

1.0 Introduction

This study was funded by a federal grant awarded to the Maine State Planning Office (SPO) and the Maine Emergency Management Agency (MEMA) in 2007. Stakeholders contributing to this study include the Maine Geological Survey (MGS), Maine Coastal Storm Management, Maine Emergency Management Agency (MEMA), Maine Floodplain Management (MFPM), Maine GIS (MEGIS), U.S. Geological Survey (USGS), and the National Weather Service (NWS) at the National Oceanic and Atmospheric Administration (NOAA).

1.1 Purpose

This report provides a basin-by-basin analysis of available data for riverine flood events from 1970 to the present (2007) in support of the State Hazard Mitigation Plan to provide detailed flood data in an accessible format to the public, local governments, and state and federal agencies. The information presented in this report will support future work, which may include developing an interactive, web-based summary of historical flooding. To date, no document has been produced to provide a comprehensive list of resources on historical flooding in Maine. This report is a foundation for future work and will serve to minimize the possible duplication of efforts.

1.2 Study Area

This report documents the availability of flood data and historical flooding for the entire state of Maine on a basin-by-basin basis. The U.S. Geological Survey divides the United States into twenty-one major geographic area (regions). Maine and most of New England are located in Region 1. Regions are further divided into subregions. For this study, the subregion classification has been used to identify six major drainage basins located within Maine including four riverine basins and two coastal basins. Some of the hydrologic regions described in this study expand beyond the borders of Maine into New Hampshire, US and New Brunswick and Quebec, Canada.

The four riverine subregions include the St. John (region 0101), the Penobscot (0102), the Kennebec (0103), and the Androscoggin (0104). The two coastal subregions include the Eastern Maine Coastal Drainage Basin (0105) and the Western Maine Coastal Drainage Basin (0106). The Eastern and Western Coastal Drainage Basins are divided by the mouth of the Androscoggin River. The Eastern Maine Coastal Region is further divided into two non-contiguous sections separated by the mouth of the Penobscot River; the northeast section contains catalog unit 0105001 (the St Croix River Basin) and parts of 0105002, which includes the Bagaduce, Dennys, Narraguagus, Pennamaquan, Pleasant, Machias, and East Machias Rivers, and Tomah, Trunk, and Big Musquash Streams, the southeast section contains parts of catalog units 0105002 and 0105003 and includes the Ducktrap, Sheepscot, St. George, Damariscotta and Medomak Rivers. The western Maine Coastal Regions is subdivided into three catalog units including the Presumpscot River (catalog unit 01060001), the Saco River (0106002), and the Piscataqua-Salmon Falls River (0106003).

This report contains chapters describing historical flooding within the four riverine basins and three of the major rivers located within the coastal drainage basins including the St. Croix River, the Saco River, and the Presumpscot River. Other coastal rivers are not included in this report because little flood data was available at the time of publication. Future work on expanding this report may include adding information on riverine flooding in these coastal rivers and streams.

Table 1 lists and Figure 1 illustrates the major drainage basins within Maine and their corresponding hydrologic unit code (HUC) as defined by the USGS.

Table 1. Major Drainage Basins and Subbasins in Maine

Hydrologic Unit Code	Name
010100	St. John River
010200	Penobscot River
010300	Kennebec River
010400	Androscoggin River
010500	Eastern Maine Coastal St. Croix River
010600	Western Maine Coastal Saco River Presumpscot River

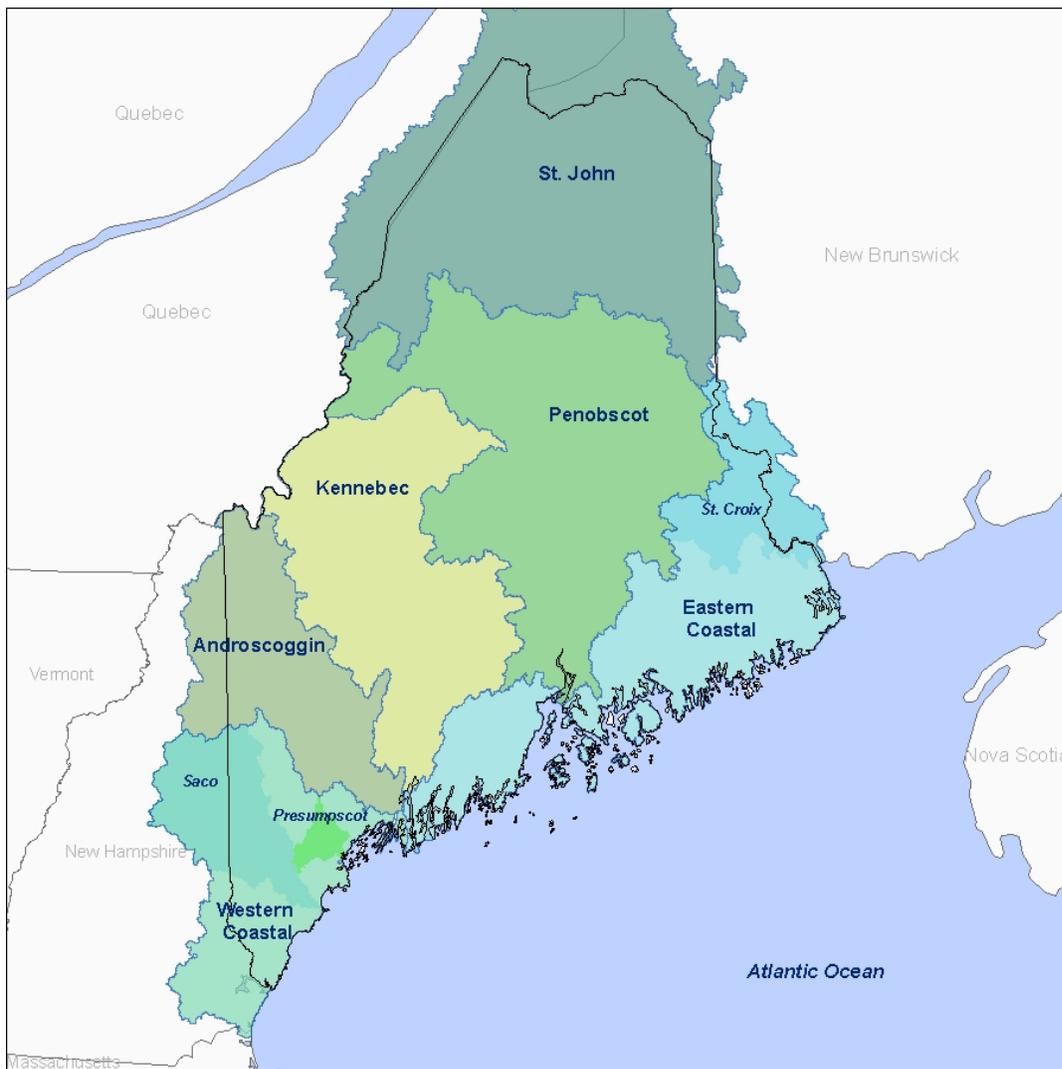


Figure 1. Major Drainage Basins in Maine, USGS

1.2.1 Natural Hazards

Flooding is one of the many natural hazards that may arise to disrupt the lives of people living in Maine. Historically, Maine has experienced fires, landslide, and earthquakes although they are relatively rare and are not a significant source of monetary losses as compared to flooding. The Maine Emergency Management Agency has developed mitigation plans for the state as a whole and for all sixteen counties to document ways to minimize the risk of loss due to natural hazards. The Maine Geological Survey (MGS) is in the process of developing a database of landslide hazard mapping which will be available in the future. The remainder of this report focuses exclusively on the riverine flooding hazards in Maine on a basin-by-basin basis.

1.2.2 Flooding

The National Flood Insurance Program provides a definition of flooding in the code of federal regulations Title 44, Emergency Management and Assistance; Chapter 1, Federal Emergency Management Agency; Part 59, General Provisions (44 CFR 59.1). In 44 CFR 59.1, flooding is defined as:

- a. *A general or temporary condition of partial or complete inundation of normally dry land areas from:*
 - 1) *The overflow of inland or tidal waters.*
 - 2) *The unusual and rapid accumulation or runoff of surface waters from any source.*
 - 3) *Mudslides (i.e., mudflows which are proximately caused by flooding as defined in paragraph (a) (2) of this definition and are akin to a river of liquid and flowing mud on the surfaces of normally dry land areas, as when the earth is carried by a current of water and deposited along the path of the current.*
- b. *The collapse or subsidence of land along the shore of a lake or other body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as flash flood or an abnormal tide surge, or by some similarly unusual and unforeseeable event which results in flooding as defined in paragraph (a) (1) of this definition.*

A flood is declared when a “*general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or two or more properties*” are affected by the flooding conditions described above.

Inland flooding may be caused by rainfall, melting snow, and/or obstructions (i.e., debris and log jams). Coastal flooding may be caused by wind, high tides, and waves that force water beyond the normal shoreline. Flooding becomes a problem when it affects people through the loss of life, property, and infrastructure. The most effective way to reduce flood losses is to minimize vulnerable property and infrastructure within the flood prone area. When property and infrastructure are removed, people are less likely to enter the flood hazard zone during a flood event.

Flooding in Maine typically occurs during the rainy periods in the spring and autumn. In the springtime, rainfall at a moderate intensity spanning several days (e.g., a Nor’easter), melting snow, and possible ice and debris jams combine to cause the most severe floods. The waterlogged or frozen soil and the lack of vegetative foliage reduce the ability of the ground to absorb excess water. Nor’easters often cause coastal flooding in addition to riverine flooding as seen during the “Groundhog Day” storm of 1978. The most recent flood of record for many rivers in Maine, occurring in April 1987, was caused by a combination of rainfall, snowmelt,

and ice jams. The previous floods of record, in 1936 and 1953, resulted from heavy precipitation caused by tropical storms.

Floods occurring in the autumn are usually the result of a large precipitation event (e.g., a hurricane). Dry soil conditions and the presence of vegetative foliage may reduce the severity of flooding as the ground absorbs excess water. Hurricanes often cause coastal flooding in addition to riverine flooding as seen during Hurricane Bob in 1991.

Severe flooding over a small area may occur at any time as the result of an acute precipitation event (e.g., a thunderstorm) or an obstruction in the flow of a stream or river.

Flood prone areas must be identified so that life and property may remain safely outside of them. The Federal Emergency Management Agency (FEMA) provides maps for most communities within the United States illustrating the areas expected to become inundated with a probability of one percent and 0.02 percent each year (known as the 100-year flood and the 500-year flood, or the floods with an expected return period of 100 years and 500 years, respectively). An area that is not mapped as a flood prone area on a FEMA map is not necessarily an area without flood risk, the risk may be small or the risk may be undetermined. Historical images and high water marks can be powerful (and often surprising) reminders of flood levels when the collective human memory has forgotten the severity of past flooding. For areas with unknown flood risk, adequate forecasting and communication can reduce the risk of death and loss.

Effective community planning combining knowledge of flood prone areas and proper community development controls can minimize future flood losses. By implementing proper zoning controls, communities can minimize development within the floodplain. By implementing proper development controls, communities can reduce impervious area in the contributing watersheds which may keep flood flows to a minimum.

Large floods that cause extensive monetary damage may be declared disasters at the State and Federal level. Table 2 presents the list of disasters declared within the State of Maine from 1970 to the present, the estimated damages, the counties declared, and the river basins affected by the declaration.

Table 2 is generated from the information presented in the MEMA/SPO disaster declaration list. The table indicates the counties included in each disaster declaration. Because disasters are declared by county and not by flood source, it is not straightforward to identify which river basins were affected by the flood disaster. In addition the large river basins often fall partially within many counties. All river basins falling partially within a declared county are indicated in yellow. In cases where the river basin that experienced flooding has been identified in documentation referenced in this report, the river basin is identified with a dark or light grey marking. Future work may go towards eliminating the yellow boxes by determining whether the river basin experienced flooding as part of the respective disaster declaration.

Table 2. Disaster Declarations in Counties and River Basins

Date	Year	Estimated Damage	Counties Declared Disaster Areas														River Basins Affected						
			Androscoggin	Aroostook	Cumberland	Franklin	Hancock	Kennebec	Knox	Lincoln	Oxford	Penobscot	Piscataquis	Sagadahoc	Somerset	Waldo	Washington	York	St. John	Penobscot	Kennebec	Androscoggin	Eastern Coast
January - February	1970	\$3,000,000				x				x		x		x				x	x	y	x		x
February 12	1972	Coastal flooding			x													x				x	x
April 24	1973	\$908,404	x			x				x	x					x	x	y	y	x	x	x	x
May 6	1973		x															x	y				x
July 1	1973		x			x				x	x					x		x	x	x	x	x	x
September 24	1973																						
December	1973	\$3,000,000							x		x		x	x	x			y	x	y	x	x	x
May 26	1974	\$3,000,000																y					
May 8	1975	\$300,000			x				x								x				x	x	x
February 9	1976										x						x	x	x			x	x
April 2	1976	\$200,000		x														y	x				x
August	1976	Crop damage		x														x	x				x
March 20	1977		x		x					x											x	x	x
February 8	1978	\$20,693,181	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	y	x	x	x
April 30	1979	\$648,500		x							x	x						y	x	y	x	x	
June	1984		x		x						x		x	x				x	x	y	x	x	x
January	1986	Roads, bridges,	x		x	x				x			x	x				x	x	x	x	x	x
April	1987	\$100,000,000	x		x	x	x	x	x	x	x	x	x	x	x			y	y	y	y		y
May	1989	\$1,396,120	x			x				x										x	y		y
April 10 - 12	1991	\$12,916,819		x														y					
March 27	1992	\$3,462,787	x		x	x		x	x		x			x	x		x	x	x	y	y	x	x
April (Easter Flood)	1993	\$3,476,507	x	x	x	x	x	x		x	x	x		x	x		x	t	t	t	t		t
April 15	1994	\$5,700,000		x														y					
October 21	1995					x			x											x	x	x	x
January - February	1996	\$2,671,119	x			x				x	x	x		x	x				t	y			
April 16 - 17	1996	\$2,492,944	x		x				x									x			y	t	y
October 20 - 21	1996	\$8,998,501			x					x								x					y
June 12 - 21	1998	\$2,519,458	x			x				x					x					x	x		
October 8 - 11	1998	\$1,997,555			x																		y
September 11	1999																						
March - April	2000	\$2,884,207	x	x		x				x		x						y	x	x	x	x	x
March 5 - 31	2001	\$1,761,573				x				x	x							x	x	x	x	x	x
December 11 - 31	2003	\$1,500,00 (est.)				x				x		x		x	x			y	x	y	y	x	x
March 29 - May 3	2005		x	x		x	x	x	x	x		x	x	x	x			y	x	y	x	x	x
May 13	2006	\$7,000,000 (est.)																x	y				x

Notes:

- * Possible Flood Event (continue research)
- Flood event
- Major Flood Event

1.3 Identifying Significant Historical Flood Events

Localized flooding may occur at any place at any time for any combination of reasons. It is not possible to compile a list of every single flood event that occurred within Maine over the past 37 years, many have undoubtedly gone unnoticed. Flood events may be captured in the historic record in a number of ways including:

- Collection of stage and discharge via USGS streamgaging stations,
- Collection of ice-jam data via personal observations and recorded in the CRREL database,
- Declaration of a disaster triggered by monetary losses and historically described in interagency reports,
- Newspaper articles,
- Photos,
- High water marks and monuments,
- FEMA Flood Insurance Studies, and
- The National Climatic Data Center (NCDC) Storm Event Database

Historical records of stage and discharge along the rivers of Maine are collected and analyzed by the U.S. Geological Survey. The USGS maintains 64 active streamgages within Maine (down from a total of 134). Daily streamflow data is available to the general public via the web-based National Water Information System (NWIS) database. Periodically, the USGS publishes synthesis reports providing statistical analysis and trends determined using streamgage data. The USGS streamgage record has some limitations for flood identification. The USGS streamgage record will not support the identification of a flood event occurring on an ungaged body of water.

The Army Corps of Engineers (ACOE) Cold Regions Research and Engineering Laboratory (CRREL) maintains a historical record of ice jams. CRREL data entries are limited to the personal observations by citizens and/or ACOE field technicians, USGS field notes, and newspaper reports. There is no fixed network of ice-jam recording stations. A flood caused by an ice jam may be isolated to a very small area and/or may not be associated with larger-than-normal discharge. The ice jam database contains a description for each recorded ice jam event and indicates whether the ice jam was associated with flood stages and/or caused any damage.

The Maine State Planning Office and the Maine Emergency Management Agency maintain a record of disaster declarations. Disaster declarations are made at the State and Federal levels when damages incurred as the result of a natural event reach a minimum threshold value. If a flood occurs but causes no damage, the flood will not be represented on the disaster declaration list. Historically, disasters have been documented in interagency hazard mitigation reports (IHMRs), which were used to summarize the event and the damages for disaster aid purposes. Interpretation of the IHMR is necessary to determine the location of the flood event. The reports typically describe events and damages on the county level and may not explicitly identify the flood source that caused the damage. In the early 2000s, IHMRs were discontinued and are no longer being produced following flood events.

Newspapers provide a unique source of flood history. Text and photos describe and illustrate large and small events that have been observed by people. A non-comprehensive set of newspaper clippings provided from the SPO files have been used to document some of the floods described in this report.

Information relevant to high-water marks and monuments is available on a town-by-town basis. This information was not compiled for inclusion with this publication. Future efforts for expanding this report may include compiling all town high-water marks and monuments into a single database.

The Federal Emergency Management Agency (FEMA) conducts Flood Insurance Studies (FISs) and publishes flood insurance rate maps (FIRMs) based on those studies to illustrate the floodplain boundaries within a community. The FIS reports often contain information on historic flood events. FIS reports are of limited utility for identifying recent flood events in Maine. Many of the FIS reports were developed in the 1970s and the 1980s prior to the flood of record at most locations.

The National Climatic Data Center (NCDC) of NOAA distributes a description of extreme weather events via the searchable Storm Event database available on the World Wide Web. The data in the Storm Event database originates from National Weather Service publications based on information obtained from county, state, and federal emergency management officials, local law enforcement officials, skywarn spotters, NWS damage surveys, newspaper clipping services, the insurance industry, and the general public. The event record within the database includes the dates of the beginning and end of the event, the location of the event, magnitude, fatalities, injuries, property damage, and crop damage. The description of the event often includes the weather conditions leading to the event. The Storm Event database includes information on three hundred and nine flood events dating between April 4, 1993 and October 10, 2007. Future efforts for expanding this report may include adding the narrative text included in the Storm Event database to the flood event descriptions found in this report. The web address to the searchable storm event database is included here.

<http://www4.ncdc.noaa.gov/cgi-win/wwcgi.dll?wwevent~storms>

A list of historic flood events within the major drainage basins within Maine have been compiled using the sources described above. A list of the flood events occurring within each basin is included in the corresponding section of the report. Where available, a brief description of the causative factors of the event, the corresponding USGS peak flow data, the estimated recurrence interval, and the extent of damages is included.