Streamflow Statistics for the Narraguagus River at Cherryfield, Maine

By Robert W. Dudley and Joseph P. Nielsen

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Charles G. Groat, Director

CONTENTS

CONVERSION FACTORS

Multiply	By	To obtain
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
inch (in.)	25.4	millimeter
inch per year (in/yr)	25.4	millimeter per year
mile (mi)	1.609	kilometer
square mile (mi^2)	2.59	square kilometer

To convert temperature in degrees Fahrenheit ($^\circ$F) to degrees Celcius ($^\circ$C), use the following equation:

$$^\circ F = (1.8 \times {}^\circ C) + 32$$

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ABSTRACT

Streamflow data have been collected for the Narraguagus River from 1948 to the present (2000) at the U.S. Geological Survey (USGS) streamgaging station at Cherryfield, Maine. This report describes a study done by the USGS to determine streamflow statistics using the streamflow record at the Narraguagus River station for use in total water use management plans implemented by State and Federal agencies. Because the effect of changes in irrigation practices from 1993 to the present on streamflow in the Narraguagus basin is unknown and potentially significant, streamflow data after December 1992 were not used in the determination of the streamflow statistics. For the period 1948-92, monthly median streamflows range from 93.0 ft³/s (August) to 1,000 ft³/s (April). The median streamflow for the selected period of record for all days (1948-92) is 302 ft³/s.

INTRODUCTION

In 1997, the State of Maine developed a conservation plan for Atlantic salmon in seven rivers in Maine (Maine Atlantic Salmon Task Force, 1997). As part of its implementation, the plan called for the development of total water use management plans for each of the river basins.

The only source of long-term hydrologic data in the Narraguagus River basin on which to base water use management plans is a U.S. Geological Survey (USGS) stream-gaging station on the Narraguagus River at Cherryfield (station 01022500), which has been operated since March 1948. As of the writing of this report, this gaging station is in operation.

This report describes a study done by the USGS to determine streamflow statistics using the streamflow record at the Narraguagus River station.

PHYSICAL SETTING

The Narraguagus River basin is in eastern Maine along the coast of the Atlantic Ocean (figure 1). Draining an area of 227 mi², the river flows predominately from north to south beginning at Eagle Lake (elevation 406 ft) in the civil division T34 MD. The basin is bounded to the east by the Pleasant and Machias River basins and to the west by the Union River basin. Largely unsettled, the basin is made up primarily of forest, blueberry barrens, lakes, ponds, and heath. The average annual temperature is 42°F and ranges from an average of 18° F in January to 64°F in July (U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1996). The average annual precipitation is 49 in. and is fairly evenly distributed throughout the year.

Monthly median streamflows in the Narraguagus River, as recorded by the USGS streamgaging station at Cherryfield, show a seasonal distribution common in Maine (figure 2). High flows typically occur in early spring and late fall, and low flows generally occur in the summer and early fall.

STREAMFLOW STATISTICS

Various streamflow statistics were computed for the Narraguagus River at Cherryfield using daily mean flow data. Median, mean, harmonic mean, and geometric mean flows (table 1) were computed for each month and for the period of record using methods defined in Helsel and Hirsch (1992). In addition, flow-duration curves and selected duration statistics were computed for each month and for the entire selected record. A flow-duration curve indicates the amount of time, in percent, that a given streamflow is equaled or exceeded for the time period in question. For example, the
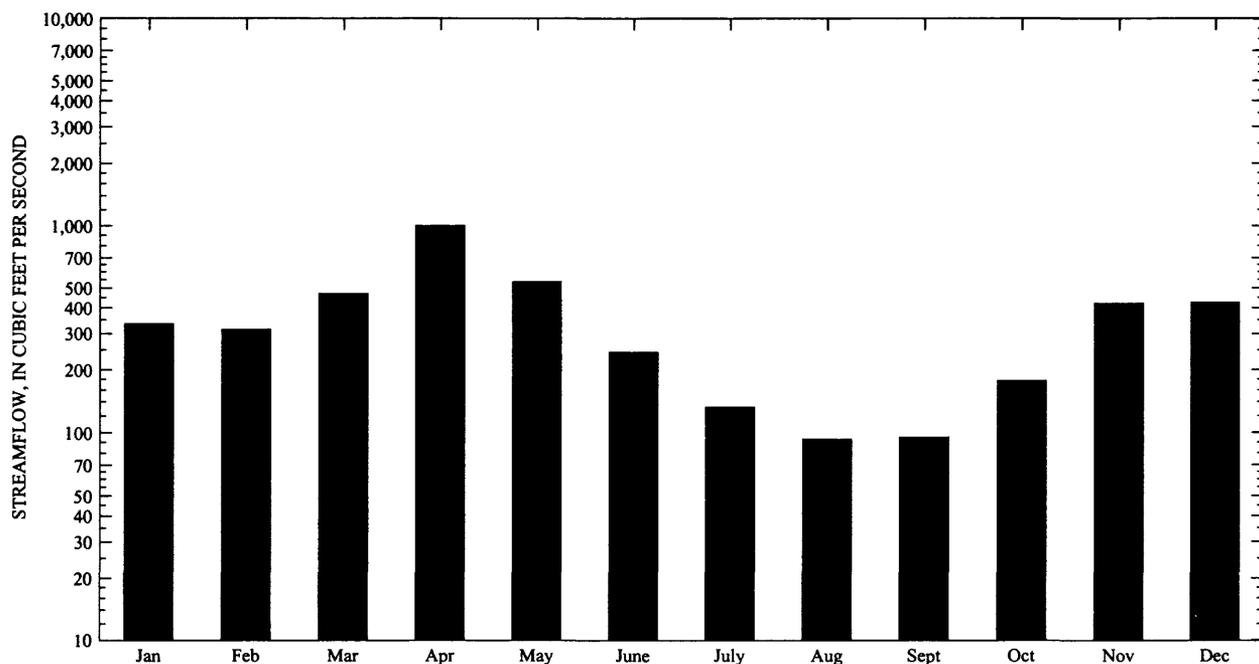
Figure 1. Study area and location of the USGS streamgaging station at Cherryfield, Maine.

Figure 2. Median streamflows for the Narraguagus River at Cherryfield, Maine for the period 1948-92.

Table 1. Streamflow statistics for the Narraguagus River at Cherryfield, Maine for the period 1948-92

Period	Median streamflow in cubic feet per second	Mean streamflow in cubic feet per second	Harmonic mean streamflow in cubic feet per second	Geometric mean streamflow in cubic feet per second
January	335	497	287	366
February	315	473	273	350
March	470	705	384	508
April	1000	1220	924	1052
May	534	693	484	563
June	244	344	221	268
July	132	187	117	142
August	93.0	142	83.5	105
September	95.0	172	78.4	106
October	177	279	125	182
November	422	589	280	406
December	426	644	353	464
Entire selected record	302	494	184	300

August flow duration curve illustrates the amount of time that various flows are equaled or exceeded for all recorded streamflows occurring in the month of August during the selected period of record. Likewise, the flow-duration curve for the entire selected period of record is computed using all recorded streamflows for all days of the year.

Effects on streamflow of the Narraguagus River due to agriculture (irrigation), sylvaculture, impoundments, and other land uses were not investigated in detail due to a lack of historical information about these practices in the basin. It is known, however, that irrigation for blueberry growing has been practiced in the Narraguagus basin since the 1950's. An effort was made to obtain the longest period of streamflow record available that was not significantly affected by irrigation withdrawal with which to determine streamflow statistics. Streamflow statistics determined using streamflow record significantly affected by withdrawal (particularly during the summer months) could bias water management guidelines set by State and Federal agencies.

Historical withdrawal information provided by blueberry growers operating in the Narraguagus basin, while insufficient to perform a detailed statistical analysis of the effects on streamflow in the Narraguagus River, provides a basis for choosing an appropriate period of record for computing streamflow statistics. Qualitative evaluation of these data imply that the impact of withdrawal prior to 1993 could be considered minor for purposes of computing streamflow statistics for this report. Because the effect of changes in irrigation practices from 1993 to the present on the streamflow is unknown and potentially significant, streamflow data after 1992 were not used in the determination of streamflow statistics in this report.

Monthly flow-duration curves and selected flow-duration statistics for the period 1948-92 are shown in the graphs and tables in Figures 3-14 in the appendix of this report. A similar curve and statistics for the entire selected record are shown in Figure 15.

REFERENCES CITED

Helsel, D.R., and Hirsch, R.M., 1992, Statistical methods in water resources: Amsterdam, the Netherlands, Elsevier Science Publishers, 522 p.

Maine Atlantic Salmon Task Force, 1997, Atlantic salmon conservation plan for seven Maine rivers, 393 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, 1996, Climatological data, annual summary, New England, v. 108, no. 13, 35 p.

APPENDIX

Figures 3-15: Flow-Duration Curves and Statistics

January
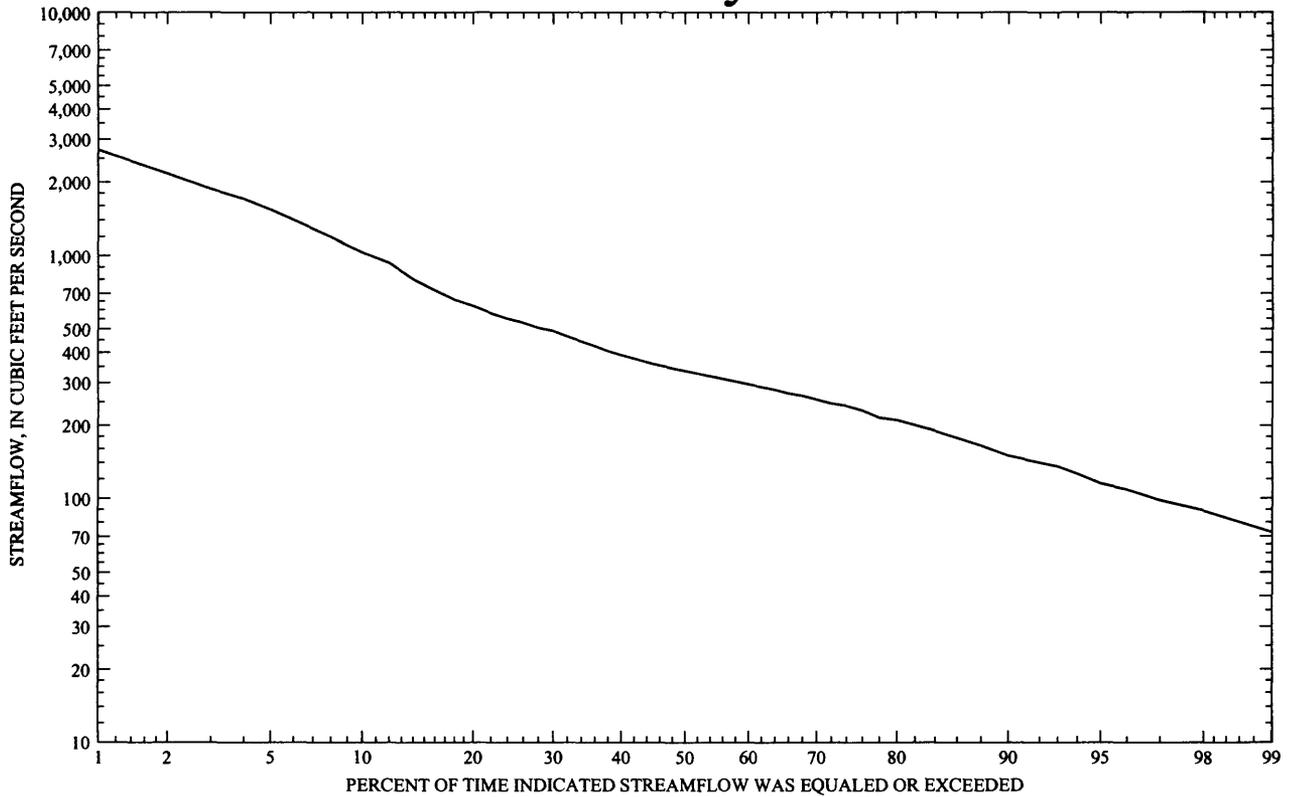
Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	2700	55	315
5	1540	60	295
10	1030	65	275
15	760	70	255
20	620	75	235
25	540	80	210
30	490	85	184
35	435	90	150
40	390	95	115
45	357	99	73
50	335		

Figure 3. Flow-duration curve and flow-duration statistics for January based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
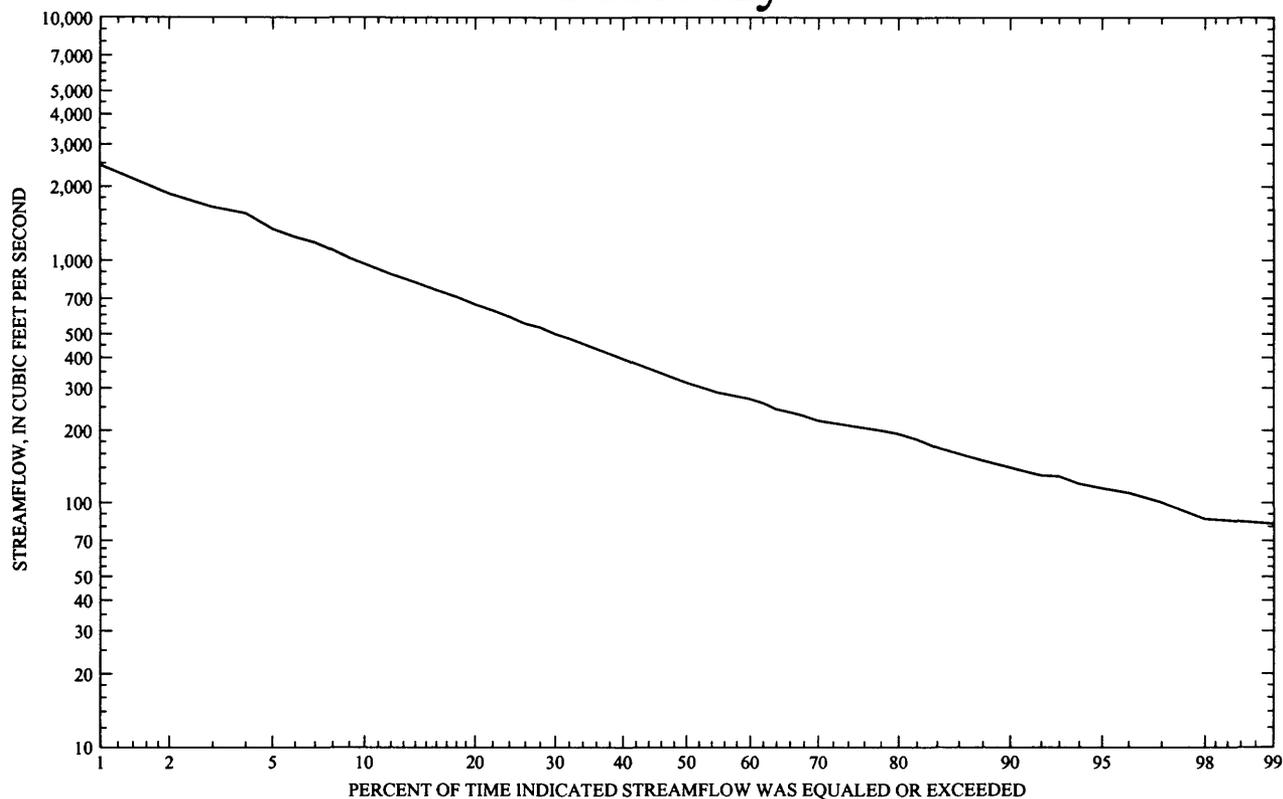
February

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	2450	55	287
5	1340	60	270
10	967	65	241
15	784	70	220
20	660	75	208
25	570	80	194
30	500	85	165
35	446	90	140
40	395	95	115
45	353	99	82
50	315		

Figure 4. Flow-duration curve and flow-duration statistics for February based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
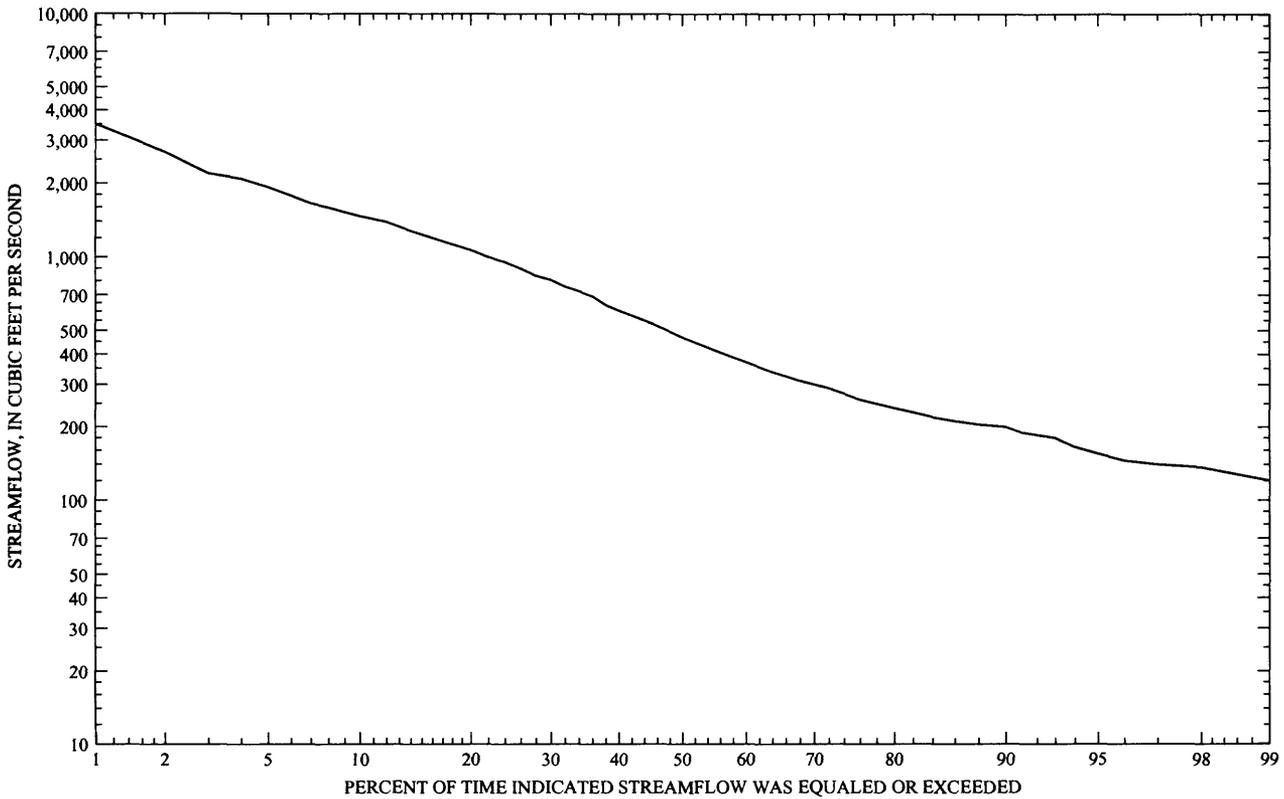
March

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	3490	55	416
5	1930	60	371
10	1470	65	332
15	1240	70	300
20	1070	75	268
25	926	80	239
30	805	85	216
35	707	90	200
40	605	95	155
45	538	99	120
50	470		

Figure 5. Flow-duration curve and flow-duration statistics for March based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.

April

STREAMFLOW, IN CUBIC FEET PER SECOND

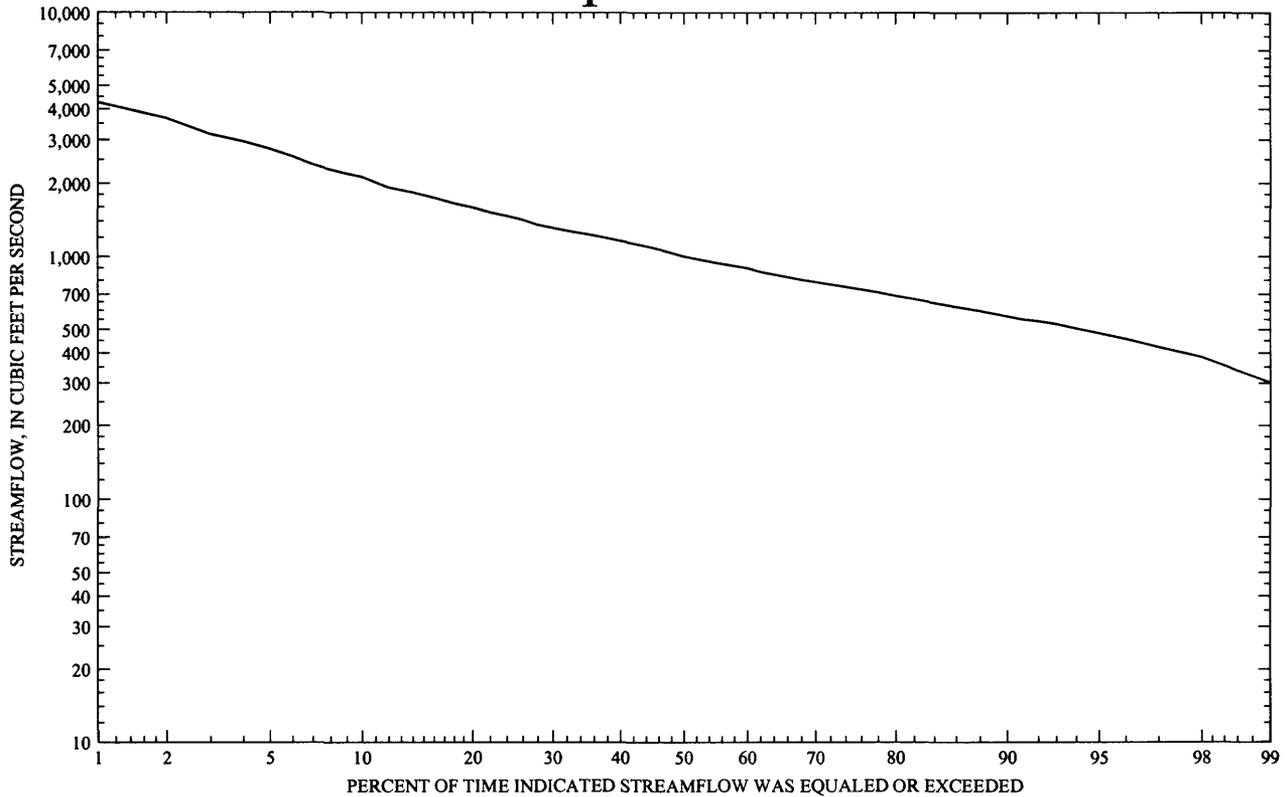PERCENT OF TIME INDICATED STREAMFLOW WAS EQUALED OR EXCEEDED

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	4250	55	945
5	2750	60	896
10	2120	65	835
15	1780	70	786
20	1590	75	740
25	1440	80	689
30	1310	85	632
35	1240	90	566
40	1160	95	484
45	1090	99	301
50	1000		

Figure 6. Flow-duration curve and flow-duration statistics for April based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
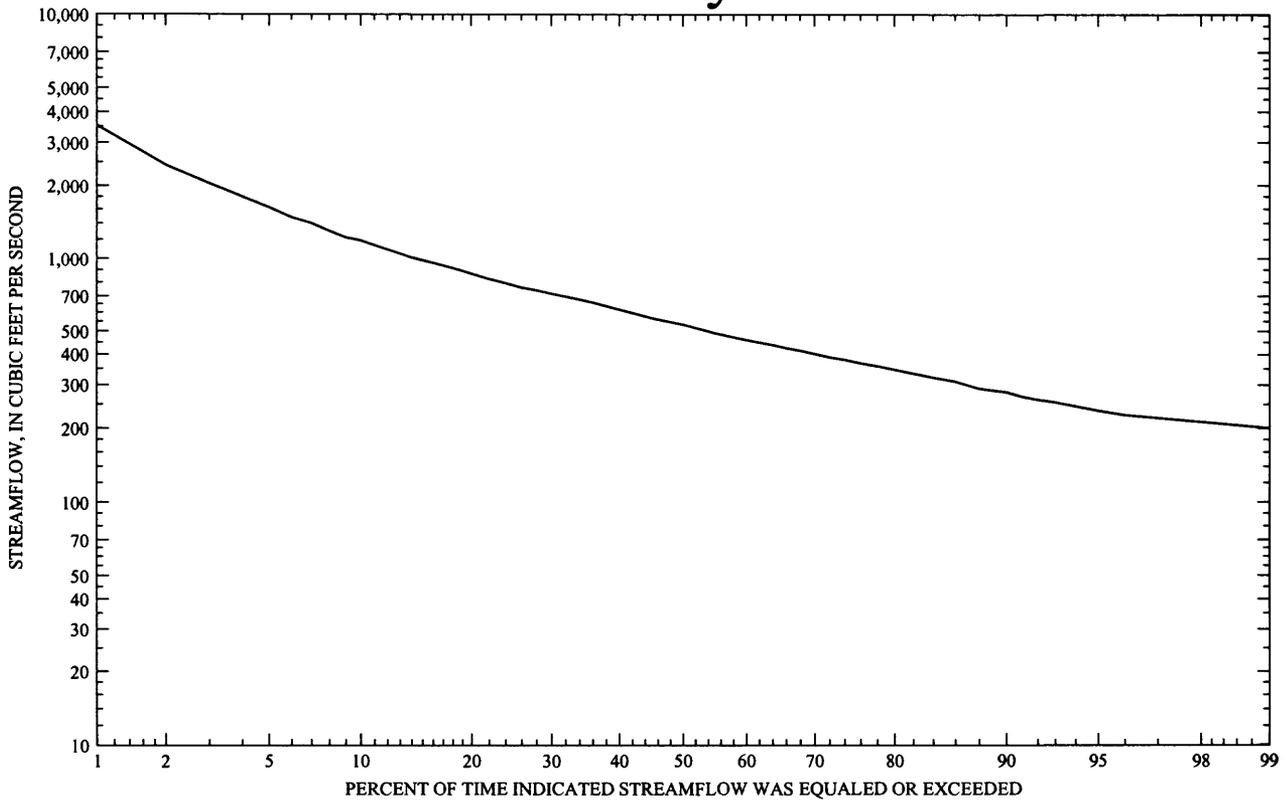
May

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	3510	55	492
5	1630	60	460
10	1190	65	432
15	986	70	402
20	868	75	374
25	775	80	347
30	716	85	316
35	667	90	280
40	617	95	236
45	568	99	200
50	534		

Figure 7. Flow-duration curve and flow-duration statistics for May based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
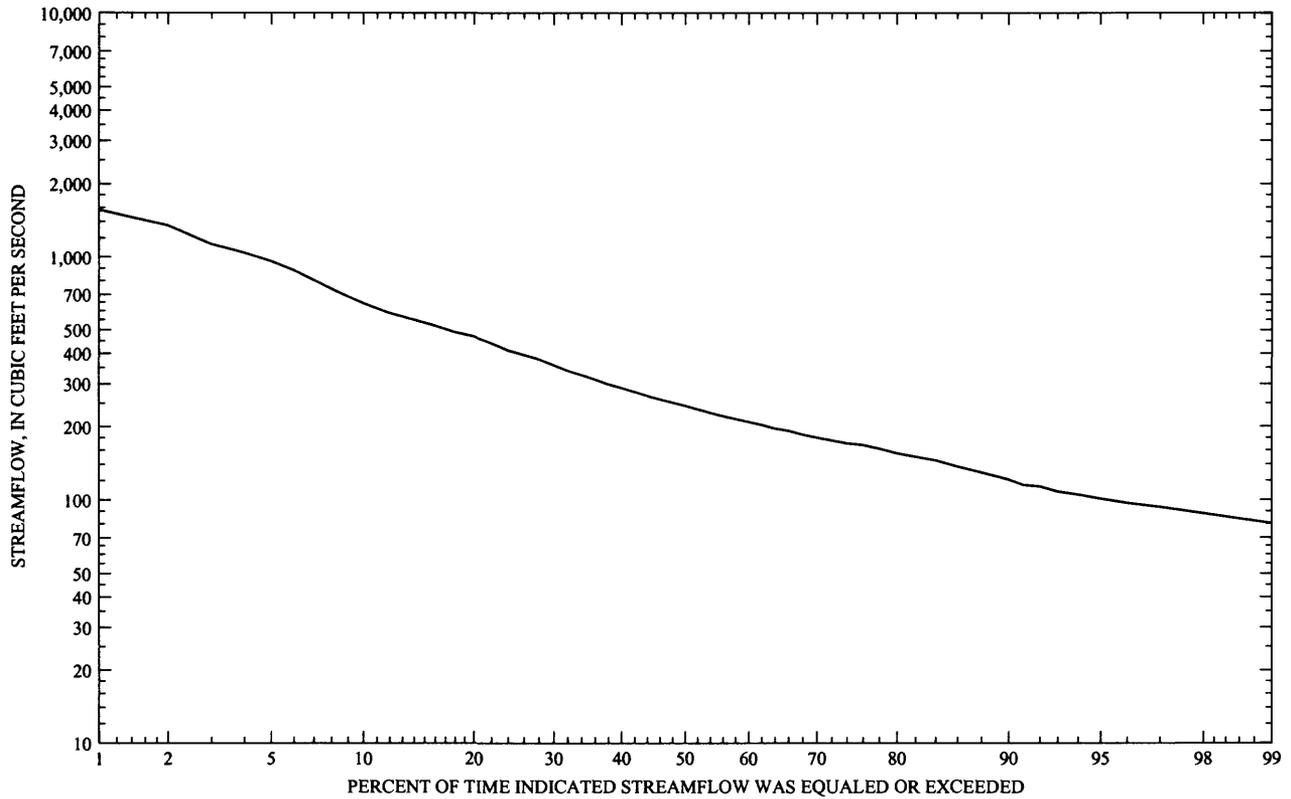
June

PERCENT OF TIME INDICATED STREAMFLOW WAS EQUALED OR EXCEEDED

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	1560	55	224
5	960	60	209
10	643	65	194
15	534	70	180
20	468	75	169
25	403	80	155
30	358	85	141
35	319	90	121
40	289	95	101
45	263	99	80
50	244		

Figure 8. Flow-duration curve and flow-duration statistics for June based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.

July

STREAMFLOW, IN CUBIC FEET PER SECOND

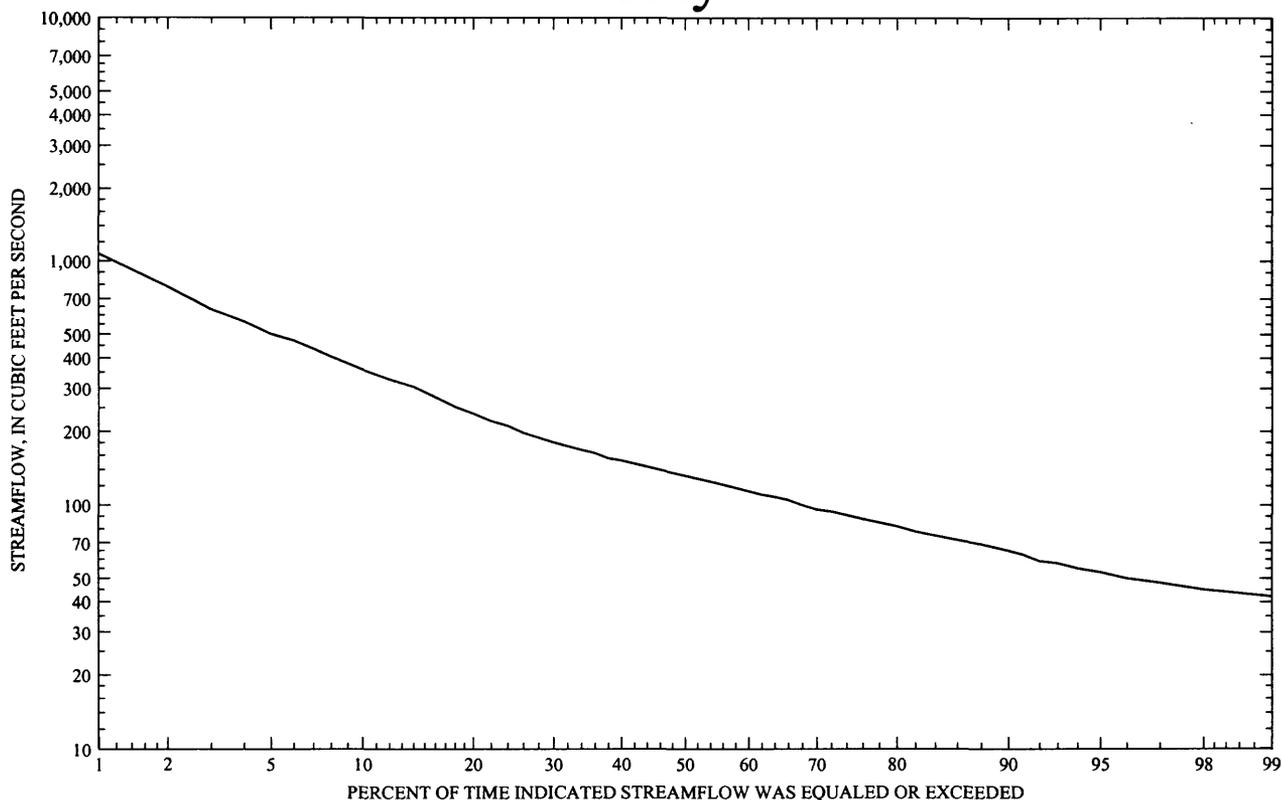PERCENT OF TIME INDICATED STREAMFLOW WAS EQUALED OR EXCEEDED

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	1070	55	123
5	501	60	114
10	357	65	106
15	290	70	96
20	236	75	90
25	204	80	82
30	180	85	74
35	166	90	65
40	152	95	53
45	142	99	42
50	132		

Figure 9. Flow-duration curve and flow-duration statistics for July based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
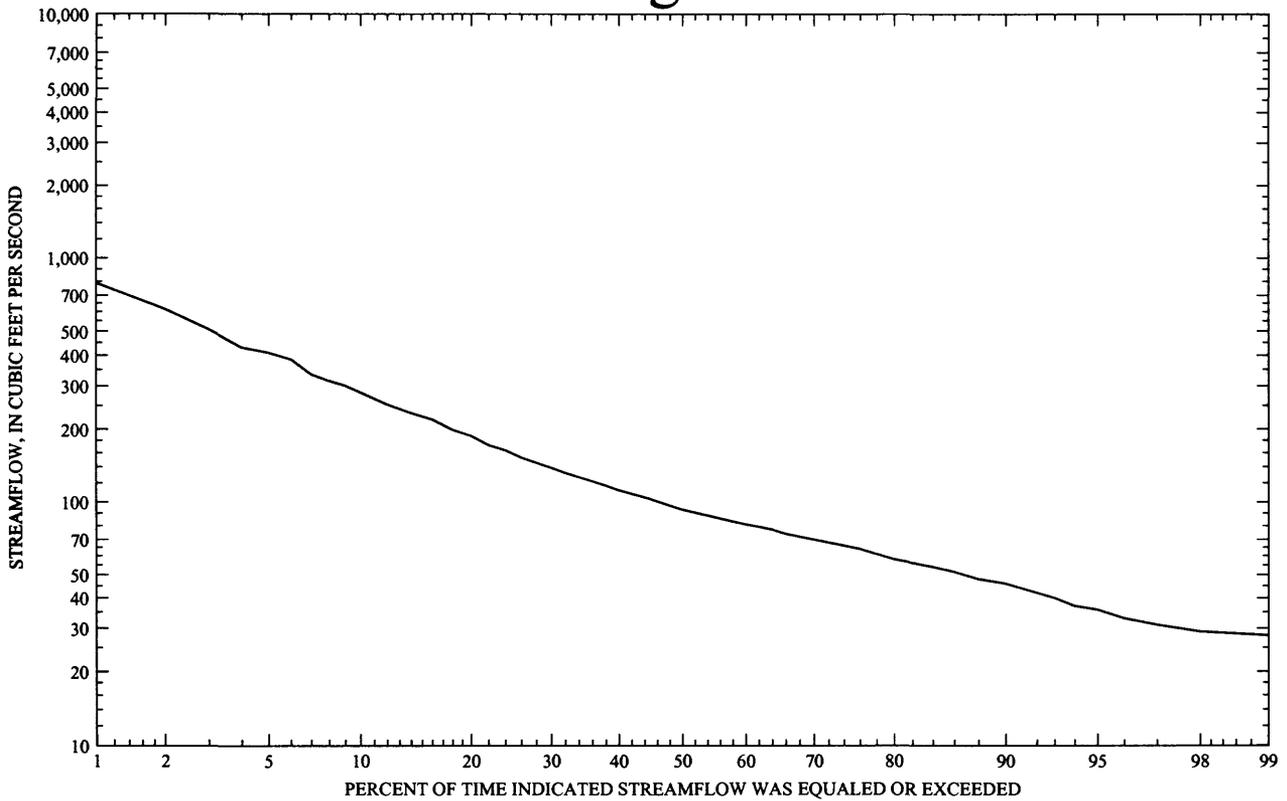
August

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	787	55	87
5	409	60	81
10	283	65	76
15	226	70	70
20	188	75	65
25	158	80	58
30	139	85	53
35	124	90	46
40	112	95	36
45	103	99	28
50	93		

Figure 10. Flow-duration curve and flow-duration statistics for August based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
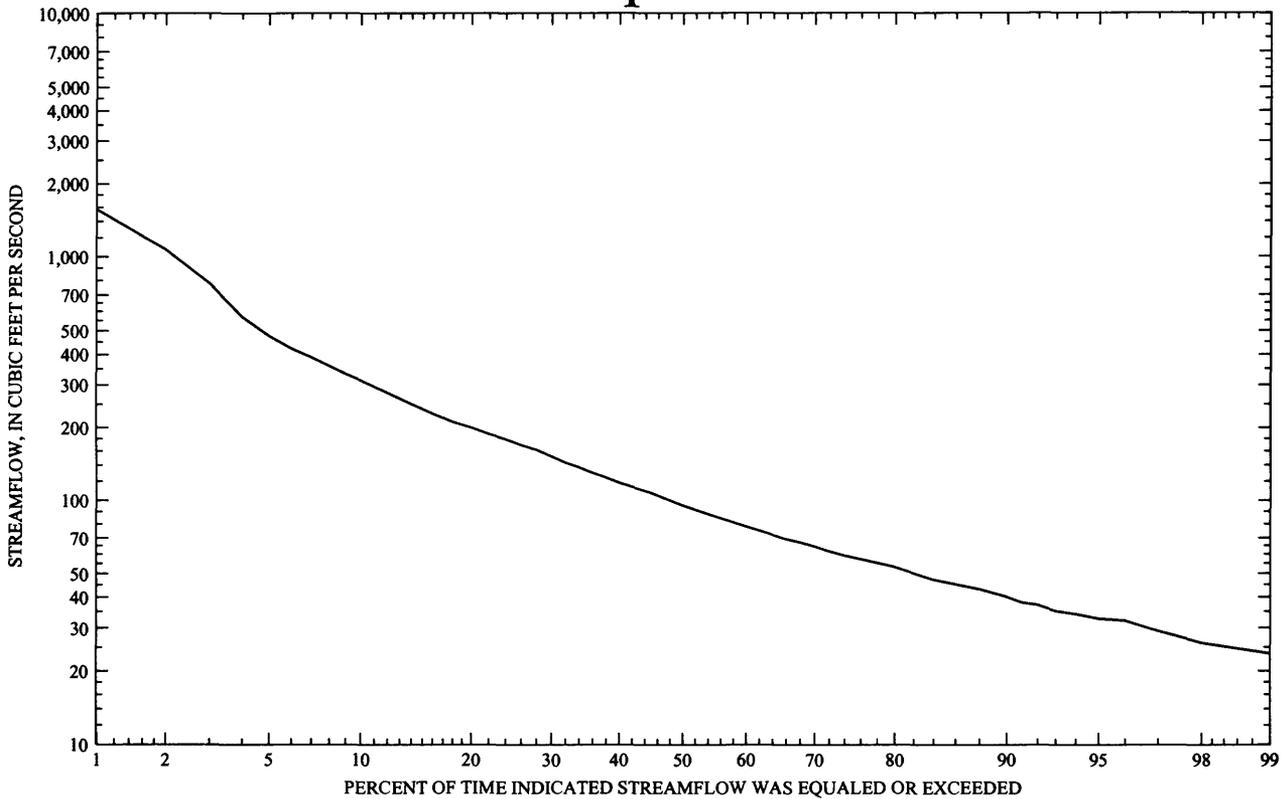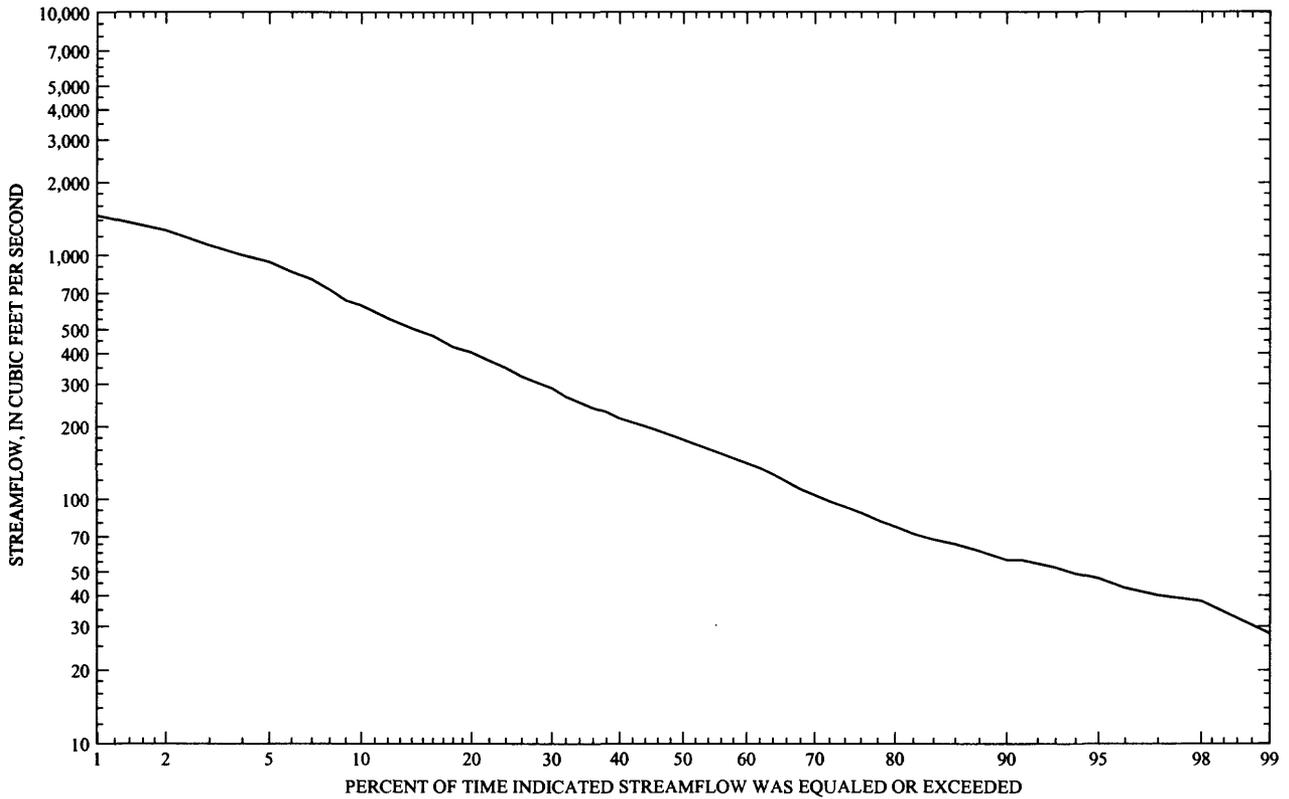
September

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	1560	55	86
5	475	60	78
10	313	65	70
15	239	70	64
20	200	75	58
25	174	80	53
30	152	85	46
35	133	90	40
40	118	95	33
45	107	99	24
50	95		

Figure 11. Flow-duration curve and flow-duration statistics for September based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.

October

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	1460	55	158
5	939	60	141
10	625	65	122
15	488	70	104
20	404	75	90
25	336	80	77
30	289	85	66
35	245	90	56
40	217	95	47
45	197	99	28
50	177		

Figure 12. Flow-duration curve and flow-duration statistics for October based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
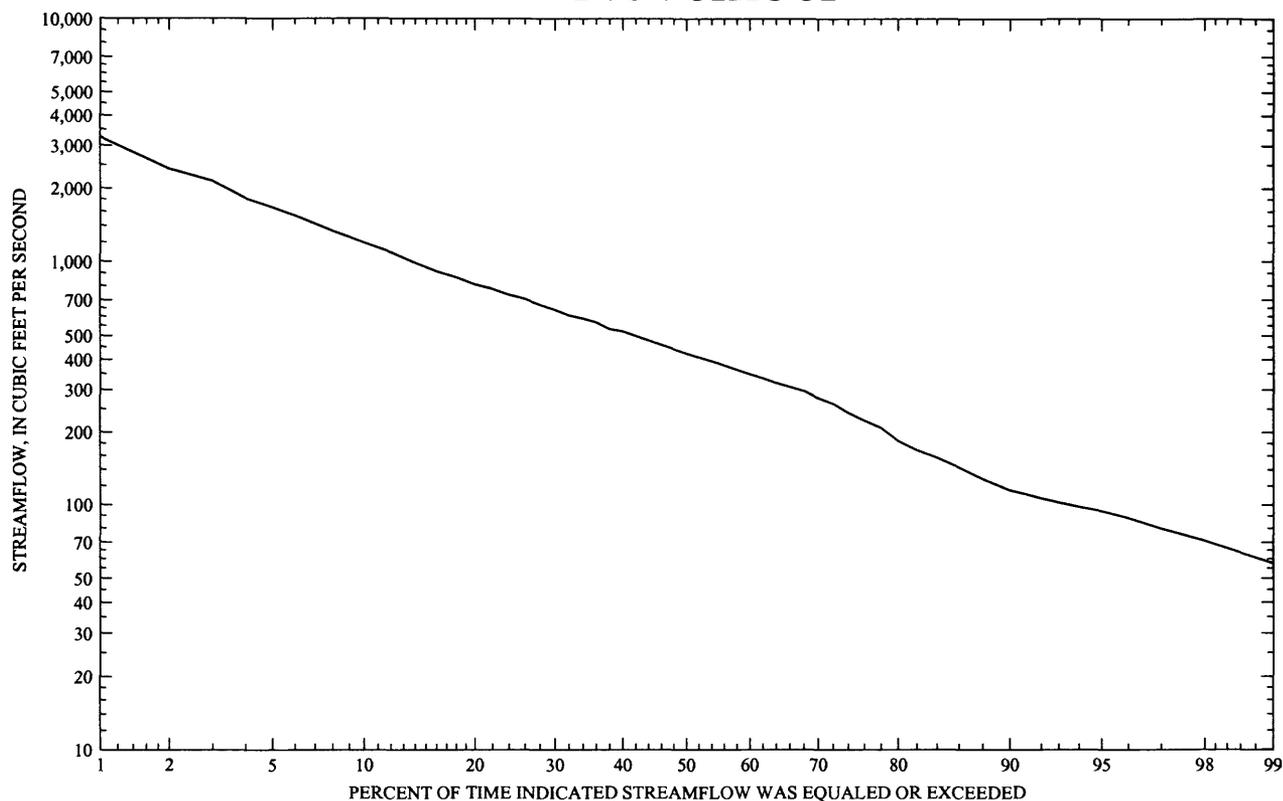
November

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	3250	55	386
5	1660	60	347
10	1190	65	314
15	950	70	278
20	808	75	233
25	719	80	184
30	637	85	150
35	576	90	115
40	520	95	94
45	469	99	58
50	422		

Figure 13. Flow-duration curve and flow-duration statistics for November based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.
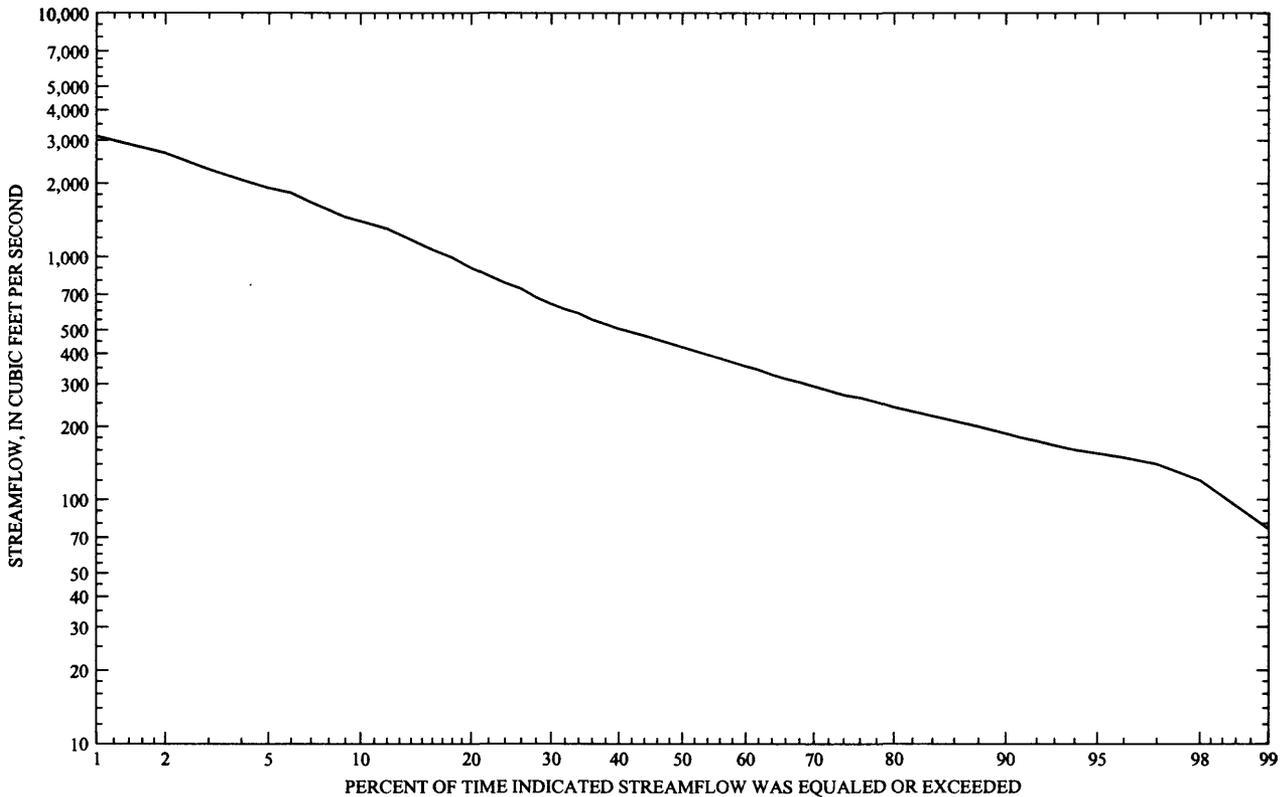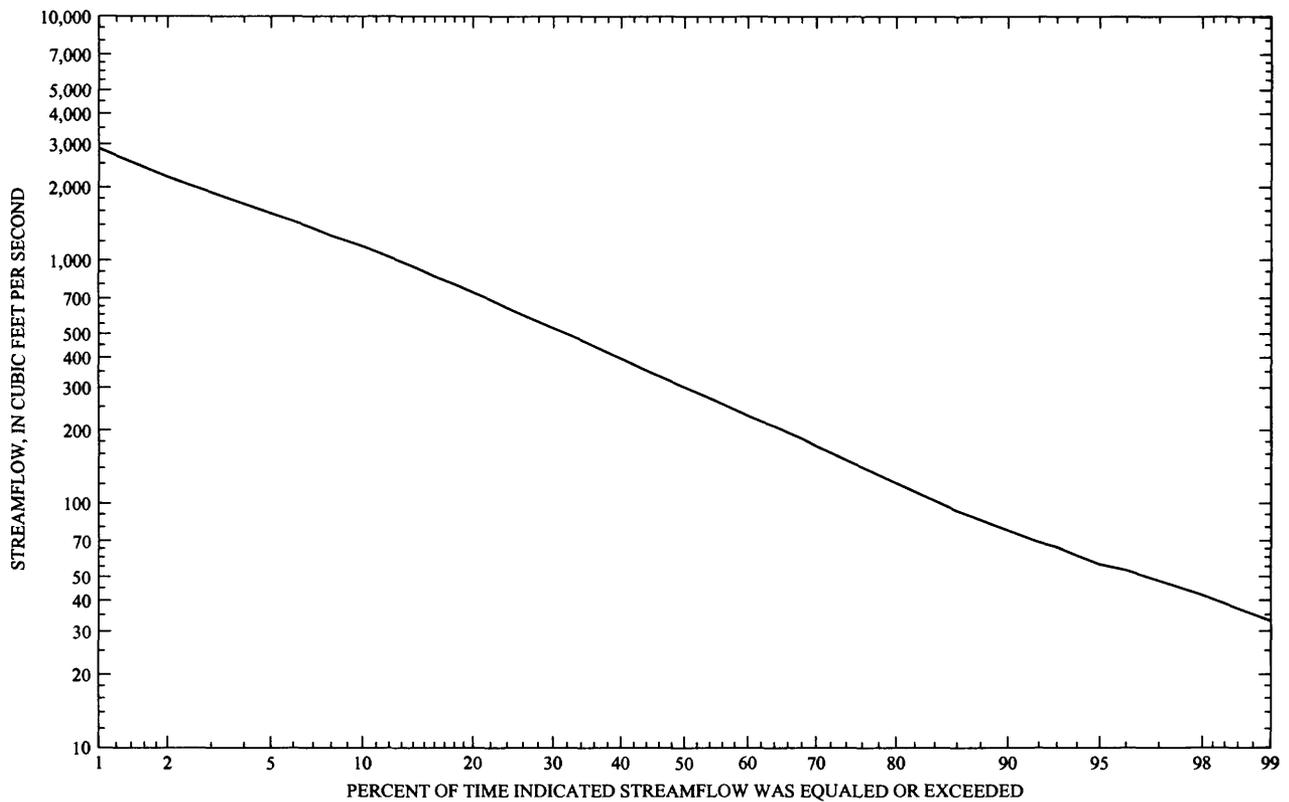
December

PERCENT OF TIME INDICATED STREAMFLOW WAS EQUALED OR EXCEEDED

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	3110	55	388
5	1910	60	355
10	1400	65	321
15	1123	70	293
20	899	75	267
25	760	80	240
30	640	85	215
35	568	90	187
40	506	95	155
45	467	99	76
50	426		

Figure 14. Flow-duration curve and flow-duration statistics for December based on historical period of record, March 1948 through December 1992, for Narraguagus River at Cherryfield, Maine.

Figure 15. Flow-duration curve and flow-duration statistics for the entire selected record, March 1948 through December 1992, for Narraguagus River near Cherryfield, Maine.

Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second	Percent of time indicated streamflow was equaled or exceeded	Streamflow, in cubic feet per second
1	2870	55	265
5	1560	60	230
10	1140	65	202
15	899	70	172
20	739	75	146
25	616	80	121
30	527	85	98
35	456	90	77
40	394	95	56
45	343	99	33
50	302		