-Jan-52	1952	Break-up	?
Oil Creek/Allegheny River	23-Mar-48	1948	Break-up	?

Oil Creek/Allegheny River	25-Feb-45	1945	Break-up	?
Oil Creek/Allegheny River	5-Mar-41	1941	Break-up	?
Oil Creek/Allegheny River	25-Jan-37	1937	Break-up	?
Oil Creek/Allegheny River	27-Feb-36	1936	Break-up	?
Oil Creek/Allegheny River	22-Mar-26	1926	Break-up	?
Allegheny River	27-Feb-26	1926	Break-up	heavy property damage
Oil Creek/Allegheny River	17-Mar-20	1920	Break-up	?
Oil Creek/Allegheny River	17-Feb-17	1917	Break-up	?
Oil Creek/Allegheny River	26-Mar-13	1913	Break-up	one death resulting
Oil Creek/Allegheny River	??Mar1883	1883	Break-up	?
Oil Creek/Allegheny River	??Mar1866	1866	Break-up	?

Missouri River at Williston, ND

River:		Missouri River		
Reach:		Williston, ND		
USGS Gages:		Gage Number	POR:	
YELLOWSTONE R NO. 2 NR CARTWRIGHT, ND		06329610		
MISSOURI RIVER NR WILLISTON, ND		06330000		
LITTLE MUDDY RIVER BL COW CREEK NR WILLISTON, ND		06331000		
Met Stations:	State	Gage No.	Start Year	Source
SIDNEY	MT	247560	1912	Coop
WATFORD CITY	ND	329233	1949	Coop
WILLISTON SLOULIN AP	ND	727670	1963	GSOD

Ice Jam Database Entries for the Missouri River in Williston, IL

Jam Date	Water Year	Jam Type	Damages
24-Feb-25	1925	?	?
28-Mar-04	2004	Released	?
18-Mar-03	2003	Break-up	lowland flooding of agricultural land
19-Jan-01	2001	?	?
23-Mar-97	1997	?	?
14-Mar-96	1996	Break-up	?
12-Feb-96	1996	Break-up	?
14-Nov-95	1996	Freeze-up	Flooding
6-Mar-94	1994	Break-up	?
11-Apr-65	1965	?	?
25-Mar-62	1962	?	?
22-Mar-60	1960	?	?
23-Mar-59	1959	?	800 acres flooded, 2K USD damages listed
5-Apr-58	1958	?	?
29-Mar-56	1956	?	?
3-Apr-55	1955	?	?
8-Apr-54	1954	?	?
3-Apr-53	1953	?	?
1-Apr-52	1952	?	?
8-Apr-51	1951	?	?
6-Apr-50	1950	?	?
26-Mar-49	1949	?	?
26-Mar-48	1948	?	?
23-Mar-47	1947	?	?
19-Mar-45	1945	?	?

24-Mar-44	1944	?	?
28-Mar-43	1943	?	?
13-Mar-42	1942	?	?
24-Nov-41	1942	Freeze-up	?
1-Apr-41	1941	?	?
8-Apr-40	1940	?	?
24-Mar-39	1939	?	?
14-Mar-38	1938	?	?
9-Mar-36	1936	?	?
27-Mar-35	1935	?	?
16-Mar-34	1934	?	?
16-Mar-33	1933	?	?
4-Apr-30	1930	?	?

Salmon River

River:	Salmon River			
Reach:	Idaho			
USGS Gages:			Gage Number	POR:
SALMON RIVER AT SALMON ID			13302500	
LEMHI RIVER BELOW L5 DIVERSION NEAR SALMON, ID			13305310	
SALMON RIVER NR SHOUP ID			13307000	
MIDDLE FORK SALMON RIVER AT MOUTH NR SHOUP ID			13310199	
LEMHI RIVER NR LEMHI ID			13305000	
Met Stations:	State	Gage No.	Start Year	Source
DARBY	MT	242221	1949	Coop
SULA 3 ENE	MT	247964	1957	Coop

Ice Jam Database Entries for Salmon River in Idaho

City	Jam Date	Water Year	Jam Type	Damages
Salmon	17-Jan-97	1997	?	Minor flooding
Pollock	6-Jan-97	1997	?	?
Salmon	31-Jan-96	1996	Break-up	Flooding
North Fork	31-Jan-96	1996	Break-up	Flooding
Salmon	6-Feb-89	1989	Freeze-up	Minimal
Salmon	24-Dec-83	1984	Freeze-up	1.8M USD (1984 dollars)
Salmon	7-Feb-82	1982	Freeze-up	1M USD (1982 dollars)
Salmon	1-Jan-79	1979	Freeze-up	?
Salmon	8-Jan-74	1974	Freeze-up	?
Salmon	??Dec1973	1973	Freeze-up	?
Salmon	20-Jan-63	1963	Freeze-up	?
Salmon	20-Jan-62	1962	Freeze-up	?
Shoup	26-Feb-57	1957	?	Unknown
Salmon	27-Jan-57	1957	Freeze-up	?
Salmon	3-Feb-56	1956	Freeze-up	?
Salmon	3-Feb-56	1956	?	Unknown
Salmon	4-Feb-50	1950	Freeze-up	?
Stanley	24-Feb-49	1949	?	Unknown
Salmon	?????1949	1949	?	Unknown
Challis	13-Jan-49	1949	?	Unknown
Stanley	7-Feb-47	1947	?	Unknown
Shoup	5-Feb-45	1945	?	Unknown
Clayton	18-Dec-43	1944	?	Unknown
Cape Horn	14-Dec-43	1944	?	Unknown

Salmon	7-Jan-42	1942	Freeze-up	?
Challis	19-Feb-42	1942	?	Unknown
Knox	25-Feb-37	1937	?	Unknown
Stanley	13-Feb-37	1937	?	Unknown
Salmon	9-Jan-37	1937	Freeze-up	?
Salmon	30-Jan-36	1936	Freeze-up	?
Stanley	15-Feb-33	1933	?	Unknown
Salmon	19-Dec-33	1933	Freeze-up	?
Salmon	2-Feb-32	1932	Freeze-up	?
Stanley	1-Feb-31	1931	?	Unknown
Salmon	22-Feb-30	1930	?	Unknown
Salmon	8-Feb-30	1930	Freeze-up	?
Salmon	20-Dec-25	1925	Freeze-up	?
Salmon	9-Jan-24	1924	Freeze-up	?
Salmon	2-Mar-22	1922	Freeze-up	?
Salmon	26-Jan-20	1920	Freeze-up	?
Salmon	10-Feb-16	1916	Freeze-up	?