Historical and Current Distribution and Abundance of the Anadromous Alewife (*Alosa pseudoharengus)* in the St Croix River

A Report to the State of Maine
Atlantic Salmon Commission
161 Capitol Street
172 State House Station, Augusta, Maine 04333-0172

- Lewis N. Flagg
May 30, 2007

Distribution and Abundance of Anadromous Alewife (*Alosa pseudoharengus*) in the St Croix River

Introduction: The St Croix River is the largest river between the Penobscot and St John watersheds. The river drains an area of 1635 square miles of which approximately 625 square miles of the river's basin is in New Brunswick and 1010 square miles is in Maine. The east branch of the St Croix forms the easterly boundary of the Atlantic seaboard between the US and Canada. Historically, the St Croix river was noted for its large runs of anadromous fish, particularly Atlantic salmon, American shad, and alewife. Due to the international boundary formed by the St Croix river, the freshwater and anadromous fish resources of the main stem and East Branch are interjurisdictional resources under the joint management of state and federal US and provincial and federal Canadian fishery agencies (St Croix River Steering Committee). The St Croix River Steering Committee was established for the purpose of seeking mutual agreement on a course of action to rebuild the depleted fish stocks and for management strategies as the fisheries develop. A long term management plan was developed by the Steering Committee in 1988 and a subsequent five year management plan was developed in 1993. Due to continued fishway closures at Woodland and Grand Falls since 1995, the 1993 plan was never fully implemented.

Overview: The upstream migration limit for anadromous species, particularly alewives (Gaspereaux) has been a center of controversy since the 1980's when anadromous alewives were perceived to be the cause of substantial declines in smallmouth bass in the upper St Croix river. Prior to 1980, an old, inefficient, and limited capacity fishway at Milltown (constructed in 1960) allowed only limited passage of anadromous fish. Construction of a new fishway at Milltown in 1980, coupled with state of the art fishways constructed in 1964 at Woodland and Grand Falls, allowed alewives virtually unimpeded access nearly to the headwaters of the St Croix. Limited numbers of alewives had ascended the river above Woodland and Grand Falls as early as 1965 because juvenile alewives were observed passing into the turbines at the Grand Falls powerhouse in the summer of that year by Fletcher (1965). By the mid to late 1980's, smallmouth bass in Spednic Lake had apparently declined substantially. Following complaints of poor smallmouth bass fishing from local guides and sporting camps on Spednic Lake, the MDIF&W undertook a cooperative study with the New Brunswick DNR. After 10 years of investigative work at Spednic lake, that study concluded that the large influx from a natural run of alewives through the Vanceboro Dam fishway, coupled with a lake drawdown of 9-14 feet, resulted in the young bass fry becoming unprotected by the rocky shoreline habitat and forced to compete for food and habitat with young perch and alewife fry. The combination of the loss of protective habitat, through water drawdown, coupled with the excessive competition from other fish fry, was believed to have caused poor bass fry survival over several successive years. In response to the smallmouth bass decline, the St Croix River Steering committee agreed to block the Vanceboro fishway during the alewife run and requested that Georgia Pacific Company (Vanceboro Dam owner) revise its water management plan on the St Croix watershed to

minimize the impacts of water drawdown on young bass. The Vanceboro fishway has been closed to alewife passage since 1988 with the exception of some limited passage in 1991 when the fishway was not closed soon enough to prevent some limited alewife escapement. In spite of this proactive effort, in 1995 the Maine Legislature passed L.D. 520, An Act to Stop the Alewives Restoration Program on the St Croix River, which resulted in unilateral closure of the Woodland and Grand falls fishways to the passage of alewives. This action, which was opposed by the fishery agencies of the state of Maine and Canada, caused the alewife run to decline from 2,600,000 in 1987 to 900 fish in 2002. The Milltown Dam, owned by the New Brunswick Electric Power Commission and with a fishway and powerhouse located on the Canadian side of the river, was not subject to the Maine Legislature's action. Alewives have continued to be released above the Milltown dam up to the present time. Because of recent dramatic declines in adult alewife returns, DFO Canada has been trucking alewives from the Milltown fishway to the Woodland impoundment since 2001. This has caused the alewife run to rebound from 900 adult returns in 2002 to about 12,000 in 2006.

Smallmouth bass sportfishing guides and upriver camp owners allege that anadromous alewives historically had no access to the waters of the upper St Croix because of a natural falls (Salmon Falls) located at the head of tide. It is the purpose of this report to examine the history of early settlement of the area, archaeological information and historical fisheries records to determine the distribution and relative abundance of anadromous alewives in the St Croix watershed.

Historical Status of Anadromous Fish Runs.

There are numerous references to the abundance of anadromous salmon, shad and alewife in the St Croix river. The first report (1867) of the Commissioners of Fisheries of the state of Maine had this to say about the St Croix River: "The St Croix was formerly very productive of salmon, shad, and alewives. Perley (1852), in his report of the fisheries of New Brunswick, states that the average catch of salmon at Salmon Falls, in Calais, was 18,000 annually. Gaspareaux, (alewives) came in such numbers that it supposed they could never be destroyed. The number of shad were almost incredible. The fisheries did not diminish up to 1825. Until that time there were fishways; but in that year the Union dam was built without a fishway, and the fisheries instantly fell off. We have the testimony of Mr. Ferdinand Tinker of Milltown, to the abundance of fish up to 1825. Perley says the whole number of salmon taken in 1851 was 200. Since that time they have remained the same until 1866, when 300 were caught. In 1867 there was a still further increase. Mr Treat of Eastport attributes this late increase of salmon to the influence of Porter's stream, a tributary on the New Brunswick side of the river, to which they sometimes have access at the breeding season."

Atkins (1887) reported: "The St Croix is remarkable, even among the rivers of Maine, for the great extent of the lake surface among its tributaries. **These lakes afford breeding ground for great numbers of alewives,** and, in the main river and its branches, here the salmon and there the shad found their favorite haunts. The exact limit of the upward migration of all these species is very naturally unknown with any degree of exactness, the entire upper portions of the basin being wilderness till long after the occupation of the lower banks and the erection of artificial obstructions**; but the fact of their existence in great numbers in the river shows they must have passed the only serious obstacle to their ascent, the natural fall at Salmon Falls near the head of tide**

and found their breeding ground in the upper waters. From the early settlement of the country until 1825, there was annually a great abundance of salmon shad and alewives. .Vessels from Rhode Island, from 100 to 150 tons berthen, followed the fishing business on the river and were never known to leave without full cargoes. There were also several seines belonging to the inhabitants, which were worked in the tideway of the river, the owners of which put up annually 1,500 to 2,000 barrels of alewives for exportation. At the same time shad were caught in great numbers, often more than a hundred of them being caught in a small net in a single night."

The St Croix River once supported large runs of anadromous species that ascended the river system nearly to its headwaters (Havey 1963). Keith Havey was the IF&W Regional fishery biologist for eastern Maine from the early 1950' to the 1980's.

In the late 1700's, mill dams were built throughout the lower St Croix watershed, impounding tidal areas, streams, and sections of the mainstem between Baring/Upper Mills and Milltown. Fletcher (1982) reported that the early dams only partially blocked the river. They were built out from either shore obliquely upstream and did not meet at the center of the river, the opening serving as fish passage and as a vent for excess flows. While water ran around the open end of these dams, the retained water served as a log holding pond and insured a head of water to power the mills on shore. Fletcher also reported that the natural ledge barrier at Salmon Falls and the rapids at Milltown may have been a barrier to the anadromous fish runs at various water stages, particularly at low water flows. He further acknowledges that the construction of the Union Dam in 1825 in Calais brought the taking of great quantities of salmon, shad, and gaspereau (alewives) to an end. This tidewater structure had no fishway. It is quite apparent that the lack of a fishway at the Union Dam virtually destroyed the anadromous fish runs of the St Croix. Fletcher surmised that the rapids immediately upstream of the Milltown dam and the rapids at Baring would be difficult for fish to pass at many water levels **but at high flows, migratory fish would probably pass these areas successfully.**

Alewife Life History and Fisheries

The Maine Commissioners of Fisheries report of 1867 makes the following observations about alewives: " The fishermen distinguish three separate schools or runs of different sizes of fish. The main body does not appear until late in May or in some rivers in June. Of the first run on the East Machias, 370 fill a barrel, of the second run, 400, of the third run, 600." **(It takes 120 alewives to fill a bushel, making a barrel of alewives equivalent to three bushels. If 2000 barrels were put up annually, this represents a minimum of 720,000 individual fish).**

Collette and MacPhee (2002) Fishes of the Gulf of Maine 3rd edition provides the following description of alewife spawning habitat: "Alewives usually spawn in quiet waters of coves and ponds, including those behind barrier beaches (if there are openings to the sea, natural or artificial) and in sluggish sections of streams above the head of tide (Smith 1907; Belding 1921; Bigelow and Schroeder 1953; Marcy 1976B). Where further upstream migration is barred by dams, alewife will spawn in shore-bank eddies or deep pools (Loesch and Lund 1977).

During their spawning migration, alewife are much more successful than American shad in navigating fishways of suitable design. They do not generally jump over obstructions although they easily negotiate white water in rapids and fishways. Negotiating swift water apparently does not stress them because increases in blood lactic

acid levels were not very great when tested during spawning runs in a fishway in the Gaspereaux river, N.S. (Dominy 1973).
Adult alewives move up our rivers in May and June on spawning runs. They spawn mostly in lakes, but may choose slow-moving streams. The eggs are broadcast and there is no parental care. The young hatch in just a few days and spend part of their first summer in the waters in which they hatched, moving down to the sea between July and December of that first year. After three to five years they return to their home rivers to produce their own young. (Havey 1963)

Most alewife are believed to return to spawn in their stream of origin (Bigelow and Schroeder 1953; Loesch 1987). This theory is supported by meristic data (Messieh 1977), by establishment or reestablishment of spawning runs by stocking gravid adults (Belding 1920, 1921; Bigelow and Schroeder 1953;Havey 1961) and by olfaction experiments (Thunberg 1971).

Alewife production in Maine is based on a production potential of 117.5 –235 adult returns per surface acre of spawning habitat. These very conservative production figures are derived as follows: Long term annual yield of alewives from the Damariscotta and St George Rivers (early 1950's to early 1980's) was 190 and 270 pounds per acre respectively. These figures do not include spawning escapement which is assumed to be 15%, based on a one-day weekly closed period which was in effect at that time. More recently, harvests of alewives have dropped dramatically to between 50 to 100 pounds per acre. The average alewife weighs about 0.5 pounds, which translates to 100-200 adults per acre yield. If 15% (a minimal % since current weekly closures have been increased from 24 to 72 hours) is added to this yield to account for spawning escapement, the production potential is 117.5 –235 returning adult fish per acre of spawning habitat. The following table shows the distribution of habitat and potential alewife production in the St Croix River drainage.(Acreages obtained from Five Year (1993-1997) Operational plan for the development and Management of the Diadromous Fishes of the St Croix River.)

Table 1
St Croix River Alewife Habitat/Production Above Milltown

River Reach	Acreage	% of Total Habitat	Production @117.5	Production @ 235
Milltowm to Woodland	131	0.1	15392	30,784
Woodland to Grand Falls	1174	1.1	137,945	275,890
Grand Falls Flowage	27,142	27.3	3,189,185	6,378,370
Spednic Lake and above	36,209	36.5	4,254,557	8,509,114
West Grand lake and above	34,549	34.8	4,059,507	8,119,015
TOTAL	99,205	100.0	11,783,486	23,566,974

Alewife habitat below Woodland represents only 0.1 % of the production potential of the drainage. There is virtually no alewife spawning habitat below the Milltown Dam (Lee Sochasky, personal communication), certainly no where near the habitat that exists between Milltown and Woodland. If we accept the theory that alewives never ascended above Salmon Falls where was the habitat that produced harvests in excess of 700,000 adults per year prior to 1825? Even the

area from Salmon Falls (Milltown) to Woodland only provides a potential production of 15,000 fish. Moreover, the number returning in recent years as a result of stocking the Woodland impoundment is only about 12,000 fish annually). If production is doubled to replicate alewife yields in the 1950's-1980's, the production is only 30,000 fish. Therefore alewives would have to have ascended above Grand Falls to produce runs of the magnitude mentioned in historical literature. Further evidence of alewife migration above Salmon Falls is provided by the following:

Petition of Joseph Whitney et. al. for Removal of Obstructions in the St Croix River for the Passage of Fish, December 3, 1822

"To the Honorable Senate & House of representatives of the state of Maine:
We the undersigned, citizens of said state, respectfully represent that previous to existing obstructions, by mills and mill dams, on the St Croix or Schoodic River, great quantities of Salmon, Shad, and Alewives annually passed up and returned down said river to the great benefit and advantage of the community generally; and in an especial manner of the new settlements in the eastern part of the state— That said obstructions have rendered it almost impossible for the Shad and Alewives to pass above the town of Calais; **whereas they used to pass from eighty to an hundred miles above; and they are now almost totally excluded from said River.**

That it is confidently believed that if suitable fish ways should be provided and also suitable regulations for the taking of fish on said river, it would, as formerly, be abundantly supplied with fish and all the privileges and advantages of the proprietors of the mills and mill dams on said River remain unimpaired--

Wherefore, we pray, that such fishways and such regulations concerning the taking of fish on so much of said river and its branches as be within this state as may be deemed necessary to restore to its citizens their ancient privileges in this respect, may be provided by the Honourable House of representatives and as in duty bound we will ever pray. Joseph Whitney, Anson G. Chandler, Enoch Darling, William Smith, Andrew Tracy, Samuel Perkins, James Stuart, and John Harvey.

Not only did the petitioners believe that alewives ascended the river above Salmon Falls before the dams were built, but they also acknowledged that the alewife, shad, and salmon runs were depleted. as a result of the dams with no fish passages. **If alewives never went above Salmon Falls, why did the run decline coincident with dam construction without fish passages?**

Table 2
Adult Alewife Returns at Milltown 1981-2006

Year	Returns at Milltown	Significant events
1981	169,620	New pool & weir fishway at Milltown
1982	233,102	
1983	151,952	
1984	152,900	
1985	368,900	
1986	1,984,720	
1987	2,624,700	
1988	2,590,750	Spednic Fishway closed to alewife
1989	1,164,860	
1990	1,531,250	Grand falls Fishway blocked
1991	586,910	Limited alewife escapes into Spednic
1992	203,750	Limited escapes above Grand falls
1993	297,720	Grand falls Fishway blocked
1994	378,330	Grand falls Fishway blocked
1995	223,133	Woodland & Grand Falls Fwys blocked
1996	645,978	
1997	225,521	
1998	173,318	
1999	25,327	
2000	8,569	
2001	5,202	Woodland headpond stocked
2002	900	Woodland headpond stocked
2003	7,901	Woodland headpond stocked
2004	1,299	Woodland headpond stocked
2005	11,632	Woodland headpond stocked
2006	11,829	Woodland headpond stocked

Table 2 represents recent counts of adult alewife returns to the Milltown fishway. The majority of adults in the spawning run return after four to five years at sea. The 1988 closure of the Spednic lake fishway reduced the adult return from 2,590,750 in 1988 to 203,750 in 1992; a ten fold reduction in the run over a span of four years. The 1990 closure of the Grand falls fishway resulted in a five fold reduction in adult returns in 1994. The 1995 closure of the Woodland and Grand falls fishways in 1995 reduced the adult return from 223,133 in 1995 to 25,327 in 1999; an additional ten fold reduction over a four year period. The run further

diminished to 900 returns in 2002 due to lack of access to alewife spawning habitat. Adult returns have increased only because DFO has been stocking the 1174 acre Woodland impoundment since 2001. **These data demonstrate conclusively that there is little habitat for alewife production below Salmon Falls and therefore alewives had to ascend the river above Salmon Falls and Grand falls to produce the historically abundant alewife run in the St Croix river.**

Recent information received from Dr Arthur Spiess, Senior Archaeologist with the Maine Historic Preservation Commission, further demonstrates that alewives have been present in the upper portion of the St Croix watershed for at least 4000 plus or minus 100 years. (See attachment A letter to Dr Spiess from Lewis Flagg and Attachment B response from Dr Spiess.). Following is a summary of Dr Spiess' report:

"The Mud Lake stream site (BkDw 5) is located at the confluence of Mud lake Stream and Spednic Lake on the New Brunswick side. Excavated in 1983/4, the **archaeologists recovered 17 alewife bones** (representing multiple individual alewives-Dr Spiess personal communication 25May 07) from a hearth and/or a garbage pit (Figure 21). Charcoal from the pit was radiocarbon dated to 4000 plus or minus 100 years. **As for specific identifications of animal bone, there are a few specialists who are quite good at the task, and we (I am included) use comparative collections as much as possible**. **When a bone is identified as "alewife" it is specifically differentiated from the larger shad on size**. Native Americans of eastern Maine and western New Brunswick moved seasonally to be near food sources. The food animal bone, plant and shellfish remains (with one exception) from their sites seems appropriate to the local ecology. They did maintain long-distance trade networks, trading rocks, furs, and other high-value commodities. We do not have any evidence of trade in food stuffs. The one exception to the "food animal bone locally caught rule seems to be movement of bone that was used for tools and/or attached to pelts (such as in the form of medicine bags). the only fish bone that was used as a tool, and therefore moved across some distance, was swordfish sword. **In short, we conclude that food was gathered within perhaps ½ day travel maximum, and often much less, from a camp site.** (½ day travel by canoe is estimated by archaeologists to be no more than 10 miles. The distance from Calais or Meddybemps Lake to the Mud Lake site is between 60 and 65 miles so there is virtually no likelihood that alewives were carried to the Mud lake site from other known alewife sites.**)We know from ethnographic records that camps were often made at good fishing locations, and the archeological record seems to support this pattern. In summary, the Mud Lake Stream site provided evidence of alewife above the head of tide on the St Croix 4000 years ago."**

It should be noted that Mud Lake Falls was reported by Mike Smith, IF&W biologist, to be impassable to anadromous alewives. Therefore, this was a logical place for native Americans to harvest alewives since they would naturally be backed up below the falls as is the case today when alewives encounter artificial and natural obstructions to passage.

Summary and Conclusions

Therefore, I conclude that anadromous alewives historically ascended above Salmon Falls and Grand Falls based on the following evidence:

1. There is not enough habitat below Salmon Falls and Grand falls to produce the historically large runs of alewives that were commercially exploited in the lower river. (See Table 1.)
2. Historical reports link the decline of alewives, shad, and salmon to the construction of dams at Salmon Falls and other sites on the lower river. If alewives never ascended the river above Salmon Falls, why did the alewife run decline dramatically coincident with dam construction on the lower river? I conclude that alewives did ascend the river above Salmon Falls and the decline in abundance of alewives, along with salmon and shad, was directly related to loss of access to upriver spawning and nursery habitat
3. Since 1990 and 1995, when alewives were denied access to habitat above Grand Falls and Woodland respectively, adult returns declined dramatically from 2,600,000 adults to 900 and has shown no appreciable recovery up to the present. The habitat below Grand falls (Milltown and Woodland flowages) is producing a run of only about 12,000 adult alewives or approximately the number projected by DMR's low range estimate in Table 1 for the river below Woodland.
4. Archeological findings at the Mud Lake Stream site provide evidence of alewife above head of tide on the St Croix 4000 years ago. This was long before any fish passage modifications may have been made at Salmon Falls by European colonists. The Mud Lake site is 65 miles upstream of head of tide and the same distance from Meddybemps Lake and more than 65 miles upstream of the Devil's Head site in the St Croix estuary, other known sites of alewife bones. These sites are much more than a ½ day travel maximum between where food was harvested and where it was consumed by native Americans. Therefore, I conclude that the alewives at the Mud Lake stream site were caught in Mud Lake stream or the immediate vicinity and therefore successfully passed upstream above Salmon Falls and Grand Falls.

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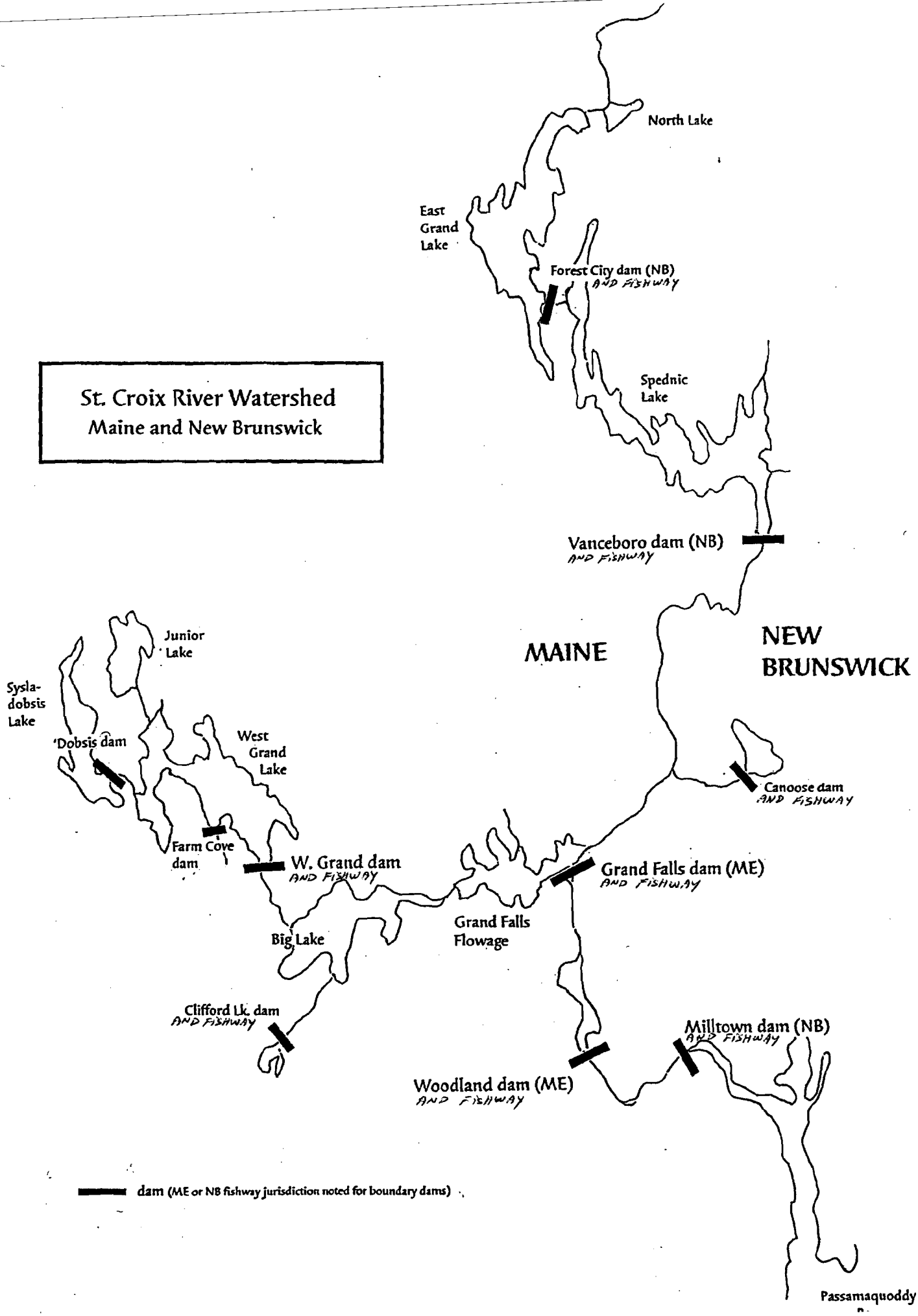
St. Croix River Watershed
Maine and New Brunswick
North Lake
East Grand Lake
Forest City dam (NB)
AND FISHWAY
Spednic Lake
Vanceboro dam (NB)
AND FISHWAY
MAINE
NEW BRUNSWICK
Junior Lake
Sysla-dobsis Lake
Dobsis dam
West Grand Lake
Canoose dam
AND FISHWAY
Farm Cove dam
W. Grand dam
AND FISHWAY
Grand Falls dam (ME)
AND FISHWAY
Big Lake
Grand Falls Flowage
Clifford Lk. dam
AND FISHWAY
Milltown dam (NB)
AND FISHWAY
Woodland dam (ME)
AND FISHWAY
Passamaquoddy
dam (ME or NB fishway jurisdiction noted for boundary dams)

ATTACHMENT "B"

MAINE HISTORIC PRESERVATION COMMISSION
55 CAPITOL STREET
65 STATE HOUSE STATION
AUGUSTA, MAINE
04333

JOHN ELIAS BALDACCI
GOVERNOR

EARLE G. SHETTLEWORTH, JR.
DIRECTOR

May 9, 2007

Mr. Lewis N. Flagg
34 Turkey Lane
Winthrop, ME 04364

Dear Mr. Flagg:

I will try to answer your specific questions of May 3 about alewife presence in archaeological sites in and near the St. Croix river within the body of this letter. To start with your last questions first, our office is the repository of a copy of most archaeological reports generated in Maine, and we also have many from our colleagues in New Brunswick. Moreover, it is part of my job to be current in archaeological research that affects the understanding of archaeological sites in the region. Therefore, with reasonable assurance, the summary provided herein is complete, and you do not need to contact any other archaeologists for further data.

The pre-Contact (pre-European Contact, or "prehistoric") Native Americans of eastern Maine and western New Brunswick were hunter-fisher-gatherers, not agriculturalists. They moved seasonally, to be near food sources. The food animal bone, plant and shellfish remains (with one exception) from their sites always seems appropriate to the local ecology. They did maintain long-distance trade networks, trading rocks, furs and other high-value commodities. We do not have any evidence of trade in food stuffs. The one exception to the "food animal bone locally caught" rule seems to be movement of bone that was used for tools and/or attached to pelts (such as in the form of medicine bags). The only fish bone that was used as a tool, and therefore moved across some distance, was swordfish sword.

In short, we conclude that food was gathered within perhaps ½ day travel radius maximum, and often much less, from a camp site. We know from ethnographic records that camps were often made at good fishing locations, and the archaeological record seems to support this pattern.

As for specific identifications of animal bone, there are a few specialists who are quite good at the task, and we (I am included) use comparative collections as much as possible. When a bone is identified as "alewife" it is specifically differentiated from the larger shad on size.

The number of archaeological sites with preserved food animal bone, and thus the amount of data relevant to your question, is rather low, because many sites on the St. Croix above tide, and on the lakes, have been heavily damaged by erosion from water impoundment construction. Many sites on the tidal portions of the St. Croix have been heavily eroded by an uncommonly rapid relative sea level rise over the last few thousand years.

There are, in fact, only three archaeological sites with alewife bone that are relevant to your question, two on the St. Croix and one on the Dennys.

The Mud Lake Stream site (BkDw 5) is located at the confluence of Mud Lake Stream and Spednic Lake on the New Brunswick side. Excavated in 1983/4, the archaeologists recovered 17 alewife bones from a hearth and/or garbage pit (Feature 21). Charcoal from the pit was radiocarbon dated to 4000 ± 100 years.

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The reference is: Michael Deal, 1985, Final Report on the 1983/4 Excavations at the Mud Lake Stream Site (BkDw 5), Southwestern New Brunswick. Manuscripts in Archaeology 15, New Brunswick Historical and Cultural Resources.

The second site relevant to your questions is the Devil's Head site (97.10) on the tip of that landform in Calais. It is composed of multiple seemingly individual "wigwam" areas, with fire hearths and clam shell dump areas, both of which yielded food animal bone. The associated artifacts date from as early as 1500 years to about 1800 A.D. Unidentified fish bone is the most common food animal bone category, and alewife is (by far) the most common bone identified to genus/species. I have enclosed the relevant pages from the report (Spiess and Cranmer 2005). Harvesting alewife was an important subsistence activity at this camp site. They were the most abundant species harvested, but specifying exact numbers is impossible.

The third relevant site is the N'tolonapemk site (site 96.2), at the outlet of Meddybemps Lake, on the Dennys River. This is the most important site so far discovered on an interior lake or river setting in Downeast Maine. The reference is: Michael S. Brigham et al., 2005, The Archaeology of N'tolonapemk (96.02 ME), "Our Ancestor's Place": Phase III Data Recovery at the Eastern Surplus Superfund Site, Meddybemps, Washington County, Maine. Archaeology Research Center, University of Maine at Farmington. Approximately 200 "features" (fire hearths, storage pits, and/or garbage pits) yielded a range of radiocarbon dates (and appropriate artifact) from 8500 years to 550 years. This site covers nearly the entire range of cultural occupation in Maine. Over 70,000 fragments of animal bone from this site were examined, and about 23,000 identified to class (mammal, bird, fish), family or genus/species. Throughout the sequence, the most common genus/species identification is alewife (906 bones), and fish (not further identified) numbers 9781 bones. (Most of those were small fish that could be alewife.) The record of alewife anadramous behavior, reaching Meddybemps Lake on the Dennys River, over 8000 years, is quite clear.

In summary, the Mud Lake Stream site provided evidence of alewife above the head of tide on the St. Croix 4000 years ago, and the Devil's Head site provides evidence of alewife inshore in tidal waters just below Calais sometime between 1500 years ago and 1800 A.D. Site 95.2 at the outlet of Meddybemps Lake provides evidence that alewife harvesting was a major seasonal activity for almost 8000 years at the headwaters of the Dennys River. Unfortunately, no site of the quality of 95.2 has been found on the St. Croix drainage, but we presume that 95.2 can be used as a proxy statement that alewives have been a major anadramous fish presence in the downeast Maine rivers for millennia.

Sincerely,

Dr. Arthur Spiess
Senior Archaeologist

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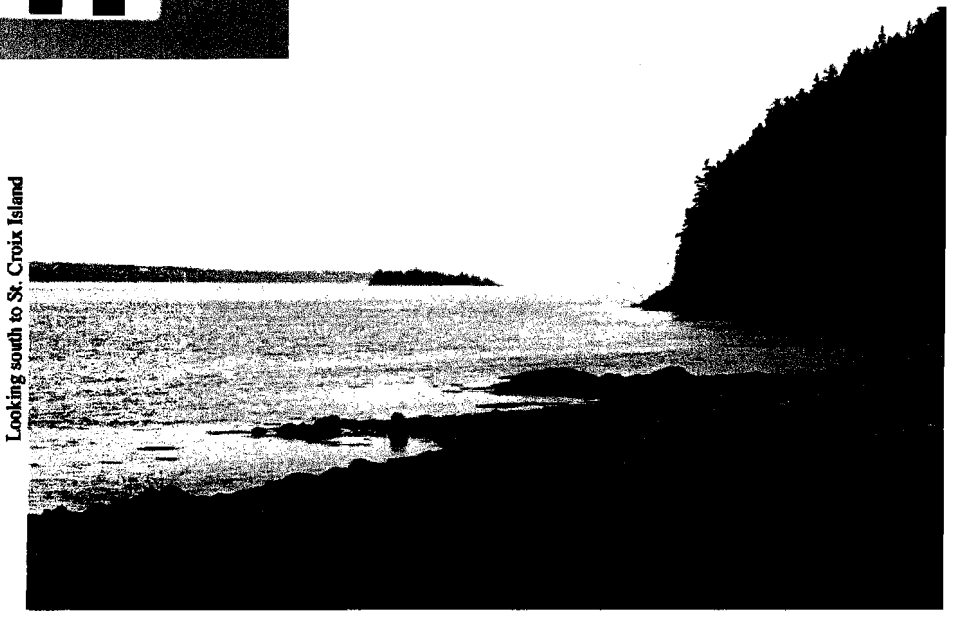
ATTACHMENT "B"

DEVILS HEAD, CALAIS, AND SITE 97.10: ARCHAEOLOGICAL SURVEY FOR THE LAND FOR MAINE'S FUTURE BOARD


Looking south to St. Croix Island

Arthur Spiess and Leon Cranmer
Maine Historic Preservation Commission
February, 2005

1600.

Fragments of pearlware ceramic, manufactured from about 1785 to 1840, were recovered in three testpits (tp 19, 20 and 28). Pearlware could, of course, have been in use as "old" camp ware during or after the Civil War, but its presence in three testpits grouped in a 25 m area argues for more than one vessel and breakage/discard during the first half of the 19th century.

As mentioned in the history section, there is no historic indication of Euro-american construction at the site 97.10 area before the 20th century. Therefore, it is likely that these historic period artifacts reflect "camping" activity. Because these historic artifacts are widespread within the site area (T2 tp 5 to tp 20 being about 80% of the length of the site) we conclude that this "camping" occurred as small occupations that can not be easily separated from a similar Ceramic period pattern that preceded them. In the absence of specific evidence of use of this location by groups of Euro-americans, these historic artifacts must indicate continued use of the location by Native Americans through the 17th and 18th centuries. Of course it is likely that these people were Etchemin, or ancestral Passamaquoddy-Maliseet, and (after the political alignment caused by the American Revolution) Passamaquoddy tribal members. This is one of the few archaeological sites in Maine to preserve archaeological evidence of continuing use from the Ceramic period through the 18th century and perhaps into the 19th century.

Faunal Remains

Faunal remains from a shell midden fall into two primary categories: shell and vertebrate bone. The shell in the shell midden deposits at Devil's Head is 99.9% *Mya* (soft shell clam). There are a few moon snail shells (a large univalve).

The vertebrate bone occurs both in unburned and calcined (burned to a chalky white) states. Calcined bone is produced when fresh bone is exposed to a hot fire. The only fire hot enough to produce calcined bone at this site would have been hearth fires, and thus the calcined bone records discard of bone (or animal parts containing bone) directly into the fire. As shown by the bone identifications (Appendix II), the calcined bone at this site is sub-sample of the unburnt bone, with the same range of species represented. Because we did not excavate a large sample of the middens, and because we can not sort the samples into different age groups or "occupations" based on the small samples we do have from the site, the bone sample is summarized as a unit. Thus, we characterize the "Ceramic period" and "Contact period" use of the site as one economic focus, although future work might detect shifts in economic focus over time.

The faunal sample is dominated (in numbers) by small fish bone, which is mostly alewife, with frequent flounder and sculpin. Sturgeon (scute or skin bone) is also common, although we can not directly compare the frequency of sturgeon scute with other fish bones, because sturgeon do not have boney skeletons. The comparative weights indicate that sturgeon were perhaps the second most important fish compared with alewife. Based on this species mix, perhaps fishing was being done with weirs or nets set in the intertidal zone. Three bones of (at least one individual) large cod fish are present, possibly indicating fishing further from shore and/or down the estuary.

The identified mammal bone sample is dominated by moose in both count and weight, with beaver and deer second and third. A muskrat tooth is present, indicating that muskrat were also trapped (along with the beaver?). A large duck is represented by one bone (and possibly a second,

All of the moose bone could come from one individual moose. Three of the bones are hoof bones, and the two of those that can be identified from from a left fore-hoof. Five teeth and mandible parts are also present. The mandible part is an articular process fragment from a left jaw, and all of the teeth are left teeth. The teeth include four deciduous upper molars ("baby teeth", or "?calf teeth") with their roots resorbing, and a premolar germ fragment (tooth still growing, not yet erupted). Thus these teeth document a moose about 15 to 18 months of age when the permanent premolars erupt and replace the deciduous molars. This specimen represents a summer to fall kill. These hoof bones come from T1 tp 20 and the teeth and mandible part from T1 tp 27, about 35 m apart, so perhaps two moose are represented. The very large mammal longbone is almost certainly moose, as well.

Fish bone constitutes 85% of the bone count at the site, while moose, deer and large mammal bone constitutes 56% of the bone weight at the site. All the fishbone constitutes about 16% by weight of the bone. So, there are various ways to quantify diet contribution to the site.

In sum, the diversity of faunal remains at the site is striking, probably representing multiple seasons of occupation and certainly representing a variety of fishing and hunting techniques. The economic base was probably clam harvesting and intertidal fishing, supplemented by a diversity of hunting and trapping activities.

Brief overview of St. Croix basin water levels and flows management

Updated to February 2006

Pre-history	The Passamaquoddy people create "rolling dams" in the watershed. These constructions of brush, logs and stones are placed in low water where fish are usually present. Fishers beat the water upstream to "roll" and hold the fish in the pool that the dam creates until they can be speared or netted. Schoodic Falls, later called Salmon Falls [now the site of the Milltown dam], is the site of a major spring fishing village. The sacred fires maintained there honor the burial ground of tribal chiefs and the entrance to the river the Passamaquoddy call "Skutik" e.g. Schoodic, meaning "burnt land".
late 1700s	Mill dams are built throughout the lower St. Croix watershed, impounding tidal areas, streams and sections of the mainstem between Baring/Upper Mills and Milltown. The dams on the mainstem are of a "V" type construction with an open mid-section. These supply water power and log transportation for numerous mills that – for over 100 years – produce lumber, shingles, laths, barrels and other products, primarily for export to Europe and the U.S. Fishways are usually included in these dams; the open "V" design may have allowed some fish passage when these were absent.
1791	The Brisk Mill and dam are constructed at Salmon Falls, on the British side. The next year, a ¾-mile long water sluice is built from the mill to the tidewater, to carry sawed lumber to waiting ships. The sluice, later enlarged, operates until about 1870. The Washington Mill, on the opposite bank from the Brisk Mill, operates a similar sluice from 1805 to1825.
1803	Donald MacDonald reports to Edward Winslow on the status of Charlotte County settlements. For St. Stephen he states: "There are 7 saw mills on the waters of the Scoodiac [St. Croix] which cut annually 4,000,000 feet of Boards; great quantities of Shingles are made likewise. During the late war [with France] two vessels loaded here yearly with masts for the use of the government. About 3,000 barrels of Alewives are annually taken at the falls. There have been lately 5 sails of shipping built in the Parish."
1810-1870	Many log drivers' dams are constructed in the middle and upper watershed to help transport timber from these areas to the lower watershed, where the wood supply is dwindling. The dams are constructed to impound the 'summer-low to spring-high' water elevation range of each waterbody (many of today's dams are of a similar height). Until 1905, when the dams ceased to operate primarily for log driving, the dam gates are typically closed in the fall to impound water through the winter and opened in the spring to flow the logs downstream. In summer, the gates are left open and the area behind the dams returns to its un-impounded level. The dams at West Grand, Sysladobsis, Forest City, Vanceboro, Canoose and Clifford are built in this era, along with many other dams that have since disappeared.
1810	The first dam is constructed at the outlet of West Grand Lake, in the vicinity of the current bridge. It can impound water to an 8ft height.
1825	The Union Mill dam is constructed at Milltown, without a fishway. This ends the taking of "great quantities (110 to 150 tons) of Salmon, Shad and Gaspereau at Salmon Falls by vessels as far down the coast as Rhode Island" (Boardman 1903). Salting and curing for these fish was conducted on the U.S. side and the fish were shipped as far as the West Indies market.
1836	The West Grand Lake dam is moved to its present location, maintaining an 8ft impoundment level. The first Spednik Lake (Vanceboro) dam is built, creating the current Spednic and Palfrey Lakes with its 15ft impoundment level.
1836	William Anson, conducting a state survey of the St. Croix during an "extraordinary drouth", finds summer water levels 7 feet 9 inches below the highest freshet marks on some waters.
1840	The first Forest City Dam is constructed on East Grand Lake, about 400 feet downstream of current dam location. It can impound water to a 7ft height.
1847	The St. Croix Log Driving Company is formed. For nearly five decades it controls most of the dams and log drives in the St. Croix watershed. In the early 1900s it merges with the Eastern Pulpwood Company; the assets of these are later acquired by the St. Croix Paper Company.
1860s	Over a hundred mills use water power from a 5-mile section of the St. Croix near head of tide to turn out large quantities of wood products, grain and other goods. The mills run only when water levels allow (i.e. not in drought, freshet or ice conditions), about 7 months a year. Some of these operate into the early 1900s. Sometime in this period a channel is dug around the mill complex at Baring; this channel remains until it is filled in during 1930.
1861	The St. Croix Log Driving Company builds the Canoose (9 ft impoundment), Sysladobsis (6 ft impoundment) and Clifford (8 ft impoundment) dams. Each of these enlarges upstream lakes or flowages.
1860s	The St. Croix becomes an international center for tanning leather. A large tannery and water supply canal are constructed at Forest City, using bark from the plentiful supply of hemlock trees to tan hides from around the world. Other tanneries are built at Princeton and Vanceboro. Hemlock bark is floated to the tanneries in huge rafts.

Pre-1869	Five dams are constructed along the Magurrewock drainage, in Calais. These enlarge Nash's Lake and others.
1869	Walter Wells, Superintendent for the Hydrographic Survey of Maine publishes *Water-Power of Maine*, following surveys commissioned by the Legislature. Chapter XIX details the existing dams, topographical, geographical and hydrological information and hydro development potential of the St. Croix system, which he finds to have one of the highest potentials for hydropower development in state. He bases his findings on an estimated "dependable flow "of 1000 cfs.
1870	One of the world's largest tanneries is built at Grand Lake Stream, along with a water supply canal, to make use of the large volume of hemlock in the area. Bark is transported to the tannery in floating rafts. A canal is also constructed at the Sysladobsis dam to allow for bark transport. The tannery operates until 1896.
1872	Plaster Company builds a stone dam at the outlet of Maguerawock (Nash's) Lake at Red Beach.
1879	The Farm Cove dam is constructed on West Grand Lake to reduce flows out of the lake through Grand Lake Brook. This increases the lake's impoundment capacity and increases the flow at the primary outlet, Grand Lake Stream.
1881	The St. Croix Cotton Mill, one of the world's largest, is constructed at Milltown, NB, along with a timber version of the current Milltown dam, which provides mechanical power for the looms. The dam creates the current Milltown headpond. In 1887 a rope drive turbine generator is installed to bring the first electricity to the mill (this generator is still operational) and later to local users. A new powerhouse and other electric turbines follow in 1920.
1895	St. Croix Gas & Light Company forms in St. Stephen. In the next few years it constructs a dam at Union Mills to generate power for St. Stephen, Calais, Milltown and later St. Andrews. The hydro plant and dam are destroyed by fire in 1924.
1899	St. Croix Water Power Company is incorporated by an Act of the Maine Legislature (Ch. 203, Acts of 1899). Established for hydropower generation, the company is empowered to make "such improvements in the Saint Croix River as will enable the said corporation to store water for the purpose of increasing the volume of water in the said Saint Croix River in times of drought, either in Summer or Winter, by owning or building dams, flowing said rivers, lakes, ponds and streams, and deepening the water channels connected therewith".
1899-1902	St. Croix Water Power Company uses Eminent Domain authority to seize assets of the Grand Lake Stream Company at West Grand Lake. Salmon Pool below the dam is excavated for material to expand the dam's East and West dikes for year-round water storage.
1902	Sprague's Falls Manufacturing Company Ltd. is incorporated in Canada, with the right to construct dams, with fishways, at Sprague's Falls (Woodland) and also auxiliary dams at Grand Falls and Chiputneticook Falls, for the purposes of holding and storing logs and pulpwood (Edward VII, Ch.103, May 15, 1902)
1905	St. Croix Water Power Company begins to operate former log driving dams for water storage purposes: these dams begin to impound water year-round. Low lying islands and shoreline areas are sometimes flooded and some erosion occurs. Public concern about the higher lake levels is documented in the book " Hinkley Township" by Minnie Atkinson.
1905	The St. Croix Paper Company, incorporated the year before, constructs the Woodland pulp and paper mill and the Woodland dam at a cost of about $500,000; this creates the present Woodland Flowage. The dam's hydropower facility is designed for minimum flow of about 800cfs. The original falls at this site was about 25 ft high.
1908	The Forest City dam is moved to its present location. This timber dam is subsequently rebuilt in 1926 and 1949. The dam is refurbished and the present fishway added in 1970.
1909	The Boundary Waters Treaty Act (January 11, 1909) results in the formation of the International Joint Commission (IJC) in 1912 with authority to regulate flows and levels on the U.S./Canada boundary waters, including the St. Croix. (Act effective May 5, 1910).
1913-14	The St. Croix Water Power Company and Sprague's Falls Manufacturing Company Ltd. construct the Grand Falls dam and dig a canal to redirect the river flow to a new hydroelectric plant that will provide supplemental power for expanded production at the St. Croix Paper Company's Woodland mill. This dam creates Grand Falls Flowage and submerges the former Kennebasis River up to and including the Princeton dam at what is now the outlet of Lewy's Lake. The dam's hydro facilities are designed for minimum flow of about 800 cfs.
1915	The IJC issues an after-the-fact Order of Approval for construction of the Grand Falls dam and power canal, and its diversion and use of waters. It sets a maximum water elevation of 202 ft m.s.l. (above mean sea level), (November 9, 1915). [The Woodland dam does not require IJC approval, as it predates the Boundary Waters Treaty].
1916	The U.S. Congress authorizes, after-the-fact, the construction of the Woodland and Grand Falls dams. (August 25, 1916)
1920	The U.S. Federal Water Power Act is passed (June 10, 1920), regulating power dams constructed after this date.

1923	The IJC responds to an application by the Commissioner of Inland Fisheries & Game for the State of Maine by issuing an Order authorizing the erection and repair of fishways by all dam owners on the St. Croix River (October 3, 1923). The action is in response to the poor condition of fishways at dams owned by the St. Croix Gas & Light Company and Canadian Cottons Ltd., at Milltown.
1931	The IJC issues an Order that raises the maximum headpond level at the Grand Falls dam to 203.5 m.s.l. (October 6, 1931). An elevation stamp is mounted on the Princeton Bridge, which reads: “St. Croix Paper Co. 204.31 ft m.s.l.”.
1930’s	The first “boom” of private camp construction occurs on the East Branch of the St. Croix. A number are built close to the shore and lead to compliants about flood and ice damage. By the 1970s, Georgia-Pacific Corp., then owner of the dams, purchases rights from many camp owners to flow their lands to specified heights.
1934	The current Milltown dam is built as a concrete version of the former structure. The IJC issues an Order of Approval that includes a maximum headpond elevation (October 2, 1934).
1955	At the request of the U.S. and Canadian governments, the IJC initiates a 2-year investigation of the potential for further development of the water resources of the St. Croix River Basin. The IJC creates an International St. Croix River Engineering Board to conduct the study.
1957	The IJC engineering board issues its findings in a 4-volume report. The recommendations include establishing a comprehensive water resource development program to manage water storage and flows to best serve all uses; installing fishways to restore anadromous fish runs; creating water quality objectives and reducing pollution to improve lower river quality; maintaining and improving inland fishery and recreational resources; and studying the potential to redevelop the Milltown dam for additional hydropower.
1959	International Joint Commission files the above report with the federal governments
1961	The federal governments adopt the IJC report’s recommended water quality objectives for pH and dissolved oxygen in the lower river, agree that pollution abatement measures should be undertaken to meet these, and ask the IJC to look into the possible restoration of anadromous fish runs.
1962	The IJC forms a St. Croix International Advisory Board on Pollution Control to monitor pollution and investigate anadromous fisheries restoration.
1965	International Joint Commission issues an Order of Approval for a replacement Vanceboro dam and the existing Forest City dam that sets maximum and minimum headpond elevations and minimum river flows for each. The former slide gate/timber crib dam at Vanceboro is replaced with a concrete structure utilizing two tainter gates; the previous storage elevation of 15 feet is reduced to 14.37. The IJC issues a new Order in 1968 that would permit the replacement of the Forest City dam, with headpond elevation changes, however this expires when the dam is instead renovated within the terms of the 1965 Order.
1971	The Geodetic Survey of Canada finds the Grand Falls dam elevation benchmark to be in error. As a result, the IJC recognizes a revised maximum elevation of 203.76 ft m.s.l. for this dam.
1972	In response to requests from lake and river interests, the IJC directs its International St. Croix River Board of Control to investigate the feasibility of raising the minimum headpond elevation and assessing the fluctuations in river flows at the Vanceboro dam.
1974	U.S. Environmental Protection Agency incorporates a minimum river low requirement (750 cubic feet per second) into the discharge license for the Woodland mill. (June 1, 1974).
mid-1970s	Maine Dept. of Inland Fisheries & Wildlife begins to establish letter agreements with dam owners to maintain water levels on certain lakes to benefit fish reproduction, initially on West Grand (winter for togue, subsequently summer for smallmouth bass) and later on East Grand (summer for bass, winter for togue) and Spednic (summer for bass). These non-regulatory agreements are implemented on an annual basis, to the extent water conditions allow.
1977-1978	The IJC Board of Control reports on the Vanceboro dam study initiated in 1972. This results in amendment of the 1965 IJC Order to implement a rule curve of operation that allows the dam owners to operate at maximum efficient flows as long as the amount of water stored in the system is above the rule curve level. It also sets a desired minimum summer elevation for Spednic Lake and restricts flow decreases at Vanceboro and Forest City to 25% per day, except in emergencies.
1983-1984	Severe drought conditions lead Maine and New Brunswick fisheries agencies and NB’s environment department to study the impact of Spednic Lake drawdowns in these circumstances.
1990	St. Croix International Waterway Commission (SCIWC) releases a preliminary comprehensive management plan for the St. Croix International Waterway that includes policies for cooperative water resource planning, better integration of water uses for multiple benefits and transboundary water quality standards. Maine and New Brunswick adopt these policies in a final cooperative management plan in 1993, for ongoing implementation.

1990	SCIWC initiates a watershed modeling project that collects information on user and natural resource preferences, and regulatory requirements, for water basin levels and flows. It forms an inter-agency coordinating committee for the project. Environment Canada agrees to model the various inputs toward shared objectives.
1992	In response to requests from lake and river interests, the IJC directs its St. Croix River Board of Control and St. Croix International Advisory Board on Pollution Control to conduct studies toward a review of all IJC Orders of Approval for St. Croix dams.
1992-1996	The IJC St. Croix boards form a Stakeholders Group to develop potential water management scenarios and technical Working Group to model and analyze these. (The SCIWC study is incorporated into this project). The Stakeholders Group collects extensive information on user preferences within the watershed and submits 14 scenarios for modeling. Based on a 20-year model, 11 scenarios violate existing water regulations or agreements not set by the IJC and 3 scenarios cause significant hardship to either river or lake users to benefit the other. The Working Group runs a further scenario that meets existing requirements with less hardship to some users, but this fails in drought years.
1997	The IJC's St. Croix boards issue their study findings. These note that non-IJC regulations and agreements are the primary limiting factors in water management and that, barring the revision of these (outside IJC control), non-regulatory cooperation offers the best avenue for improved multiple-use management. On this basis, the boards recommend that no changes be made to the IJC's existing St. Croix Orders of Approval.
1998	The IJC accepts the St. Croix boards' recommendations and concludes its review.
2000	The IJC combines its two St. Croix boards into a single International St. Croix River Board to address both water management and quality issues within the IJC's international terms of reference.
2000-2001	Drought conditions result in low lake and river levels. Users and dam owners are sensitized to the impact of low water availability and the possible effects of climate change.
2004	Drought conditions result in low lake and river levels. User interests ask dam owners to improve water management planning to anticipate future drought conditions.
2005	The SCIWC initiates the St. Croix Water Forum to bring together water user and management interests to discuss ways to better communicate and collaborate on water issues.

Prepared by L. Sochasky (St. Croix International Waterway Commission, staff@stcroix.org) and J. Beaudoin (Domtar Industries Inc., jay.beaudoin@domtar.com). Version 2006/02/28